GENERAL METHODOLOGICAL MANUAL FOR THE PREPARATION AND EVALUATION OF SOCIAL INVESTMENT PROJECTS

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PROJECT AND INVESTMENT PROGRAMMING DIVISION

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AND EVALUATION OF SOCIAL INVESTMENT PROJECTS

Héctor Sanín Angel *

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Abstract

This document was prepared to serve as conceptual and instrumental support for the identification, preparation and evaluation of projects which seek resources from the Local Social Investment Programme - PROINSOL, the Social Investment Fund of Venezuela (FONVIS).

This General Methodological Manual is an integral part of a set of materials and constitutes the conceptual frame of reference for the sector guidelines prepared to orient the elaboration and evaluation of specific projects in those sectors served by PROINSOL. A first set contains methodologies for four sectors: Roads, Drainage, Education and Health.

As its name suggests, this General Manual discusses those basic elements which may be common to sector projects. The elements proper to each sector, such as those for diagnosis, eligibility criteria and physical-technical parameters, are developed in the corresponding sectoral guidelines. In contrast, in order to avoid the repetition of common elements, this Manual contains the general reference material not developed in the sector documents. For this reason, the general and sector guidelines should be employed together.

This document pursues two ends. The first is to provide information on the identification, preparation and evaluation of local, generally small-scale, social projects. The second objective is to provide didactic background material to be used in the training and technical aid activities designed to instruct the human resources responsible for preparing projects for PROINSOL.

In function of that objective, this document is unsophisticated, easy to use and has been written in simple language.

All observations and suggestions to improve this effort are welcome.
1. Projects, Investment Rationalisation and Management Control

1.1 What is an investment project?

Generally, we can state that:

*an investment project is a proposal for action which implies the use of a specific set of resources to achieve certain results.*

A project is conceived for the achievement of specific objectives which will generate benefits for the group of persons affected positively by the action (usually the users, or the target population of project activities). Costs, understood as the value of the resources which must be employed in project implementation, will be incurred in the pursuit of those benefits. If resources are scarce, the project must compete for them with other projects.

The difference between costs and benefits provides an idea of whether or not the investment project is viable, which is a vitally important concern in the analysis prior to the decision to execute it.

1.2 The nature of investment projects

A project may be private or public.

1.2.1 Private investment projects.

These are undertaken by entrepreneurs to satisfy their own ends. The benefits sought by private economic agents are the results of the sale value of the product (goods or services) generated by their projects. Costs arise from the value which entrepreneurs must pay for the use of those productive resources needed to install and operate their projects.

In a clothing project, for example, the benefits sought by the entrepreneur will be generated by the sale of the shirts; and the costs, from the various investment (factory, machinery) and operational (hired labour, raw materials, energy) resources employed.

The project will be of interest to the entrepreneur to the degree that the balance is in his favour, that is, insofar as the income from the sale of the shirts (benefits) is greater than the total costs paid. The
entrepreneur usually has several investment opportunities, so he will expect the capital invested in the project to yield a higher - or at least equal - return than would be obtained from another investment. For this reason, it is said that there is a "capital opportunity cost", understood as the alternative return foregone by employing the resources in the project, rather than in other investment opportunities.

1.2.2 Public investment projects.

Public investment projects are an instrument of State intervention in those areas proper to its mission and nature. Generally, the State has important functions to fulfill in the economic and social areas, either because they are not attractive to the private sector, or because the services in question are essential and cannot be delegated. These include projects to produce "public goods", such as those which safeguard national security or operate the judicial system, projects to operate natural monopolies and in sectors considered strategic by the State, or to provide infrastructure to support productive investment or social services when market prices do not guarantee a profit for private investments.

To achieve these objectives, the State promotes, develops and executes projects at its different political-administrative and territorial levels. With regard to micro-regional and local concerns, public investment projects are designed to solve community problems and satisfy social needs. Their main objective is to provide a specific service (or set of services) for a needy population and their benefits are usually expressed in terms of the target population’s real satisfaction of that need, always as long as the social opportunity cost of the resources justifies the activity.

To implement the project, the public institution must dispose of the resources which would otherwise - were the project not executed - be allocated to some other activity (or project) to satisfy other social needs. The value of the resources allocated for project installation, operation and maintenance are the project costs.

With regard to benefits, a public investment project has objectives different from those of private projects. Benefits are not necessarily measured in terms of the value returned by users to the government entity for
the services provided (although the value paid should be as close as possible to the use value). The public institution -as a representative of society's interests- should seek the highest degree of citizen satisfaction possible for each Bolivar invested in the project.

Thus, in a sewage project, the Municipal company seeks to solve the problem of a population which suffers the negative impact of the lack of that service (unpleasant odours, environmental pollution, the spread of disease). In function of this goal, benefits could be expressed in terms of the eradication or reduction of the negative impact suffered by the population prior to project implementation. All these benefits could be expressed, for example, in terms of the greater value the inhabitants assign to their dwellings in the new situation (with project), compared to the earlier situation (without project). It should be noted that, to a degree, public investment project benefits tend to be measured "outside the project", in terms of the impact they produce in a specific environment, their effect in a certain community.

This observation implies another factor which distinguishes public from private investment projects. While the private sector measures the internal profitability of its projects without considering their external effects -or without recognising their true value-, public projects involve the analysis of their overall impact on society and the economy. For this reason, their "social" benefits and costs, which do not always coincide with the interests central to private projects, must be examined.

This methodological guideline deals with public investment projects, regional and local in nature -specially small and medium scale projects-, and very especially those which may qualify for co-financing by PROINSOL.

1.3 Projects and public investment rationalisation

Public investment projects primarily seek to satisfy community needs. However, they simultaneously achieve the objective of using public funds rationally.

The well-being of the population depends on the quantity and quality of the goods and services available. Today's goods and services are the result of past investments. Greater investment today makes for
increased well-being tomorrow, with greater impact if resources are scarce. Progress is made toward this eventual objective insofar as the public budget assigns greater importance to investment than to financing current State operations. To this end, public investment projects have great potential.

When project resources are allocated to maximise benefits over costs (or achieve certain levels of social benefit at minimum cost), this means that the resources allocated to that project are being applied efficiently. Note, then, that if public resources are allocated in terms of projects, on the general basis of privileging those which will guarantee the most benefits for each Bolivar of the investment budget so allocated, the result must be increased overall efficiency in the use of government resources.

There is usually a positive correlation between investment and economic growth: greater investment, greater growth. This correlation should also obtain for public investment: investment profitability stimulates growth, so that it should figure as an element in growth models. Therefore, if projects become an effective means of effecting public investment and, moreover, that investment is channelled thorough the most efficient projects, the whole process should constitute a positive contribution to overall growth.

These observations highlight the importance of establishing a "System of Public Investment" to co-ordinate the activities of diverse institutions, inducing change in resource allocation criteria and, given finance limitations, making it possible to define project priorities, at least at the sector level.

Thus, it is important to "projectise" public investment budgets, in the sense of incorporating project evaluation techniques into the processes of budget formulation. The traditional modality of institutional resource allocation on the basis of global, undefined or open-ended programme budget items, must be gradually abandoned. To the contrary, resources should be authorised in response to investment requests based on ever more specific, detailed and evaluated projects.

Budget priorities, financing procedures and follow-up on resource use must also ensure that those investments yield benefits and that projects are fully implemented, as a requisite for their real contribution to economic growth and social well-being: investment initiated which ends; installations terminated which operate; operations begun which ensure their implementation; maintenance and replacement over time.
1.4  A project’s repertory of objectives

Parallel to the decisive role public projects play as an instrument for rationalising investment, an additional spectrum of important objectives should be noted:

1.4.1  The project as a means to solve problems

In fact, this is the reason to be of a public investment project, specially small and medium scale projects implemented at the local and micro-regional levels. Their basic objective is to serve populations affected by specific problems or to eliminate present deficits of certain services.

1.4.2  The project as a mechanism for resource concertation and management

*  It favours coherence in the programming and execution of public administration budgets at their diverse investment levels and acts as an instrument for the complementary use of multi-institutional resources.

*  It encourages the convergence of public, private and community resources on the solution of local problems.

1.4.3  A mechanism for interinstitutional co-operation

Interdependence of project flows requires the creation of spaces for interinstitutional concertation and co-ordination among State sector entities and territorial organisms for the identification and implementation of projects of common interest. Within national organisms, bilateral communication between the central office and the regional or section units should also be efficient.

1.4.4  A management control mechanism

Projects guide decision-making, planning and budget processes in the fulfilment of institutional missions. They reveal the need to establish follow-up and evaluation systems, in order to:

*  generate timely reports on expenditures and funds use;
*  review the achievement of project execution objectives;
*  facilitate corrective action during the preparation and execution phases, and
* verify the project’s social efficacy, as a solution to the problem which gave rise to the project, as well as in terms of its overall impact.

1.5 Public investment project categories

Public investment projects can be classified in diverse categories, according to type of product or benefit generated:

1.5.1 Productive projects

We include here projects for the installation of input transformation capacity for the production of goods to satisfy consumer needs.

Examples: farm production, mining or industrial projects.

It should be noted that, in light of the modern tendency to pursue efficiency in government interventions, de-bureaucratisation and decongestion in public administration and the transfer of productive activities to the private sector, this type of project is disappearing within State organisms. However, they may still retain a degree of legitimacy in terms of governmental objectives to promote and support diverse modalities for the organisation of private sector and community initiative.

1.5.2 Infrastructure projects

This category covers projects designed basically to generate conditions to facilitate, induce or stimulate economic development. For this reason, they may be called, more specifically, "economic infrastructure projects".

The results of this type of project serve as an instrument or lever, such that the users will be able to engage in productive activities to improve their income levels and, consequently, generate other economic and social effects in other agents and population groups.

Examples: Road works, electrification, irrigation.
1.5.3 Social projects
These are also called "social benefits (or infrastructure) projects". As their name suggests, these are mainly geared to satisfy social needs in a target community through the immediate use of the services produced.

Examples: health projects, basic sanitation, education, recreation.

1.5.4 Programme-projects and basic studies
These projects have the central objective of supporting the types of project described above. They are designed to achieve specific goals in a defined period of time. Therefore, they do not consist in the implementation of installed capacity for subsequent operation in the generation of products which will yield direct benefits.

* The so-called “programme-projects” perform the function of strengthening or restoring the capacity of other projects to generate direct benefits.

Examples: literacy campaigns, vaccinations, citizenry education campaigns.

* So-called “basic studies” projects do not generate direct benefits but do make it possible to identify future projects. These include research projects.

The consideration of projects according to these typologies makes their differentiated analytical treatment possible, specially in the identification of benefits, the distinction between investment and operation phases, and the application of evaluation methodologies.

1.6 Public investment projects in a process of decentralisation and participation
Parallel to their contribution to economic efficiency, public investment projects should perform an energising function in institutional relationships: a) among the diverse government organisms which participate in the project cycle; and b) between public institutions and the community.
It is important to note three spheres of the policy-institutional framework which condition those relationships: participation, articulation and decentralisation.

1.6.1 Participation

If projects exist to solve community problems, it is only natural that the communities themselves participate in the diverse phases of project development, beginning with problem identification. If this is not permitted, the project is denatured and solutions may be imposed, with inappropriate technologies, inadequate standards, or which may not respect certain cultural norms.

Together with making problem solutions more viable, community participation in the execution of local projects implies an important degree of citizen self-formation and brings about attitude changes in the State-society relationship, insofar as government interventions abandon paternalistic models and the community becomes ever less dependent and more a protagonist in the construction of its own development.

1.6.2 Decentralisation

The State is more effective in the face of social need when the capacity to generate solutions emerges closer to the source of the problems. This is of the essence of a decentralisation process, as it also is of public investment projects. Thus, this type of project and decentralisation go hand in hand:

* As the decentralisation process moves ahead, the action scenario for the development of regional, state and local projects becomes more realistic.

* As projects achieve their objectives, they may stimulate further decentralising measures and actions.

The project-decentralisation dynamic should activate an irreversible process in which the increasing delegation of competencies receives corresponding support in the form of resources and institutional capacity to exercise that delegation.
1.6.3 Institutional articulation

The public investment project cycle occurs within a context of multi-level (national, regional, state, municipal) institutional interdependence. Procedures must be efficient and institutional systems must be duly articulated and co-ordinated so that projects will be expeditiously prepared and evaluated, will receive adequate and timely funding, and be executed without delays and in co-ordination with support activities and other complementary actions.

Projects are generated on the basis of frequently shared interinstitutional decisions, co-financing with resources from diverse levels, complementary actions, and co-operative efforts. These demands become more evident as the decentralisation process advances. In this sense, the degree of interinstitutional project fluidity is an accurate measure of the degree of articulation found in a given system of public administration.
2. The project life cycle

The project cycle begins with a problem to be solved. Generally, investment projects pass through four major phases: Preinvestment, Investment, Operation and Evaluation of Results.

These phases can, in turn, be broken down into sub-phases (which we will call stages), all or some of which may be found in a given project, depending on certain factors: its nature, complexity, investment amount and the norms established by finance organisms.

2.1 Pre-investment

This is the process of the elaboration and evaluation of the project to be executed to solve the problem or address the need which gave rise to the project. Pre-investment is broken down into the following stages:

IDEA: in this stage, the problem or need is identified, together with the basic alternatives for solving that problem.

PROFILE: in this stage, the alternatives are evaluated on the basis of technical information and non-viable options are discarded. The project becomes more specific and is described in terms of the alternative chosen. Generally, the information on which the profile is elaborated comes from secondary sources.

PRE-FEASIBILITY: in this stage, the alternatives found to be viable are evaluated in greater depth and the relative worth of each is determined.

FEASIBILITY: in this stage, the recommended alternative is perfected, generally on the basis of data specially collected for that purpose.
DESIGN: once project execution has been approved, the definitive project design is elaborated. Preliminary designs may have been elaborated in the previous stages, but the execution of definitive designs and detailed engineering—especially for more complex projects and those which entail larger investments—is only justified once the viability and favourable financing decisions have been made.

This process is repetitive and all projects do not necessarily pass through each step (see box below).¹

Pre-investment facilitates the evaluation-decision making process geared to verify the project’s relevance, viability and worth, before the requested resources are allocated. At least three aspects, among others, should be verified:

* whether the project is a good solution to the problem identified;

* whether the alternative selected is more convenient than those rejected and that a better alternative is not available, and

* whether the project entails efficient technical standards and investment return indicators in comparison to similar projects.

Generally, different protagonists (persons, entities) intervene in project realisation and each will want the project to reasonably respond to their interests and institutional objectives, which do not always coincide. They will view the project from their own perspective and in terms of their own convenience and, therefore, may apply their own appraisal criteria.

Thus, for example, the promoter, designer, executor, financial entity, planning entity, local executive, Municipal Council, community and users constitute, together, a set of agents directly or indirectly involved in the development of the project. Their opinions and criteria must be kept in mind for the timely

¹ A basic principle for the allocation of resources to improve relevant information, which must be kept in mind during the stages of project development, is the following: "if the cost of obtaining additional information needed to pass from one stage to another (from profile to prefeasibility, for example) is greater than the benefits produced by that action, the decision to accept or reject a project should be able to be taken without passing to the next stage".
detection of eventual congruencies and divergences in order to avoid inappropriate decision-making or ultimate failures.

In any case, the group responsible for project elaboration, while being open to the opinions and suggestions of external agents (direct and indirect evaluators), must also be permanently alert so that, during design and evaluation, the project does not suffer metamorphosis -as frequently occurs- which deviates it from the central objectives framed in function of the definition of the original problem.

The evaluation process may lead to changes in the project as originally elaborated; it may be postponed; it may be integrated or fused with another project with complementary objectives; authorisation may be denied as inconvenient or unjustified; or it may be approved with no change.

The first two stages -idea and profile- constitute the central concern of this methodological guideline.

2.2 Investment

This includes all actions involved in project realisation.

EXECUTION: the project is executed in this stage.

A series of activities for the preparation of implementation must be kept in mind, such as the following:

a) Review and up-dating of the Project-Document (specially when considerable time has passed between project identification and the final decision, given that the circumstances may have changed).

b) Up-dating and detailed calendars for Project execution.

c) Negotiation of credit and resources for the project, so as to ensure that they are secured in the most favourable conditions and are available in timely fashion for project execution.
d) Institutional and administrative organisation for the Project and definition of implementation responsibilities (direct execution, under contract or with community participation).

e) Management of human resources (recruiting, selection, hiring, training) and of materials (licitations, contracts and acquisitions).

Implementation (or installation) involves the set of activities necessary to equip the project with productive capacity. Physical investments are made in this stage and terminate when a unit is handed over, ready to begin the generation of the goods or services through which the project will achieve its objectives.

Thus, for example, the implementation phase of a drinking water project consists in the technical installation of the entire system (intake, plant, distribution network) and the organisation of an administrative unit capable of initiating and sustaining Project operation.

The implementation stage requires a managerial system capable of:

a) project realisation within the programmed time frame.
b) activity completion within the pre-established cost limitations.
c) activities execution according to the established technical specifications.

The implementation stage ends with the "start-up", that is, when the installed capacity has been tested and the necessary adjustments have been made, which ensure that the project has achieved full operational capacity.

2.3 Operation

Once installed, the project begins operations. In this stage, also called the production or operational stage, the project becomes an objective reality, that is, the productive unit installed begins to generate the product (goods or service) in fulfillment of the specific objective formulated for the solution of the problem or the satisfaction of the need out of which the project originated.
The project is a transformation unit in permanent operation, as long as the need to which it responds still exists. The project is "institutionalised" by the creation of an organisation responsible for its operation over time, or the assignment of that responsibility to an already existing entity.

Compared with the implementation stage, operation requires a different managerial system. It is not concerned with non-routine activities in a race against time, but rather with the administration of a system which receives and transforms inputs and delivers products, in a repetitive process of on-going activity.

As this phase progresses, management should be alert so as to introduce modifications and improvements to increase the efficiency of the system. However, other situations will also appear over time:

a) the need to expand the system to cover new users, and
b) the deterioration and obsolescence of the installations and equipment imply the need for repair and replacement.

Does the project cycle end here?
The answer to this question is: No!

2.4 Evaluation of results

If the project is an action-response to the problem, after a reasonable time of operation, it will be necessary to verify whether the problem has been solved by the project intervention. If not, the pertinent corrective measures must be introduced. Moreover, project design may cause other effects, so that it will be necessary to determine if those effects have occurred in the desired direction and intensity and what type of new reality has emerged as a consequence of the project.

Projects often experience metamorphosis, changes and adjustments in the prior phases, which involve additions or modifications of their objectives to the extent that the original objective is blurred or distorted so that, given that the proposed objective arose out of a need, it will be pertinent to ask: To what extent has the project, during its operational life, really contributed to the satisfaction of the original need?
General Methodological Manual for the Preparation and evaluation of Social Investment Projects

The context also evolves and, over time, the conditions exogenous to the project may modify the characteristics of the problem or the type and level of the original need.

The (ex-post) evaluation of results goes beyond managerial oversight of the investment and operational phases to ask whether the presence and social use of the product is really contributing to produce results in the ambience of its execution, as an effective solution to the original problem, and to verify the satisfaction of the need identified and the derivative effects attributable to the project.

The evaluation of results "closes the circle", by asking about the effects of the last stage, in function of what began the process: the problem.

The evaluation of results has at least two important objectives:

* Evaluate the real impact of the project now operation, so as to be able to suggest pertinent corrective actions.

* Assimilate the experience, so as enrich levels of knowledge and the capacity to act, thus improving future projects.
Figura 2: Stages in the Life Cycle of Projects

- Problem
  - Idea
    - Profile
      - Prefeasibility
        - Feasibility
          - Design
            - Execution
              - Operation
                - Evaluation of Results
  - Rejected Execution
  - Rejected Execution
  - Rejected Execution
  - Rejected
3. Identification

Public investment projects are means of action to solve specific community problems which must be adequately identified and which imply resource allocation. The emergence of a problem or the perception of a social need requires a solution. Thus, the overflowing of the river which runs through a city, a high illiteracy rate or dirty streets are problems which must be solved. They constitute signs which must be adequately perceived, in timely fashion, by Municipal authorities for their detailed analysis and the search for alternatives coherent with the means available.

This means that we must become familiar with the use of analytical and problem-solving methods, which are discussed in this chapter.

3.1 How to identify and solve problems

First step: Identify the problem
When statements such as: "let's build a dike", "let's build schools", or "let's buy more garbage trucks" are the starting point for project execution, things usually end badly, because the problem to which the actions proposed ought to respond remains unknown. That way of proceeding creates the possibility of making investments which do not respond to specific social needs, with the attendant danger of mis-spending the resources allocated.

We cannot arrive at a satisfactory solution to a problem if we do not first make a reasonable effort to understand that problem. The starting point to problem solving is to adequately identify the problem.

Problems are usually evident in their external expressions or manifestations, in how they affect the community. A problem is a situation which involves inconvenience, frustration or a negative fact. It may be summarised as the lack of something good, or the existence of something bad.
The following are three initial expressions or identifications of problems:

* A neighbourhood flooded by a river.
* Illiteracy in a segment of the population.
* A Municipality’s dirty streets.

The problem must not be defined as the lack of a specific solution, because the lack of a solution is the lack of an alternative and that lack can only be supplied by that alternative. Such an analytical procedure is incorrect, because it limits the creative search for other possible solutions. Example: if the loss of a harvest is defined as a problem of “the lack of pesticides”, the solution suggested will be to supply pesticides. Thus, other possible and important alternatives, such as biological control or pest prevention, will not emerge. In this case, a better definition of the problem may be “harvest loss due to pests”.

Each problem-situation identified needs to be solved. However, it is first necessary to understand the problem better, in order to facilitate the proposal of adequate solutions. Understanding the problem has at least two parts:

1. Understanding its importance, its impact, the danger it represents, that is, its effects. This leads us to verify whether or not “it is worthwhile to solve” the problem.

2. Understanding the reason for the problem, to what it owes its existence, the causes which generate it. This understanding is the basis for the search for solutions.

3.2 Analysis and understanding the problem

Second step: Examine the effects of the problem

Given scarce resources, the public administrator must form a preliminary opinion that the problem merits resource allocation for its solution, whether in his or another area of competence. To understand the scope of the problem, he may examine its repercussions by exploring its effects. Those effects may be of two types: those already actually perceived and those which pose a threat or danger if the problem is not managed in timely fashion. Both types should be included.
Figura 3: Effects Tree

SOCIOECONOMIC UNDERDEVELOPMENT

SOCIAL STAGNATION AND IMMOBILITY

LOW INCOME LEVELS

LIMITATIONS ON LOCAL ECONOMIC PRODUCTIVE POTENTIAL

INCAPACITY FOR PAID EMPLOYMENT

SOCIO-CULTURAL UNDERDEVELOPMENT

LOSS OF INDIVIDUAL SELF-ESTEEM

CULTURAL INACTIVITY

LOSS OF IDENTITY AND VALUES

INCAPACITY TO INTERPRET EXPRESS AND COMMUNICATE

HIGH RATE OF ILLITERACY IN THE MUNICIPALITY
The **EFFECTS TREE** is a simple and effective instrument for identifying the problem's chain of repercussions. It consists in graphically noting upwards the effects identified as stemming from the problem. To draw the tree, the following instructions should be followed:

1. At the first level, place the direct or immediate effects of the problem. Each effect arises from the problem, as indicated by an arrow from the problem toward each immediate effect.

2. For each "first level" effect, ask if there are one or several significant ulterior effects which may derive from it. Place these on a second level, indicating them with upward arrows from the first level effect which operates as its cause. If one first level effect concurs with another as a cause, indicate that interdependence with an arrow.

3. Proceed successively to other levels, arriving at a level considered highest within the geographic or institutional ambience in which we have competence or it is possible for us to act.

**Example:**  
**Expression of the problem:** HIGH ILLITERACY RATE IN THE MUNICIPALITY.

It is clear that the problem transcends the Municipal context and that it is worth the effort and resources to solve it.

**Third step: Identify possible causes of the problem**

The possible causes of the main problem are noted from below. The causes of the causes are noted successively, creating a linked tree.

At first, creativity should be given free rein. An adequate definition of the problem, with its chains of causes examined without initial restrictions, will increase the probability of arriving at successful solutions. In our example, the causes have been identified as follows:
The Cause-Effects Tree
joining the "effects tree" to the "causes tree" creates the "Cause-Effects Tree":

3.3 Objectives

Fourth step: Define solution objectives
The situation which it is hoped the solution to the problem will produce can be expressed as the reverse manifestation of the problem itself. If the problem was a lack, the solution will be a sufficiency. It is as though the causes and effects tree were a film "negative" and its reverse manifestation is the "positive" print, that is, the "Objectives Tree".

The Objectives Tree
As the problem tree was a bottom-up linked sequence of causes-effects, the Objectives Tree will be an interdependent flow of means-ends.

Once the logic and accuracy of the objectives tree has been verified, adequate references will then be available for the determination and planning of alternatives to solve the problem. The "basic means" go
on the lowest level: they are the "roots" of the tree and the alternatives should be based on them. Subsequent analysis asks: What are the strategies or actions suggested by the lowest levels of the objectives tree?

3.4 The search for solutions

Fifth step: Formulate actions to solve the problem

For each base of the objectives tree (basic means), an action to employ them effectively should be sought creatively. In the example, the suggested actions are:
3.5 Presentation of alternatives

Sixth step: Configure viable and pertinent alternatives

The proposed actions should be examined from various angles:

1. Analyse their incidence in the solution of the problem. Assign priority to those which will probably have the greatest incidence.
2. Verify the degree of interdependence among the proposed actions and group those which are complementary. Each grouping of complementary actions may constitute an alternative.

3. Verify the feasibility of each alternative (physical, technical, budgetary, institutional, cultural).

In the example, two alternatives have been configured:

ALTERNATIVE A: Integration of components 1 and 3.

New classrooms to attend the unsatisfied demand of the school population, complemented by a programme of adult literacy workshops.
ALTERNATIVE B: Integration of components 2 and 3.

More efficient use of capacity already installed by a longer school day, complemented by a programme of adult literacy workshops. This alternative assumes that the current number of classrooms is adequate and that the problem consists in the inadequate use of that capacity.

In practise, the alternatives are considered to be mutually exclusive: either A or B will be implemented. In the example, the actions of 1 and 2 are treated as mutually exclusive in terms of the objective of school literacy. Action 3 is the only strategy proposed for the objective of adult literacy and, therefore, can be a component in both alternatives.

If the verification of impact reveals that two strategies proposed as alternatives are not exclusive, they will probably reinforce each other in the achievement of the objective. And, if both contribute significantly to the achievement of the expected result, they should be put forward as complementary components of the proposed alternative.

It should be kept in mind that the analysis process is repetitive or generates feedback; doors are never closed, it is always possible to incorporate new alternatives or integrate several which may be considered complementary components of the solution.

The result of this "identification" stage is knowledge of a problem and the presentation of a set of alternatives deemed feasible to solve the problem identified.

THE RESULT OF THIS "IDENTIFICATION" STAGE IS UNDERSTANDING OF A PROBLEM AND THE PRESENTATION OF A SET OF ALTERNATIVES DEEMED FEASIBLE TO SOLVE THAT PROBLEM.

The alternatives generated should be analysed in function of the geographic and socioecononomic area to which they relate in order to make the project more specific and continue to verify their feasibility and pertinence as adequate solutions of the problem. They will then receive rudimentary development and be evaluated in comparative terms for the selection of that which will best solve the problem and guarantee the most efficient use of the resources allocated. The following sections deal with this concern.
4. **Determination of needs and target population**

4.1 **Purpose of population and demand analysis**

Once a problem has been identified or a social need identified, it is necessary to deepen its analysis so as to acquire adequate knowledge of the population associated with that need and determine the type and quantity of product (goods or services) required to satisfy the need.

TARGET POPULATION refers to the number of potential beneficiaries (persons, families, businesses) identified with the need which gave rise to the project and whom the project will be able to attend.

The purpose of demand analysis is, then, to characterise and quantify the current “needy population”, define it in geographic terms, estimate its evolution for the coming years and define the quality and quantity of goods and services needed to attend it.

4.2 **Characterisation, delimitation, quantification and projection of the target population**

In the analysis process to determine social demand, it is possible to identify three types of population, from larger to smaller:

1. **REFERENCE POPULATION**: This is the total population, taken as a frame of reference, for comparison and demand analysis.

2. **AFFECTED POPULATION**: This is the segment of the reference population which requires the project services to satisfy the need identified. It is also called the needy population.

3. **TARGET POPULATION**: This is that part of the affected population to which the project can really respond, once its criteria and restrictions have been examined.

Naturally, the ideal is that the target population will be identical to the affected population, that is, that the project will effectively respond to the entire needy population. However, due to technological, financial, cultural and institutional restrictions, demand usually exceeds the capacity to respond, so that
it will often be necessary to apply feasibility criteria and define priorities to focus attention on that percentage of the needy population allowed for by resource limitations (for example, determine the population strata which suffer most from the problem or are at greatest risk). The percentage unattended by the project is the POSTPONED TARGET POPULATION, with respect to which the authorities should be alert so as to respond to their needs with subsequent plans as soon as resources are available, or by some other action. It is important to not forget this segment: keep it within the focus of the search for solutions. The TARGET POPULATION is the GOAL of the project and serves as the basis for dimensioning it.

EXAMPLE OF POPULATION TYPES

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>REFERENCE POPULATION</th>
<th>AFFECTED POPULATION</th>
<th>TARGET POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LACK OF DRINKING WATER</td>
<td>Total municipal population.</td>
<td>Population lacking service (25% of the total population).</td>
<td>70% of the affected population.</td>
</tr>
<tr>
<td>CONTAMINATION BY SEWAGE</td>
<td>Total dwellings in the urban municipal zone.</td>
<td>Number of dwellings lacking sewer connections.</td>
<td>Western Zone of the city: 40% of dwellings without connections.</td>
</tr>
<tr>
<td>ILLITERACY</td>
<td>Number of inhabitants over 6 years old.</td>
<td>Number of illiterates over 6 years old.</td>
<td>a) Total illiterates between 6 and 20 years old.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b) 50% of illiterates over 20 years old.</td>
</tr>
</tbody>
</table>
It is necessary to delimit the affected population adequately:

a. **in terms of its diverse characteristics:** specially those relevant for dealing with the problem, such as socioeconomic and cultural traits, age groups, and degree of impact by the problem;\(^2\)

b. **in geographical terms:** problem area and related influence areas;

c. **in temporal terms:** current size of the affected population and estimate of its growth in the coming years.

### 4.3 Methods of population estimation and projection

We will review here several simple and useful methods for estimating current population and projecting its growth.

a. **Available up-dated information:**

This information may be taken directly from studies performed during the last year: population censuses or special studies elaborated by reliable entities. However, this will be an exceptional situation, because population censuses are taken at relatively long intervals (normally every ten years) and, apart from censuses, specific studies within Municipal territories are the exception.\(^3\)

Census publications usually contain aggregated data: total Municipal population, broken down by sex and urban and rural zones. For the population of a smaller area (for example, a number of neighborhoods

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\(^2\) Examples of population stratification for the demand analysis: socioeconomic classification (to fix prices); age group structures (for recreational projects); educational levels (for cultural projects); classification by sex (for health, home safety or women's participation projects).

\(^3\) For data broken down at very small territorial levels, it is important to bear in mind that CELADE has developed the "REDATAM" Plus programme (Computer Recovery of Census Data for Small Areas). Data can be broken down to the level of city blocks. In Venezuela, this programme is available in the Central Office of Statistical Information.
which constitute a "commune", "district", or "parish", as the case may be), it will be necessary to consult national or state institutions, specifying (on maps) the zone in question.

b. **Estimate on the basis of assumed rate of growth.**

Example: It is necessary to know the municipal population for 1994. The last census, taken in 1990, numbered a population of 69,275 persons. The annual growth rate is estimated to be 4%.

Population growth is assumed to be "geometric", calculated by the following formula:

\[
Pt = Po \times (1 + r)^t
\]

- \(Pt\) = Population in year "t", to be estimated.
- \(Po\) = Population in "base" year (known).
- \(r\) = Annual growth rate.
- \(t\) = Number of years between "base year" (zero year) and year "t".

In our example:

- \(Po. = 69,275\) (1990 population).
- \(r = 4\% = 0.04\) = assumed rate.
- \(t = 4\) years (1994 - 1990 = 4).

\(Pt\) = population estimated for 1994.

Introducing these data into the formula:

Usually, the last intercensus rate is assumed to be the growth rate, that is, the rate calculated on the basis
\[
Pt. = 69,275 \times (1 + 0.04)^4 = 69,275 \times (1.04)^4 = 69,275 \times (1.17) = 81,052
\]

of the target population's growth between the last two censuses.

c. **Field research.**

Although the calculation of the intercensus growth rate is commonly employed, because it is simple and inexpensive to use, there may be cases in which it is difficult to apply or will generate unreliable results, for several reasons:

* The last census was taken many years ago and there is evidence that recent trends (growth rate) are different from the last intercensus rate.

* There is serious doubt with regard to the reliability of the last census(es). (Census-taking is a complex, difficult task and, for diverse reasons, does not always successfully number the population).

* It is necessary to number a small population segment (a neighbourhood or number of neighbourhoods) about which detailed data or any statistics at all are unavailable.

In those cases, the FIELD RESEARCH METHOD can be applied, which involves numbering dwellings and taking samples. Execution is simple, inexpensive and yields sufficiently reliable results.

Summary of the steps to be taken:

1) Define the spatial zone for the population study (entire urban area or a certain zone within the city).
2) Study available maps. Selection of the most recent, highest quality and appropriately scaled maps.

3) Cartographic up-dating. Field verification and inclusion of observed novelties: recent developments, name changes, etc.

4) Divide maps into sectors and number areas. Divide into contiguous city block groupings for field work.

5) Numeration. For each block, number and list the "structures" used independently: houses, apartments, businesses, noting residences specially. This numbering will yield a census or "count" of the dwellings, that is, the number of dwellings in the research area will be known.

6) Sample design and selection. The concept "dwelling" provides the sample universe or framework. According to the statistical method (if necessary, consult a sample design technician), the relative size of the sample is defined. A sample of 1/10 means that one of every 10 dwellings will be selected. That selection must be random (by lot, chance). The dwellings chosen for sample survey application are identified.

7) Sample survey. All the dwellings chosen for the sample are visited and the questionnaire designed for that purpose is applied. The questionnaire must be simple and straightforward. It may only be necessary to ask for the number of persons who reside in the dwelling. Bear in mind that each additional question makes the operation more difficult. For this reason, only those questions which are strictly necessary for achieving the central objectives of the research should be included.
8) Statistical critique and processing. Verify, in different ways, that the information gathered is valid and calculate the population, as follows:

\[ IHP = V \times \left( \frac{P}{H^m} \right) \]

\( IHP \) = Individual Home Population.

\( H \) = Total Homes numbered.

\( P \) = Average number of persons per dwelling in the sample.

The Collective Housing Population (CHP) (hospitals, homes for the elderly, convents, jails, hotels, orphanages, camp grounds, etc.) is added to the Individual Home Population. Data on the population usually found in these establishments is gathered directly by interviews of their directors.

The sum of those two populations yields the TOTAL POPULATION (TP):

\[ TP = IHP + CHP \]

**EXAMPLE:**

The Population Study for a certain locality produced the following data.

* The numbering of dwellings (step 5) yielded a total of 4,850 individual dwellings.

* A sample size of 10%, that is of 485 dwellings, was chosen (step 6).

* The sum of the persons who reside in those 485 dwellings was 3,056 (step 7).

* A population of 268 persons was recorded in the Collective Housing.
What is the population of that locality?

The sample yields:

\[ P = 3.056 \text{ persons} = 6.3 \text{ persons per dwelling} \]
\[ H = 485 \text{ dwelling} \]

The Individual Home Population is:

\[ \text{IHP} = 4,850 \text{ dwellings} \times 6.3 \text{ persons} \]
\[  \text{dwellings} \]

\[ \text{IHP} = 30,555 \text{ persons}. \]

The Collective Housing Population is:

\[ \text{CHP} = 268 \]

Therefore, the Total Population is:

\[ \text{TP} = 30,555 + 268 = 30,823 \text{ persons}. \]

It is important to realise that field work should be performed by properly selected, trained and supervised personnel, to avoid errors in the survey. Work with the community, which motivates people and makes them participants in the process, also makes the task of numbering and interviewing easier and helps generate more reliable data.

4.4 Estimating the deficit

The need identified in the target population must be satisfied by the delivery of the goods or services produced by the project. The quantification of that need yields a DEFICIT, determined by the difference between current SUPPLY and the DEMAND for the product which will satisfy that need:
State supplied services are usually not delivered in competition with other institutions; in these cases, current supply is understood to be the current level of use of public installed capacity.

When there is no supply, the deficit is equal to the total demand estimated.

Once the type of product (goods or service) needed to satisfy the target population has been defined, it is necessary to estimate the quantity required.

Here, we will examine the two most commonly used methods to estimate and project the deficit (or specific demand) for the project.

a) On the basis of consumption standards

Many projects are associated with an identifiable target population, so that demand can be translated into "per capita consumption units". If we know the total demand population (to be attended by the project) and an acceptable coefficient of per capita (or family) consumption, it is easy to quantify the global volume of product required for the project. The deficit is determined by the difference between supply and demand.

The urban Municipal population is 35,000 persons in 1992. The installed capacity produces a daily average production of 5,000 cubic metres/day of water and is inadequate to attend the current population, which
is revealed by the following figures. It is necessary to estimate unsatisfied demand for the next 20 years, on the standard basis of 180 litres/day per capita consumption for the next 10 years, when it will increase to 200. The approximate annual growth rate of the population is 3.2%, but it is estimated that it will fall to 2.8% in 10 years. With the available information, we can construct the following table:

PROJECTION OF DRINKING WATER DEFICIT

<table>
<thead>
<tr>
<th>YEAR</th>
<th>URBAN POPULATION</th>
<th>DEMAND M3/DAY</th>
<th>SUPPLY M3/DAY</th>
<th>DEFICIT M3/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>35200</td>
<td>6336</td>
<td>5000</td>
<td>1336</td>
</tr>
<tr>
<td>1993</td>
<td>36326</td>
<td>6539</td>
<td>5000</td>
<td>1539</td>
</tr>
<tr>
<td>1994</td>
<td>37489</td>
<td>6748</td>
<td>5000</td>
<td>1748</td>
</tr>
<tr>
<td>1995</td>
<td>38688</td>
<td>6964</td>
<td>5000</td>
<td>1964</td>
</tr>
<tr>
<td>1996</td>
<td>39927</td>
<td>7187</td>
<td>5000</td>
<td>2187</td>
</tr>
<tr>
<td>1997</td>
<td>41204</td>
<td>7417</td>
<td>5000</td>
<td>2417</td>
</tr>
<tr>
<td>1998</td>
<td>42523</td>
<td>7654</td>
<td>5000</td>
<td>2654</td>
</tr>
<tr>
<td>1999</td>
<td>43883</td>
<td>7899</td>
<td>5000</td>
<td>2899</td>
</tr>
<tr>
<td>2000</td>
<td>45288</td>
<td>8152</td>
<td>5000</td>
<td>3152</td>
</tr>
<tr>
<td>2001</td>
<td>46737</td>
<td>8413</td>
<td>5000</td>
<td>3413</td>
</tr>
<tr>
<td>2002</td>
<td>48232</td>
<td>8682</td>
<td>5000</td>
<td>3682</td>
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<td>2003</td>
<td>49583</td>
<td>9917</td>
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<td>4917</td>
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<td>2004</td>
<td>50971</td>
<td>10194</td>
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<td>5194</td>
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<td>2005</td>
<td>52399</td>
<td>10480</td>
<td>5000</td>
<td>5480</td>
</tr>
<tr>
<td>2006</td>
<td>53866</td>
<td>53866</td>
<td>5000</td>
<td>5773</td>
</tr>
<tr>
<td>2007</td>
<td>55374</td>
<td>55374</td>
<td>5000</td>
<td>6075</td>
</tr>
<tr>
<td>2008</td>
<td>56924</td>
<td>56924</td>
<td>5000</td>
<td>6385</td>
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<td>2009</td>
<td>58518</td>
<td>58518</td>
<td>5000</td>
<td>6704</td>
</tr>
<tr>
<td>2010</td>
<td>60157</td>
<td>60157</td>
<td>5000</td>
<td>7031</td>
</tr>
<tr>
<td>2011</td>
<td>61841</td>
<td>61841</td>
<td>5000</td>
<td>7368</td>
</tr>
<tr>
<td>2012</td>
<td>63573</td>
<td>63572</td>
<td>5000</td>
<td>7715</td>
</tr>
</tbody>
</table>
(1) = POPULATION grows 3.2% during the first 10 years and 2.8%, the last 10 years.

(2) = (1) * (180 litres/day)/1000 m3, until the year 2002 = (1) * (200 litres/day)/1000 m3, from the year 2002 to 2012

(3) = SUPPLY: With no increase in capacity, it will remain 5000 cubic metres/day

(4) = DEMAND minus SUPPLY = (2) - (3)

b) Projections based on historical consumption records.

Projections can also be made on the basis of an historical data series, without it being necessary to have recourse to the target population as the calculation base.⁴

This method consists in determining the usage trend during previous years and projecting expected use for the coming years, maintaining that trend. The visual representation of consumption in recent years makes it possible to visualise that trend and to estimate the line which best interprets the behaviour of the variable in question. Estimated consumption for the coming years is determined by the graphic continuation of that line.

Example: Series of livestock butchered(*)

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⁴ Or employ both methods to check and validate the information received.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>MAJOR LIVESTOCK</th>
<th>MINOR LIVESTOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(beef) (N° of head)</td>
<td>(pork) (N° of head)</td>
</tr>
<tr>
<td>1986</td>
<td>8.658</td>
<td>5.274</td>
</tr>
<tr>
<td>1987</td>
<td>9.492</td>
<td>5.686</td>
</tr>
<tr>
<td>1988</td>
<td>10.268</td>
<td>5.890</td>
</tr>
<tr>
<td>1989</td>
<td>10.974</td>
<td>5.996</td>
</tr>
<tr>
<td>1990</td>
<td>11.068</td>
<td>6.095</td>
</tr>
<tr>
<td>1991</td>
<td>11.670</td>
<td>6.389</td>
</tr>
<tr>
<td>1992</td>
<td>12.446</td>
<td>6.382</td>
</tr>
</tbody>
</table>

(*) Source: Public Municipal Companies

Current installations are obsolete and the slaughterhouse must be replaced completely. Estimates of major livestock butchering volumes for the next 10 years should be determined.\(^5\)

A good estimate method is lineal adjustment, by which we seek the straight line which best represents the series trend.

The procedure for the series projection involves two steps:

First step: Find the straight line best adjusted to the trend in the data.

Second step: The continuation of that straight line provides the values expected for the coming years (projection).

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\(^5\) The use life of the new slaughterhouse should be projected for 20 years; however, to simplify the example, we will work with only 10 years. The projection of minor livestock is left to the reader, as an exercise.
See the graphic solution of the series and the future estimate in the following graphic representation.
The solution produced by the application of a statistical model is presented in the Appendix.

It must be understood that this demand projection method is not applicable when consumption is already limited, precisely because demand has surpassed installed capacity and, in that case, projections would be inaccurate (underestimated) because unattended demand is greater than known consumption.

c) The need to confront information

It is worthwhile to complement quantitative methods with other data sources and analytic instruments. Thus, the confrontation with records of the electoral population, or with censuses of the student population of the locality, among others, will serve as reference data which will facilitate the verification of the results generated by specific methods and may help determine a more reliable estimate of demand, thus facilitating the introduction of the adjustments deemed pertinent. Obviously, mechanisms of direct consultation of current and potential users provide necessary information.

4.5 Appendix

Application of a regression method to adjust and project a consumption series
Series of livestock butchered (*)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MAJOR LIVESTOCK (beef) (N° of head)</th>
<th>MINOR LIVESTOCK (pork) (N° of head)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>8.658</td>
<td>5.274</td>
</tr>
<tr>
<td>1987</td>
<td>9.492</td>
<td>5.686</td>
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<td>10.974</td>
<td>5.996</td>
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<td>1990</td>
<td>11.068</td>
<td>6.095</td>
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<tr>
<td>1991</td>
<td>11.670</td>
<td>6.389</td>
</tr>
<tr>
<td>1992</td>
<td>12.446</td>
<td>6.382</td>
</tr>
</tbody>
</table>

(*) Source: Public Municipal Companies

Recall that a straight line is given by the formula

\[ Y = a + bx \]

in which:

\[ Y = \] the variable in question (number of animals butchered).

\[ X = \] chronological variable (years).

\( a \) and \( b \) are the "parametres" which define the straight line.

Our objective is, then, to find \( a \) and \( b \) to determine the straight line.

The lineal adjustment method provides us with two simultaneous equations for finding the values of \( a \) and \( b \):

\[ \Sigma Y = na + b \Sigma X \quad (1) \]
\[ \Sigma XY = a \Sigma X + b \Sigma X^2 \quad (2) \]
Recall that $X$ is the temporal variable and that we can reassign the values of the years, so that their sum is zero ($\Sigma X = 0$). Thus, the calculation process is simplified, because in equation (1):

If $\Sigma X = 0$, $b \Sigma X = 0$, and the equation becomes:

$$\Sigma Y = na - a = \Sigma \frac{Y}{n}$$

in which $n =$ number of times in the series.

In equation (2):

If $\Sigma X = 0$, $a \Sigma X = 0$, and the equation becomes:

$$\Sigma XY = b \Sigma X^2 \quad b = \frac{\Sigma XY}{\Sigma X^2}$$

Consider the variable of major livestock butchered (number of animals, in thousands) and construct the following table to solve the problem.

Variables can be rounded off, because approximate figures are sufficient for our purposes.
Butchering of major livestock- Data table

(thousands of head)

<table>
<thead>
<tr>
<th>Year</th>
<th>X</th>
<th>Y</th>
<th>XY</th>
<th>X²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>-3</td>
<td>8.7</td>
<td>-26.1</td>
<td>9</td>
</tr>
<tr>
<td>1987</td>
<td>-2</td>
<td>9.5</td>
<td>-19.0</td>
<td>4</td>
</tr>
<tr>
<td>1988</td>
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<tr>
<td>1989</td>
<td>0</td>
<td>11.0</td>
<td>0</td>
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<td>1990</td>
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<td>11.1</td>
<td>11.1</td>
<td>1</td>
</tr>
<tr>
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<td>2</td>
<td>11.7</td>
<td>23.4</td>
<td>4</td>
</tr>
<tr>
<td>1992</td>
<td>3</td>
<td>12.4</td>
<td>37.2</td>
<td>9</td>
</tr>
<tr>
<td>Sum</td>
<td>Σ</td>
<td>74.7</td>
<td>16.3</td>
<td>28</td>
</tr>
</tbody>
</table>

n = 7 = Number of consecutive years observed.

Applying the formulae for a and b:

\[
a = \frac{\sum Y}{n} = \frac{74.4}{7} = 10.7 \text{ thousands of heads}
\]

\[
b = \frac{\sum XY}{\sum X^2} = \frac{16.3}{28} = 0.58 \text{ thousands of heads / year}
\]

The line for the best adjustment of this data series is:

\[
Y = 10.7 + 0.58X \text{ in thousands of animals, or}
\]

\[
Y = 10.700 + 58.0X
\]
This means that every year butchering will increase by 580 head of major livestock.

To find the estimated value for each year, substitute $X$ for the corresponding value on the scale. Thus, for 1993, the value is four:

$$Y = 10.700 + 580 \times 4 = 13.020 \text{ and add 580 for successive years}$$

Recall that this method presupposes that the observed trend will continue in the near future.

### Projection of major livestock butchering

<table>
<thead>
<tr>
<th>Year</th>
<th>$X$</th>
<th>$Y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>4</td>
<td>13.020</td>
</tr>
<tr>
<td>1994</td>
<td>5</td>
<td>13.600</td>
</tr>
<tr>
<td>1995</td>
<td>6</td>
<td>14.180</td>
</tr>
<tr>
<td>1996</td>
<td>7</td>
<td>14.760</td>
</tr>
<tr>
<td>1997</td>
<td>8</td>
<td>15.340</td>
</tr>
<tr>
<td>1998</td>
<td>9</td>
<td>15.920</td>
</tr>
<tr>
<td>1999</td>
<td>10</td>
<td>16.500</td>
</tr>
<tr>
<td>2000</td>
<td>11</td>
<td>17.080</td>
</tr>
<tr>
<td>2001</td>
<td>12</td>
<td>17.660</td>
</tr>
<tr>
<td>2002</td>
<td>13</td>
<td>18.240</td>
</tr>
</tbody>
</table>
5. Size, location and technology

On the basis of the presentation of alternatives and a broader knowledge of the target population and the deficit level to be covered, it is necessary to develop the conceptualisation and basic elaboration of the alternatives proposed. This involves the general treatment of the physical-technical aspects, which consist in three basic interdependent components: size, location and technology.

5.1 Size

5.1.1 Concept and objectives

The size of the project is understood to be its production capacity during the period in question. Technically, capacity is the maximum quantity of units (goods or services) which can be obtained from the productive installations, per time unit.

The analysis of project size is intended to jointly dimension its real productive capacity and use level, both for its implementation phase and during the evolution of the use life of the project.

5.1.2 Dimensioning the solution

Project size should be expressed in the type of unit which best expresses its productive capacity. The most appropriate measure is usually the quantity produced per time unit. Consider the following examples:
Size measurement units for diverse projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Measurement unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueduct, sewers, irrigation.</td>
<td>Cubic metres per year, litres per second.</td>
</tr>
<tr>
<td>Electricity.</td>
<td>Kilowatts, kilowatt-hour.</td>
</tr>
<tr>
<td>Public Transportation.</td>
<td>N° of passengers per day or year.</td>
</tr>
<tr>
<td>Street cleaning.</td>
<td>N° of tonnes per day or year.</td>
</tr>
<tr>
<td>Market.</td>
<td>N° of tonnes per day or year. Annual sales volume.</td>
</tr>
<tr>
<td>Slaughterhouse.</td>
<td>N° of head per day or year. Tonnes per day or year.</td>
</tr>
</tbody>
</table>

5.1.3 Incidental factors

Diverse factors affect the decision about project size. Generally, the most decisive factors are the following:

a) Affected population and unsatisfied demand (deficit)

This is the most important guiding factor and, therefore, in a first approximation, size analysis should begin with the data on unsatisfied demand (the deficit to be covered by the solution proposed).

b) Financing

This is usually the most important restrictive factor. The exploration of the volume of possible financial resources for the project indicates the limits of the search for size alternatives (as long as demand is not less than that limit).
c) Economies of scale

This is a very important factor for projects in which ever greater returns can be obtained by size concentration, which generates lower costs per unit. By way of example, we can mention school concentration to provide 6 teachers for 220 students, against the alternative of 5 separate schools with 2 teachers each. Or, a garbage dump organised jointly be three neighboring Municipalities, against the option of each operating its own dump and multiplying the expenses which would be shared otherwise.

d) Technology

The available technology may be the determinant size factor in projects such as the following:

* for certain types of processes, technology suppliers do not generate solutions below a given capacity.

* technological scale inflexibility or discontinuity, insofar as the range of configurations available in the market contains significant capacity gaps, which means that the project must take an option either above or below the required level (example: thermoelectrical generating plants).

e) Location

Size and location affect each other reciprocally. Example: A market in which different alternatives or combinations, ranging from one central location (which will cover the entire area to be attended by the project) to several sites strategically distributed, may be considered.
f) Input availability

Solution alternatives may be considered in which size is limited by a supply of resources which is less than that required by demand or is available financially. Examples: projects for the extraction and transformation of construction materials, limited by the potential of sand, clay or stone deposits. Aqueduct, limited by drinking water sources.

g) Seasonal and other fluctuations

Some projects are subject to seasonal variations in the supply of inputs or demand which may involve significant fluctuations during the year (harvests, vacations, rainy or dry seasons). In these cases, it is not sufficient to analyse size in function of annual or monthly average figures, given the risk of leaving seasonally relevant months without coverage. However, it is also necessary to examine the cost of over-dimensioning the project with extensive idle capacity for much of the year.

h) Risk assessment

Every investment decision involves risk. The size-technology factor pair is decisive for project investment size, which implies that great care is needed in analysis prior to the decision. However, certain projects, given their complex nature, the insufficiency of background information and research data, or the degree of uncertainty with regard to their future evolution, may involve a considerable degree of risk. This may constitute sufficient cause for the person or entity responsible for the final decision to choose the smaller alternative within the range of proposed options.

5.2 Location

5.2.1 Objective

The purpose of location research is to select the most appropriate site for the project, that is, the site which
will yield greatest user and community benefits, with the least social cost and within the context of the determinant and conditioning factors, as compared with other possible sites.

5.2.2 From "macrolocation" to microlocation"

Generally, an adequate process of location research consists in addressing the issue by moving from the macro to the micro. First, within the framework of the criteria and parameters given by the nature of the project, explore the region or zone appropriate for project location: region, Municipality, rural or urban zone, and the most adequate geographic areas or sub-sectors within these.

Thus, macrolocation research leads to the pre-selection of one or several appropriate sites, leading later to microlocation, that is, the specific definition of the project site.6

5.2.3 Location factors

Location factors are the elements which influence location analysis. They function as determinant or restrictive guiding parameters for the decision. The most common are:

a) Target population placement

b) Location of raw materials and inputs

c) Communications channels and means of transportation

d) Infrastructure and public services (energy, water, sewage, telephone, etc.)

---

6 Microlocation is often not addressed in the profile stage: general location criteria may be employed in the consideration of alternatives and the definitive location may be delayed until the best alternative has been chosen, or until project resources have been approved and the definitive design stage has begun.
e) Topographic conditions and soil quality

f) Climatic, environmental and sanitary conditions

g) Ecological control

h) Municipal regulations and urban zoning rules

i) Spatial trends of municipal development

j) Land prices

k) Urban traffic patterns and system

l) Desconcentration policies, plans or needs

m) Explicit local development policies

n) Policies for the urban-rural distribution of public Municipal investment

o) Financing

p) Political-municipal interests and pressures

q) Protection and conservation of historical and cultural patrimony

r) Size

s) Technology

Usually, no one factor is more important than the others. The weight of each locational factor is linked to the specific nature of each project and the special circumstances which surround the problem.
5.2.4 Microlocation

As stated above, this is the definitive selection of the project installation site, once macrolocation research has been completed.

The following factors are specially important for the microlocation decision:

- Existence of communications channels and means of transportation
- Basic public services
- Topography and soils studies
- Environmental and sanitary conditions
- Ecological control
- Land prices
- Traffic patterns and system
- Financing
- Size and technology
- Conservation of historical-cultural patrimony
- Space availability for current requirements and future expansions

If the alternative of renting instead of building installations is considered, it will be necessary to verify capacity, facilities, and reconditioning costs. Idem for the purchase of existing structures.
5.3 Basic technology

5.3.1 Concept and objective

The physical installation and productive system of the project are two of the main issues addressed by technological analysis. Generally, technology is understood to be the way things are done, that is, the systematic set of knowledge, methods, techniques, instruments and activities, the application of which transforms inputs into the desired product, for the achievement of a specific objective.

Recall that, in the Project Cycle, we defined this element as a system which is tangibly expressed in a "productive unit", which receives inputs, processes them and generates a product (goods or services) to solve a problem or satisfy a social need. Thus, technology is the project component concerned with the design, installation, implementation and operation of the productive system.

The basic process is the crux of the technology element. The productive process is found in all projects. Transformation is more evident in some than in others. A transformation process occurs whenever there is change from an initial state to a final state of different characteristics (transition from input to product), deliberately achieved as the objective of the productive function. This is valid both for projects which produce goods and those which produce services.
Examples of initial and final states in diverse types of processes

<table>
<thead>
<tr>
<th>Project</th>
<th>Initial State (Input)</th>
<th>Final State (Product)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueduct</td>
<td>Water at source</td>
<td>Drinking water in home.</td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>Live beef</td>
<td>Beef slaughtered and butchered.</td>
</tr>
<tr>
<td>Transportation</td>
<td>Passenger at origin</td>
<td>Passenger at destination.</td>
</tr>
<tr>
<td>School</td>
<td>Child without knowledge or formation</td>
<td>Child with knowledge, formation and skills.</td>
</tr>
<tr>
<td>Health</td>
<td>Patient (ill person)</td>
<td>Person treated or cured.</td>
</tr>
<tr>
<td>Street cleaning</td>
<td>Garbage in streets and at homes</td>
<td>Garbage at final disposition.</td>
</tr>
</tbody>
</table>

During the profile stage, it is sufficient to address the aspects of basic technology, that is, to decide on a basic conceptualisation of the technological system (how each alternative will operate), without necessarily entering into detailed definitions.

5.3.2 Elements of technology analysis

The following aspects should be included in the analysis performed to define project technology:

a) Review of the specific project objectives

b) Definition of the product

---

7 It is sufficient, for now, to simply name these elements. We will deal with them in greater descriptive detail later, in the stage of detailed project design.
c) Design and description of the productive process

d) Definition and specification of physical inputs

e) Definition of equipment

f) Labour requirements

g) Buildings, construction and their spatial distribution

h) Infrastructure and complementary works

5.3.3 Factors involved in technology

Many factors bear on the technological decision, several of which were explained above, including the following:

a) Financing (resource availability)

b) Location

c) Size and future evolution

d) Economies of scale (also linked to size)

e) Regional or local customs and usages and environmental conditions

f) Product characteristics, defined to adequately satisfy the social need identified

g) Inputs requirements and availability, or deliberate concern for employing autochthonous inputs

h) Supplier terms (price, financing, technical aid, guarantees, maintenance service and spare parts)

i) Obsolescence and likelihood that the technology chosen will continue to be available in the market

j) Risk level of dependence on the supplier in a situation of supply monopoly
k) Employment (policy to create jobs versus non labour-intensive alternatives)

l) Tariff policy (for importing equipment and inputs)

m) National policy on technology transfer

n) Deliberate policy to protect national, regional or local industry

o) Licitation and contract rules

p) Environmental controls

q) Industrial safety

5.3.4 Community participation

It is important and, indeed, necessary to ensure active and dynamic community participation in the technology analysis process. This is more feasible in smaller projects and generates situations which are beneficial for the project:

a) Technological design which responds to the inhabitants’ values, customs, usages and preferences.

b) Technological design in accord with specific environmental conditions (topography, climate, solar intensity, etc.).

c) Possibilities of the application or adaptation of local technologies (including traditional modalities), both in the “forms of production” and in the use of autochthonous materials.
d) Creative possibilities in the search for solutions. When a problem is examined with those who suffer it, the likelihood of finding a solution is improved, including the discovery of creative and innovative alternatives.

5.4 Development of alternatives

Detailed physical-technical study is justified at the end of the pre-investment phase, once the project profile, represented by the alternative ultimately deemed most suitable, has been defined. Nevertheless, basic analysis, at the level of alternatives, is necessary for the following effects:

1. The analysis of factors which condition location, size and basic technology makes earlier decisions on alternative feasibility possible. This introduces efficiency, rationality and realism into the comparative analysis of the proposed solutions because, from here on, it will be possible to discard unfeasible solutions, before entering into the elaboration and appraisal of cost and benefit flows.

2. The gathering and assimilation of information about physical-technical matters makes it possible to recycle the analysis process and incorporate possible new alternatives, not formulated during the identification phase. It must be kept in mind that the project elaboration and analysis process advances in successive approximations from beginning to end (that is, it is repetitive, with systematic feedback).

3. Based on concrete assumptions, this analysis makes the conceptual and technical development of the alternatives formulated during the identification stage possible. Thus, it establishes
sufficient bases for the definition of the calendars for installation, the use life of investment components, and the technical-economic horizon of the alternative, all of which are prerequisites for the adequate elaboration of its cost and benefit flows.\(^8\)

### 5.5 Optimisation of base situation

One recommended alternative, which should be examined if possible, is to solve (or lessen) the problem by making only minimum improvements, without incurring investment costs, that is, when administrative or procedural measures, or some other change in method, will produce a satisfactory, stable solution or avoid resource expenditures over a certain period. This type of solution is called an “optimised base situation” and its importance lies in the generation of benefits by solving a problem with only marginal changes in the original situation – or by significantly postponing other alternatives which may involve large investments.

Consider the example of a health clinic, where a doctor’s productivity can be duplicated by adding a half-time wage for an office assistant, so that the clinic will be able to attend 30% more persons who would otherwise lack that service, without incurring in physical works or equipment investments.

---

\(^8\) At the end of the pre-investment phase, once the project profile –represented by the alternative selected– has been defined and implementation resources have been allocated, the physical-technical aspects must be reconsidered to determine in detail those elements which will guide the execution and operation phases.
6. **Cost and benefit flows**

6.1 **Object**

The examination of the alternative (in terms of its basic physical-technical aspects) generates information on installation, operations and resources use time-table requirements.

The degree of elaboration of each alternative will now make it possible to:

- quantify, assess and distribute over time the expected benefits of the alternative. This is the benefit flow.
- quantify, assess and distribute over time the investment and operation costs for the alternative. This is the cost flow.

The relation between costs and benefits yields information about the convenience of each alternative and makes comparison possible for improved option selection.

6.2 **Benefits definition and their distribution in the time-table**

The only benefits to be considered are “incremental”, that is, those which are expected to accrue if the project is, in fact, implemented. Thus, those which are already being generated, without the project, should not be included.

Benefits can be expressed in different ways, as deemed appropriate to reflect the impact of the use of the goods or services produced by the project:
1. It is necessary to determine the quality and quantity of the product which the project will generate, apart from the current situation. It will also be necessary to identify and quantify the population which will benefit directly each year from the use of the project's goods and services. In most cases, it will suffice to quantify product units and define the number of beneficiaries (health and education projects).

2. In other cases, it will be necessary to determine the final impact of project product use by the beneficiary population. Here, it will be necessary to undertake a monetary estimation of project benefits, as a true expression of the satisfaction perceived by the project target population. This assessment modality is suggested for creation infrastructure projects, such as road and drainage works.

Generally, quantitative benefits are associated with projects which increase the social availability of a good or service. When the purpose of a project is to improve the quality of something which already exists, benefits are qualitative (example: improve drinking water by change in treatment system).

If the nature, quality, quantity and timeliness of the benefits is the same for all alternatives, it will suffice to make only one determination of the benefits of “the project”. However, if each alternative contains its own benefits component, it will be necessary to define and quantify them of each.

Benefits can be determined in two steps:

a. **Identification**, employing a format in which the benefits which the project (or alternative) should generate are listed and briefly described.
Benefits identification depends on the nature of the project. The following table contains examples for each of the four project types defined in Unit I.

b. **Elaboration of benefits flow**, by means of a table in which the number of units produced or attended is quantified for each year of operation. A table should be created for each measurable product or benefit.

If the nature of the project requires the monetary assessment of benefits (examples: road or drainage works), the corresponding appraisal should be made, by establishing a perceived benefit per unit price. (Instructions for this appraisal are found in Unit 9).
<table>
<thead>
<tr>
<th>TYPE OF PROJECT</th>
<th>EXAMPLE</th>
<th>BENEFIT MEASUREMENT BY:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PRODUCT</td>
</tr>
<tr>
<td>PRODUCTIVE</td>
<td>MICRO-COMPANY TO PROMOTE WOMEN</td>
<td>UNITS PRODUCED# OF SHIRTS</td>
</tr>
<tr>
<td>INFRASTRUCTURE</td>
<td>ROADS</td>
<td>ML OR M2 OF ROAD</td>
</tr>
<tr>
<td>SOCIAL BENEFIT</td>
<td>EDUCATION</td>
<td># OF COURSES</td>
</tr>
<tr>
<td>IN SUPPORT OF OTHER PROJECT OR ACTIVITIES</td>
<td>TECHNICAL AID</td>
<td># OF SESSIONS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* These projects have "derived effects", usually intangible or difficult to assess. According to simple methodologies -such as those utilised by FONVIS-PROINSOL- for this type of small or mid-sized project, evaluative indicators are based on the quantification of products or beneficiaries (not derived benefits or effects) for the selection of the least expensive alternatives.
Unlike the others, in this type of project, the effects generated serve as the basis for benefit identification, which, once properly assessed, are compared with costs in order to construct indicators for selection in terms of greater social profitability (cost-benefits). This is discussed in greater detail below.

Both the definition of benefits (or products) and their distribution during the operations phase are input data which can be more easily elaborated on the basis of the elemental conceptualisation of the physical aspects of the project, as discussed above, because the benefit flow is a direct function of the project's installed capacity and, above all, of the use level foreseen for each year.

In this view it seldom occurs that a project begins operations at full capacity. The general rule is that the use of capacity grows gradually during the first years, reaching stability at around 100% (the limit is rarely achieved, due to practical restrictions). There are several reasons for this type of evolution, such as the initial lack of user familiarity with the project; a rise in the "learning curve" as personnel are trained to operate the productive unit and technology is calibrated; demand function below project capacity, etc.

In each case, the benefit flow for the operational life of the project is elaborated according to the nature of the benefit in question. This is an issue to be addressed by the specific methodology of each sector. Recall that interest should always be centred on the definition and measurement of "incremental benefits", those which are attributable exclusively to the project, that is, those which arise from the difference between the situation "with project" and that "without project".

6.3 Project costs

All inputs, goods or resources which must be employed to implement and make the proposed technological solution (alternative) operational, for the purpose of generating the desired benefits flow, are costs.
For the purposes of this guideline, costs are classified in three categories: Investment, Re-investment and Operations.

6.3.1 Investment Costs

Investment costs are those which must be incurred to endow the project with operational capacity. They usually include those costs incurred between the first outlay and "start-up", when the project is ready to initiate operations.

Investment costs are classified in four categories:

a. **Physical works**, which include civil engineering works and the like, such as buildings and access infrastructure. Land is included here. When the project involves construction, all the necessary materials and the value of machinery use, separate from labour costs, are included here. When completed installations are purchased, general real estate values are used. The same holds when a contract is extended for an "all costs included" work and the labour component cannot be distinguished.

b. **Machinery and equipment.** This includes all instrumental investment: machines and tools, including vehicles and furnishings. This item refers to the inventory physically incorporated into project installations and not the machinery used in construction, which belongs in the preceding category.

c. **Labour.** Labour is skilled and unskilled. The former refers to human resources which require a certain level of formation and specialisation for the adequate performance of functions (professionals, specialised workers). Unskilled labour, as the name suggests, refers to human resources which require no special preparation for the performance of the tasks in question.
d. **Other.** This is an open category for investment categories which do not fit in the other categories, such as yearling livestock in farm projects, or **working capital** in projects which need specific inventories of inputs to complete their productive capacity.

### 6.3.2 Replacement Costs

These are the expenditures necessary to replace investment components as they wear out or become obsolete as a result of their use in the project during its use life. Naturally, replacement costs occur after the initial investment.

### 6.3.3 Operations Costs

These are the inputs and resources necessary for the productive process of the project. As their name indicates, they are incurred during the operations phase and are necessary to use and maintain project installed capacity in order to deliver the products (goods or services) geared to generate the expected benefits.

Operations costs are divided into several categories:

a. **Inputs and materials.** Includes all elements necessary for project operation, which are usually intermediate goods (raw materials, supplies and fuels).

b. **Labour.** As in investment, it is broken down into **skilled** and **unskilled.** Any other operations cost can be included in "inputs and supplies" or, if appropriate, a category of "other" can be created.
It should be noted that only "economic" costs are included, that is those which involve the real use of resources in the project (in contrast to the so-called financial costs, such as interest paid on loans, which refer to mere transfers that do not involve the allocation of a productive good or service).

6.4 Works budget for feasible or pre-selected alternatives

Once the basic technology and the scope of the proposed installed capacity of the alternative have been defined, the works budget should be elaborated to determine the total amount of the investment. Define, for each cost element:

1. Concept or item name
2. Unit of measurement
3. Quantity
4. Unit price
5. Total cost = (3) x (4)
6. Use life

Cost concepts should be grouped in the investment categories, as proposed above. Double accounting should be avoided. For example: if the price for a constructed square metre of a school has been included in the physical works item as "all costs included", and the value of labour is also calculated, the value of the latter element is being accounted for twice. It is preferable to break down the value for physical works and account for labour separately. Only when it is impossible to break the values down, will labour be included in the physical works item. In that case, no value should be shown in the labour category.
6.5 Appraisal at market prices and constant prices

6.5.1 Market price

Unit prices are expressed at market prices. Market price is the price actually paid for items placed or utilised in the project construction site. It is important to cite the source consulted for that price, in each case.

6.5.2 Constant prices

For the different years of the project horizon, prices should be estimated in constant currency, that is, expressed in the purchasing power of the currency at a certain time chosen as a reference. Generally, for practical purposes, constant prices should be those which obtain when the project is being prepared.

* Constant prices and current prices

Consider the following example: Two years ago, a kilogram of hypochlorite cost Bs37.50 and, today, it costs 60.9 Here, we are talking in current Bolivars (or prices), that is, we express the price in the value of the currency each year. Money loses purchasing power over time, due to the effects of inflation. Today, more Bolivars are needed to purchase the same kilo of hypochlorite.

We can refer to value in constant terms, by stating that “to purchase a kilo of hypochlorite today, I need a sum of Bolivars equivalent to Bs37.50 of two years ago”. By saying this, I maintain the purchasing power of Bolivars of two years ago as a constant unit.

---

9 Hypochlorite is used in treating drinking water.
To summarise, in the example, today’s price for a kilo of hypochlorite can be expressed in two ways: Bs60, in today’s currency (current prices), or Bs37.50, in Bolivars of two year ago (constant prices).

If it is necessary to measure the change in current prices over time, the following calculations can be made:

Increase in current price: Bs60 - Bs37.50 = Bs22.5, which implies a percentage increase of 60%:

\[
\frac{60.00 - 37.50 \times 100}{37.50} = 60\%
\]

This can be expressed as an index, by stating that we need 1.6 monetary units to purchase the same quantity of resources we purchased two years ago for one unit.

Comparative values table

<table>
<thead>
<tr>
<th>Moment</th>
<th>Two years ago</th>
<th>Today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current price (in Bs each year)</td>
<td>Bs37.50</td>
<td>Bs60.00</td>
</tr>
<tr>
<td>Price Index</td>
<td>100</td>
<td>160</td>
</tr>
<tr>
<td>Constant (In Bolivars of two years ago)</td>
<td>Bs37.50</td>
<td>Bs37.50</td>
</tr>
</tbody>
</table>

For a past period, we can actualise the values expressed in constant Bolivars of the base year to current prices today, by simply applying the corresponding inflation index, already known:

What is today’s value of 80 kilos of hypochlorite which cost Bs37.50 two years ago, with a known inflation rate for the period which rose from 1 to 1.6?

Answer: \(80 \times \text{Bs37.50} \times 1.6 = 80 \text{ Bs60} = \text{Bs4800}\)

* The project’s costs in constant values
Now, look to the future. Suppose that our project, during its operations phase, needs 200 kilos a year, during the first three years, and 300 a year, from the fourth year onward.

How can we translate those quantities into values in the project operations calendar, if we are not fortune-tellers and cannot know the inflation for those years in advance?

The answer is: estimate the value in constant terms, that is, in the known prices of the year in which the calculation is made:

<table>
<thead>
<tr>
<th>Operations calendar for the item “hypochlorite”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
</tr>
<tr>
<td>Quantity (Kilos)</td>
</tr>
<tr>
<td>Constant price (Today’s Bs)</td>
</tr>
<tr>
<td>Constant value (Today’s Bs)</td>
</tr>
</tbody>
</table>

The last row contains the sum of today’s Bolivars needed to purchase the quantities programmed for each year.

And what answer should we give to the person who insists that the table "does not reflect reality because it does not account for the effects of inflation"? The answer is that the effects of inflation will be felt later, when the financial resources for project execution are to be disbursed. At that time, when the variation in price indexes is known -a posteriori-, those responsible for the financial management of the project must make the corresponding adjustments, to convert -and here it is necessary- today’s constant Bolivars into the current Bolivars of the moment in which the resources are disbursed.
If, a year later, it is known -a posteriori- that inflation was 26%, then prices should be multiplied by a factor of 1.26, to convert constant Bolivars into current Bolivars. (For that year, the project managers should be supplied with Bs12,000 x 1.26 = Bs15,012, to ensure delivery of the 200 kilos of hypochlorite). And so forth, according to the accumulated inflation index of each year.

We conclude by stating that there is no need to speculate with future inflation indexes. It is sufficient to express annual values (both for investment and operations) in constant currency of the base year, for all effects of estimations and “ex-ante” economic analysis. For future actualisations, it is necessary to have noted the date of the prices included in the project explicitly.  

6.6 Investment flow

The alternative’s investment flow consists in distributing, over time (annual periods), the values assigned in the works budget, as foreseen in the installation time-table. Values are to be expressed in constant prices of the moment in which the alternatives are developed. For small projects, the investment is seldom longer than one year, so that the investment values for the first year will coincide with the works budget (for the level of analysis recommended for the pre-investment phase, the information must be broken down into periods shorter than a year, such as trimesters, or months).

In the exercise being developed here, which is a small project, all investments are made in the first year and the flow will coincide with the works budget.

---

Note for those interested in the issue of relative prices: The methodology validly assumes that, on average, resource price changes follow the evolution of the national consumer price index (which measures inflation), that there are no relative price changes among the diverse inputs, and that, if they occur, we do not now have sufficiently reliable indicators to be able to guess the trend of those changes.
6.7 Replacement costs (re-investment) and residual values

Fixed assets in projects must be replaced when the use life foreseen for that asset is less than that of the project itself. To establish a common language for the elaboration of replacement flows, the following rule has been adopted: Each time the life cycle of an asset ends, it must be replaced totally, in the same quantity and at the same (constant) value as in the original investment.

The use life of assets is defined according to criteria related to estimates of wear or the technical-economic obsolescence of certain goods. Procedures commonly accepted by project evaluators exist and, in some cases, the financial organisms will suggest those periods. For PROINSOL projects, the following use life values should be used:

<table>
<thead>
<tr>
<th>CONCEPT</th>
<th>USE LIFE (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical works</td>
<td>10 to 20</td>
</tr>
<tr>
<td>Machinery</td>
<td>10</td>
</tr>
<tr>
<td>Electronic equipment, vehicles, furnishings</td>
<td>5</td>
</tr>
</tbody>
</table>

Residual Value (salvage value) is defined by the undepreciated value of the object on the completion of its use life in the project, also expressed in constant (today’s) prices.

Example, if the use life of a project is eight (8) years and a vehicle for one million Bolivars was included in the initial investment, it should be replaced at the end of the fifth year, as worn out. Since each year one fifth of the vehicle’s value is “consumed” in the project (lineal depreciation), in the eighth year two fifths of its value (in constant prices) will remain as residual value = 400,000 of today’s Bolivars, that is, the value which “would be rescued” by its assumed realisation in the market if the project were cancelled.
Replacement costs should be indicated in the cost flows for the corresponding years and, at the end, residual values should also be indicated (to be subtracted from the costs because they should be recovered).

Land is an asset which is not consumed during operations and, therefore, should be assigned a residual value, in constant prices, equal to its initial value.

6.8 Operations and maintenance cost flow

The operations cost flow begins when project installed capacity is ready. Operations usually begin when the investment phase has ended completely, as most frequently is the case in small projects.

* If the investment is made during one year, operations costs begin the second year.

* If the investment is made in less than one year, operations may begin that same year.

* In some projects, the investment is made in stages or sections, allowing for operations to begin at the end of each stage (example, road works, in which each section is put into operations when finished). In these cases, investment and operations flows overlap.

The three most common types of operations costs are inputs and materials, skilled labour and unskilled labour.

The annual evolution of costs may vary somewhat in relation to the product volume generated or the service provided: costs may rise (in constant values), as the use of installed capacity increases.
The operations flow continues to the end of the economic horizon of the project, which is the total time period estimated for the satisfactory functioning of the project without it being necessary to modify or redesign it completely. Operations costs must also be expressed here in terms of today's constant prices.

In the calculation of annual operations and maintenance costs, those which will vary with production volumes must be distinguished from those which will not vary. For example, in the case of an aqueduct, inputs costs (hypochlorite) vary with the volume of water treated, while others remain constant or grow by scaled increments.

Investment and operations flows for PROINSOL Projects are to be elaborated according to the corresponding sector methodologies.

6.9 "Installation projects" and "programme-projects"

* Until now, we have discussed projects which have an investment phase which consists in the installation of a productive unit, after which the operations phase begins to generate the desired benefits. This is generally the case for the projects which fall within the first three typologies defined earlier: "productive" projects, "economic infrastructure" projects and those "social benefits" projects which involve the creation of physical infrastructure. In these projects, the investment and operations phases are clearly different in temporal terms, separated by the "start-up". The operations phase is long -permanent-, as is the need it was designed to satisfy: people will always drink water. There are practically no stages in the investment phase during which benefits are generated: the entire installation must be completed before benefits can be generated, that is before operations begin. Those projects which involve partitionable technology, which -for convenience sake- can be installed in stages or sections, as in road works, are an exception to this modality.
However, there is a modality of projects which are designed and executed to achieve specific goals in a fixed time period, without "hard" investment, meaning that they do not require significant installation costs. In these cases, the investment phase incorporates operations and benefits are generated as soon as project resources are disbursed. Here, benefits are generated with part of the investment. The scope of the objectives (benefits) can be graduated, as is also true of the investment, so that it is feasible to achieve a percentage of the objective with a percentage of the investment.

These projects can be called "project-programs", in contrast to "installation projects", which require "hard" investment.

These projects operate with fixed term goals, usually no longer than five years, at the end of which their impact should be carefully evaluated to inform decisions about objective achievement, reformulation, extension, etc. In many of these projects, the need should disappear or be reduced as an result of the project: adults have become literate.

Most of the projects of this type belong to the fourth category defined earlier, that is, those designed to support other projects or "soft" investment activities, such as training, technical aid, communications, or research. They also include social benefits projects which do not involve installation costs (or imply irrelevant implementation costs), such as vaccination or adult literacy campaigns.

The distinctive characteristics of this type of project are important, specially with regard to two factors:

1. the definition and elaboration of cost flows: generally, the other projects require separate investment and operations tables, while "program-projects" only need investment tables;
2. The scope of "program-projects" is highly flexible, because product quantities can be distributed in discreet allotments in function of limited resources or institutional restrictions.
7. Actualisation of costs and benefits

Where are we going? Toward the configuration of indicators to evaluate and compare alternatives. To do this, we must balance the benefits and costs of each alternative, on the basis of the flows discussed in the preceding Unit. We will demonstrate this procedure through an example.

Compare two alternatives to solve a problem, which will generate similar benefits. Their cost flows are summarised in the following table. They have the same use life (five years); neither involves replacement costs or residual values.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Cost flows</th>
<th>Investment</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>YEAR</td>
<td>0 1 2 3 4 5 6 (Thousands of Bolívares)</td>
<td></td>
<td></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>YEAR</td>
<td>10000</td>
<td>3000</td>
<td>4000</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>A2</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>

Graphic representation of the two flows:

Which alternative involves the lowest total cost?

One approach would be to calculate the total cost of each alternative by adding (investment and operations) costs for the entire use life: The sum of A1 is 35 million and of A2, is 33 million, which seems to suggest that A2 will yield the same benefits as A1 at lower cost. However, this procedure has an Achilles Heel. What is it?
That the same weight is being assigned to the values, independently of when they occur: spending resources today is the same as spending them in five years. However, an investment-minded person would call attention to the following:

"If I embark on Alternative 2, I have to spend 23 million at the beginning, while, in Alternative 1, the initial outlay is only 10 million. That is, A2 involves an additional initial outlay of 23 - 10 = 13 million, more than A1. I will be forgoing the yield which I could gain, if I kept the 13 million for another productive investment, instead of investing them in Alternative 2. Result: I incur a cost by making an outlay which I could make later and, meanwhile, I keep resources in production which will increase my overall riches in the future".

Generally, this line of reasoning leads to the conclusion that resources grow over time, which means that their real value is different (tends to increase) as time passes. The potential for the accumulative growth of resources increases our estimation of their value over time.
7.1 Value change over time. The rate of return

Consider an investment in a livestock operation. Today, 100 head are purchased. Weight increase, milk production and biological reproduction increase the herd’s real value, so that, in one year, the stock operation has the equivalent of 112 head. In real terms, during that year, its investment resources have increased by 12%. That is, there is a real growth rate of 12% annually. And, if this is the average yield of that operation, we can conclude that the owner regularly expects his livestock investments to grow at 12%. This is their rate of return.\(^{11}\)

100 resource units today, with the expected growth, are the equivalent of 112 units in one year. If you have a right to 100 head today, in one year, you do not expect 100, but 112.

This suggests that resource units (or the real values in which they are expressed) cannot be merely added, if they are applied in different moments in time. It is, however, valid to refer to the "sum" or integration of values over a given time period, during which they can be added together.

7.2 Future value and present value

Goods usually have potential yield, either as directly productive resources or because they may be somehow exchanged for other productive goods (livestock, for example). The yield potential of goods (or what they represent as alternative investment resources) enables them to increase their real value in the future.

\(^{11}\) Note that this is a real rate of return, or real goods, independently of their price. It is unrelated to the effects of inflation.
General Methodological Manual for the Preparation and Evaluation of Social Investment Projects

Today, we have 100 value units (be they livestock, goods, resources, constant values) and these grow at a real rate of 12%.

How much will accumulate in one year?

: Answer

\[
100 + 12\% \text{ of } 100 = 100 \times (1 + 0.12) = 100 \times 1.12 = 112
\]

That is, at a given rate of return, present value is converted into future value by multiplying it by a factor of 1, plus the rate. In our example, \( 1 + 0.12 = 1.12 \)

\( 1.12 \) = the factor for converting a present value into a future value for the coming year.

And what is the future value of 100 in 2 years?

We can solve this in two steps:

1) Movement from base moment to year 1:

By multiplying 100 by \( 1.12 = 112 \), we convert Present Value into Future Value in one year.

2) Movement from year 1 to year 2:

We can convert the 112 to the coming year, by multiplying by the factor 1.12 again:

\[
\text{Future Value for the second year} = 112 \times 1.12 = 125.44
\]

By joining these two steps, we obtain:

Which is equivalent to the successive multiplication by the factor, as many times as there are time
Future Value for the second year = \( \frac{(100 \times 1.12)}{\text{First step}} \times \frac{1.12}{\text{second step}} \)

periods (years) in question.

\[ \text{Future Value for the second year} = \frac{(100) \times (1.12 \times 1.12)}{\text{Twice}} \]

That is: Future Value for the second year = \( (100) \times (1.12)^2 \)

This procedure can be generalised in the following terms:

* Call \( r = \text{rate} \)

* then, the annual growth factor = \( 1 + r \)

* the Future Value (FV) for the following year will equal the Present Value (PV), multiplied by the factor:

\[ FV = (\text{following year}) = PV (1 + r) = PV \times (\text{Factor}) \]

* The Future Value for \( n \) years is equal to Present value, multiplied \( n \) times by the factor, or:

\[ FV \ (\text{year} \ n) = PV (1 + r)^n \]

The factor for converting present into future value is found in the tables (annexes), facilitating this exercise so that there should be no difficulty for persons unfamiliar with quantitative methods. Use the factor from the first column: From Present to Future, that is, from P to F.
7.3 Estimating future costs

* Exercise 1

In 5 years, what is the future value of a present value of 100,000 today’s constant Bolivars? (annual real rate = 12%).

Graphic representation: (Thousands of today’s constant Bs)

```
0  1  2  3  4  5

Bs.100 → ? = Future Value
```

Solution:

Future Value (year 5) = Bs100 \times (1.12)^5 \text{ Or, using the tables directly: }

Future Value (year 5) = Bs100 \times \text{(Factor of P to F, } n = 5 \text{ years)}

Future Value (year 5) = Bs100 \times 1.7623

Future Value (year 5) = Bs176.23

7.4 Actualisation: from future value to present value

The preceding exercise has shown us that, with a given rate of return, there is real growth due to the accumulative effect of the rate, when present values are projected into the future: At a 12% growth rate, today’s Bs100 become Bs112 in one year, Bs125.44 in two years, and Bs176.23 in five years. We will now perform the opposite exercise:
If we state that 112 units of value of the coming year equal 100 of today's units, we are performing the opposite operation to that which calculates accumulation: Instead of multiplying by the factor, we now divide by that same factor (rate = 12%):

$$\text{Present Value} = \frac{112}{1.12} = 100$$

That is:

Present Value = Future Value (the following year) divided by the growth factor

We will now convert the value of 125.44 of the second year into Present Value.

$$\text{The first operation} = \frac{125.44}{1.12} = 112$$

converts the value of the second year to that of the first;

brings the value of the first year to the present.

Integrate the two steps by dividing by the growth factor 1.12 successively

And, generally:

$$\text{Present Value} = \frac{\text{future value}}{(1 + r)^n}$$

**Actualisation** is, then, the inverse of Exercise 1: it consists in converting future into present values. This procedure, that is, converting future into present values, means that future values must "return" or discount the effects of accumulation.
Dividing by the accumulation factor is the equivalent of multiplying by its inverse value:

\[
\text{Divide by } (1 + r) \text{ is the equivalent of multiplying } \frac{1}{(1+r)}
\]

To actualise by one year (at the discount rate of 12%), divide by 1.12, or multiply by \(\frac{1}{1.12} = 0.8929\). This factor is found in the tables, for \(n = 1\), in the actualisation column (second column), which is use to convert future into present value, that is, "From F to P".

To actualise from year 2, divide again by 1.12 (or multiply by its inverse 0.8929), which yields the result of 0.7972, which is the actualisation factor for \(n = 2\) in the tables.

The reader may verify the equivalent actualisation results:

\[
\text{By one year } = 112 \div 1.12 = 112 \times (0.8929) = 100
\]

(Results are approximate, because the factor is rounded off)

Generally, then:

Present Value = Future Value multiplied by the Actualisation Factor for n periods

Present Value = FV x (Factor from F to P, in n years)

* Exercise 2

Perform the opposite operation to Exercise 1, that is, actualise a future value from year 5, the amount of which is 176.23 (constant Bs), at an annual discount rate of 12%.
The problem is, given a Future Value, to discover its Present Value:

\[ PV = FV \times \text{(Factor from F to P, } n = 5) \]

Go to the tables, in the "From F to P" actualisation column and, in row 5, find the factor 0.5674

\[ PV = 176.23 \times 0.5674 = 100 \text{ (constant Bs) (Approximate due to factor rounding)} \]

The discount rate operates in function of the expected value increases of the investors' goods or real resources over time and does not refer to inflation or ordinary interest rates. For this reason, reference is made to the real discount rate:

### 7.5 Annualisation

We will now discuss the procedure for distributing present value in a uniform series of annual values, which is somewhat frequently necessary, for example when a project's operations and/or maintenance costs are the same (in constant terms) for a given period.

**Exercise 3**

Convert a Present Value of Bs500 into a series of uniform annual quotas over five consecutive years, at a real annual rate of 12%.

Express the exercise graphically:
Each of the annual values in the uniform series is called an "annuity". We will call it "A", so that the problem becomes: Find "A", with a known Present Value, and \( n = 5 \): \( A = PV \times (\text{Factor from P to A, } n = 5) \). The Factor is found in the table, in the corresponding column: Find an "annuity", beginning with a Present Value: From P to A. Go to the third column. \( A = B$s500 \times (0.2774) = B$s138.7\)

7.6 Actualisation: comparison of alternatives

Return to the initial exercise of comparing alternatives A1 and A2, as discussed above. Recall that the initial result, without weighting resource values over time, was that A1 was more expensive.

We will now examine the results produced by the incorporation of an annual discount rate of 12% and will "actualise" the alternatives, that is, we will calculate the present (current) value of the costs of each.

1. Actualisation of A1

Convert each cost element (from F to P) from the Future to Present Value (to the zero moment) and the Actualised Total Cost will be their sum:

Taking the values from the Discount Table for \( r = 12\% \)

\[
\text{ACTUALISED COST (A1)} = 10000 + 3000x(0.8929) + 4000x(0.7972) + 5000x(0.7118) + 6000x(0.6355) + 7000x(0.5674)
\]
ACTUALISED COST (A1) = Bs27,211

To actualise the uniform series of annual operations costs, they are treated as an "annuity" (example 3):
From A to P

ACTUALISED COST (A2) = 23000 + 200x (factor from A to c, n = 5)

ACTUALISED COST (A2) = 23000 + 2000x(3.6048)

ACTUALISED COST (A2) = Bs30,210

NOTE THAT THE RESULTS ARE DIFFERENT FROM THOSE OBTAINED WHEN THE OPERATION WAS PERFORMED WITHOUT APPLYING A DISCOUNT RATE.

NOW, THE ACTUALISED COST OF A2 IS HIGHER THAN THAT OF A1. This is the CORRECT RESULT, because the proper procedure was followed.
7.7 Discount rate

7.7.1 The discount rate of the individual investor

Return to the concept of the investor's expectation of value increase, according to which I, as an individual investor, expect the resources which I place in a project to increase their real value at an anticipated rate or return, which usually corresponds to what I could obtain in alternative investments.

As an investor, I base "my" expectation of value increase for my level of wealth on what my present investments are generating, or on the real return offered by a guaranteed alternative investment. Thus, if my options are to receive 112 units of real value within one year for 100 of today's units, my expectation constitutes an anticipated 12% rate of return, which, in my case, is my discount rate.

That is, since I have a somewhat "guaranteed alternative" real return on my resources, that real return is my "opportunity cost" which I will use as the rate to discount (this can be read as "punish") the projects in which I am invited to invest my capital. In this way, I will require the project to increase my wealth at a rhythm at least equal to what I would obtain otherwise in alternative endeavours. As noted above, this concept is the "investors' opportunity cost".

As an economic actor, the investor's concern is that the rate of return offered by the project will be greater that his own "opportunity cost", or discount rate: The necessary condition for the project to be interesting to him.

Thus, the discount rate is the investor's (responds to his expectations), independently of the project's internal rate of return (which is generated by the project's own flow of costs and benefits).
7.7.2 The social discount rate

According to this analysis, in a given economy, there can be as many discount rates as there are opportunity costs of the diverse economic actors operating in that society (the anticipated return of a person skilled in business matters may be different from that of a homemaker). However, we can attempt to visualise a “rate for society as a whole”, different from that of each individual economic actor.

We will now examine the other side of the coin. Behind the investment resource lies its consumption value: Each Bolivar which society allocates to investment is subtracted from consumption. In other words, investment means sacrificing or postponing consumption.

Present consumption produces welfare today. Generally, individuals prefer to not postpone their possibilities to satisfy their desire for well-being. Thus, the commonly accepted logic is to only postpone present welfare (to sacrifice today's consumption) in exchange for the expectation of obtaining a higher level of welfare later, which is made possible by converting the amount which would be dedicated to consumption today into investment.

This expectation of social return, which makes it possible to exchange a level of present welfare for a higher, future level of welfare highlights the need to also differentiate projects’ values (costs and benefits) in terms of when they occur from the perspective of society. This draws our attention to the concept of the “social discount rate”, which is of interest in the evaluation of projects from the social perspective (and not from that of the individual investor).

In principle, public investment projects are intended to generate social welfare (present and future), by the allocation of the resources which society has placed in the hands of government entities. Therefore, it is of interest to examine, in this manual, the "opportunity cost of social investment" made by the State
through the diverse projects which it finances with public funds. That opportunity cost is expressed as the social discount rate, which is estimated to be 12% annually\(^\text{12}\) for Venezuela. All projects advanced by PROINSOL will be evaluated at that discount rate.

\(^{12}\) The interested reader will find greater detail on this matter in Unit 12.
## 7.8 Appendix: 12% discount table

<table>
<thead>
<tr>
<th>n</th>
<th>P to F</th>
<th>F to P</th>
<th>P to A</th>
<th>A to P</th>
<th>A to F</th>
<th>F to A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1200</td>
<td>0.8929</td>
<td>1.1200</td>
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<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>2</td>
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<td>1.6901</td>
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8. Evaluation indicators. Cost efficiency analysis

8.1 Comparison of alternatives

* A Case study

Consider the beneficiary flow attended in the two alternatives of the example discussed in the preceding Unit. It is an educational project, in which incremental beneficiaries are considered in terms of "number of students/year" (for simplicity's sake, the analysis period for the example project is five years, although in practice the temporal horizon would be longer).

<table>
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<td>3</td>
<td>4</td>
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<td>6000</td>
<td>8000</td>
<td>10000</td>
<td>12000</td>
<td>14000</td>
</tr>
<tr>
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<td>10000</td>
<td>3000</td>
<td>3000</td>
<td>4000</td>
<td>6000</td>
<td>7000</td>
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* Number of students;  ** Thousands of today's constant Bolivars

<table>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>BENEFICIARIES *</td>
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<td>6000</td>
<td>8000</td>
<td>10000</td>
<td>12000</td>
<td>14000</td>
</tr>
</tbody>
</table>

* Number of students;  ** Thousands of today's constant Bolivars

Graphic representation of the two flows.
The question now is: if-as seen in the graphic representation- the cost flows are different, how can we translate them into a common expression so as to compare them?

One way of resolving this matter is to translate each alternative into the same indicator which will reveal their comparative convenience or advantages.

An indicator which fulfills this requirement is cost per student.

To calculate cost/student for each alternative, we must first homogenise the flows by applying the annual social discount rate of 12% (as explained in the preceding chapter).

8.2 Equivalent annual cost (eac)
An alternative's integrated cost flow is the combination of investment costs (initially high) and operations costs (which may be constant or variable in function of the benefits evaluation). These flows are usually irregular (fluctuating during the use life of the alternative).

In the analysis, it is valid to work with a sort of "average annual cost", as an equivalent to the series
of costs which are irregular over time. We achieve this by converting the original flow into an equivalent expression of uniform annual costs, with the discount rate incorporated. The value of each year in this new uniform series is called the **EQUIVALENT ANNUAL COST**.

In operational terms, Equivalent Annual Cost is obtained by converting all the elements of the original cost flow into **annuities**. Generally, the conversion should be performed in two steps:

1. **Actualise all elements of the original cost flow of the alternative.** That is, calculate the Present (Current) value of the costs.

Reconsider the results obtained previously for the example Alternative 1: (Convert "From F to P", for all years) PRESENT VALUE OF COSTS (PVC) PVC (A1) = Bs27,211 thousand.

2. **Convert Present Value of Costs into an Annuity**, for the operational life of the alternative. (Convert "From P to A")

The result is the Equivalent Annual Cost (EAC) of the alternative:

\[ EAC (A1) = PVC \times (\text{Factor of } C \text{ to } A, n = 5) \]

\[ EAC (A1) = Bs27,211 \times 0.2774 \]

\[ EAC (A1) = Bs7,548 \text{ thousand} \]

We have converted an irregular original cost flow into a uniform equivalent:

**Figura 16: Original Flow**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Value thousands of Bs 7,548**
8.3 Construction of an evaluation indicator

The Equivalent Annual Cost is already an "average" uniform expression of the total costs of the alternative.

We also need to convert the beneficiaries into a corresponding expression, into an "annual average". A simple method suggested for cases in which the benefit units are persons (students, in the preceding example) is to calculate the annual arithmetic average of the beneficiary flow:

Annual Beneficiary Average = \#B

\[
B = \frac{6000 + 8000 + 10000 + 12000 + 14000}{5} = 10000 \text{ students year}
\]

By dividing the Equivalent Annual Cost (Bs) of the alternative by the Annual Beneficiary Average, we discover the cost of attending a beneficiary.

\[
A1 = \frac{\text{Equivalent Annual Cost Annual Average of Beneficiaries}}{\text{Bs (thousands)}} = \frac{7,548}{10000} \text{ st}
\]

\[
A1 : EAC = \frac{\text{EQUIVALENT ANNUAL COST}}{\text{STUDENT}} = \frac{\text{Bs775}}{\text{students}}
\]

This coefficient is a COST/EFFICIENCY indicator and will be used to compare the two alternatives.

**Alternative 2:**

1. **Equivalent Annual Cost = EAC**

Note that, in this alternative, operations costs are uniform. Thus, it will suffice to distribute the initial investment in annuities and add operations costs (which are already in annuities):

\[
\text{EAC (A2)} = 23000 \times (\text{Factor from C to A, } n = 5) + 2000
\]
EAC (A2) = 23000 \times (0.2774) + 2000
EAC (A2) = Bs8,380 thousand

2. Annual Average of Beneficiaries: #B

#B = 10000 students/year

3. COST/EFFICIENCY Indicator:

\[
\frac{EAC}{B} = \frac{Bs \text{ (thousands)} \times 8.380}{10000 \text{ students}} = Bs \frac{838}{\text{student}} (2)
\]

Comparing results (1) and (2), alternative A1 is seen to be preferable, because it involves a lower annual cost for each student.

8.4 "Cost/efficiency" evaluation

8.4.1 Meaning and criterion

Indicators such as these are of great economic importance, because they can be employed to compare alternatives and inform decisions on their convenience with respect to the proposed objective (associated with a problem), in order to achieve the greatest economic efficiency possible in resource allocation, given that, if the satisfaction level delivered by a pre-selected set of alternatives is similar (in nature, intensity and quality), the most economically and socially acceptable alternative will be that which entails the least cost per unit of benefit covered.

This evaluation approach implies the following principle: When the satisfaction of the basic needs of the population is sought, these projects produce undoubted benefits but are difficult to evaluate. Their social benefits are evident and do not require demonstration and, therefore, analytic concern is displaced to the selection of the least costly alternative (or project). For this reason, "cost/efficiency" methodology is widely used on social benefits projects, such as education and health projects.
8.4.2 Coefficient variety

Various cost/efficiency indicators can be constructed, according to the types of benefits identified. The simultaneous and complementary use of the two most common cost/efficiency indicators will improve the analysis:

a. Cost per beneficiary (or per unit of coverage)

Examples: Cost/student, in educational projects; cost/attention, in health projects; cost/family, or cost/househook-up, in drinking water and basic sanitation projects; cost/hectare, in farm infrastructure or environmental projects. The exercise performed above confronted two alternatives for cost/efficiency in terms of "minimum cost per beneficiary".

b. Cost per unit produced (or of installed capacity)

Examples: Cost/cubic metre, in aqueduct or irrigation projects; cost/built kilometre, in road projects; cost/tonne or cost/head butchered, in slaughterhouse projects.

8.5 Cost/efficiency and social benefits projects

8.5.1 Evaluation of social benefits projects

Most so-called social benefits projects generate extremely important benefits, the true value of which is difficult to measure: the education of a child, the prevention of a disease, lower levels of morbidity and mortality as a result of the delivery of high quality water.

---

13 Recall the discussion of benefits, in terms of project typologies, in point VI-B.
14 Given that PROINSOL recommends cost-benefit evaluation, the cost/benefit indicator complements the analysis and can even be used to evaluate alternatives which solve the same problem with identical benefits, in these environmental sanitation projects.
15 Same comment as in the previous note on drinking water and road projects.
The derived effects (final benefits) of those projects are, then, accepted as undoubtedly worthwhile, so that the project evaluator is relieved of the task of having resort to quantitative stratagems to demonstrate, for example, that it is economically convenient to avoid the death of a person.

If this is so, what remains is to verify that project impact, widely accepted as being worthwhile, can be achieved by alternatives which are economically (socially) less expensive than others. This implies having recourse to some criterion for the selection of the most efficient alternative. And that criterion is supplied by cost/efficiency analysis, according to which decisions are made on the basis of minimising the product or beneficiary cost per unit, specially in projects of a social nature, such as those for education, health or basic sanitation.

It is assumed that the anticipated effects of social projects are effected through their product, always as long as it is of high quality, timely, fluid and adequately used. This assumption makes it possible to employ simple evaluation methodologies for social projects, such as those based on cost/efficiency indicators.

8.5.2 Cost/efficiency: simple measurements

Only costs are calculated (monetarily) in the construction of cost/efficiency indicators. It is sufficient to measure and add benefits, because they are generally homogeneous units.

For example, a drinking water project generates only one product, assumed to be homogeneous (of guaranteed quality), so that it is sufficient to add the cubic metres produced in a given period to measure the anticipated benefit. This makes the calculation of cost/efficiency indicators simple and easy and, therefore, it is unnecessary to appraise benefits monetarily, because they are measured in terms of a common unit - as is the case for many so-called “social benefits” projects: cubic metres of water, students, patients attended in heath projects, passengers moved.
If product units are heterogeneous or benefits are complex, this indicator loses coherence and is difficult to manage operationally. In those situations, it is necessary to have recourse to benefits assessment methods, which are discussed in the next Unit.
9. Cost-benefit analysis

9.1 Concept. Benefits appraisal

In a wide variety of projects, it is difficult to identify (or measure) benefits at the level of the products or delivery of infrastructure at the site. In many of these cases, it is necessary to "follow the trail of the product" and locate the impact produced by product use, because it is there that the benefit can most readily be appreciated.

Appraisal difficulties are greater when we must examine multi-purpose alternatives (or projects), designed to achieve several simultaneous goals, through complementary components, activities or products which generate benefits for diverse users (example: a dam for generating power, to provide drinking water, irrigation and flood control).

To overcome these limitations (on benefit identification or appraisal), we have recourse to COST-BENEFIT ANALYSIS.

When benefits are diverse in nature, indicators which join or integrate those benefits into one measurement unit should be employed. This involves the use of weighting factors to join concepts of diverse values. For this reason, the best, most commonly used and simplest methodology is to appraise benefits monetarily.

Likewise, when products are not necessarily diverse but are difficult to measure "in kind", monetary appraisal is performed. There are also projects in which monetary appraisal is not feasible (there are no market prices for the product), but their impact can be perceived in practice; in these cases, impact appraisal overcomes the limitations on product appraisal.

To summarise: once the alternatives' benefits have been defined: cost/benefit analysis overcomes the shortcomings of impact appraisal which cannot adequately express cost/efficiency indicators for this type of project and, therefore, it performs the appraisal of the benefits incorporated into the analysis.
9.2 Cost-benefit indicators: PNV, IRR, C/B

Cost-benefit analysis is based on the following operation: Cost-Benefit indicators, as well as appraising costs, also appraise benefits. In these cases, values must be assigned to each type of benefit, multiplying, for each year, the anticipated amounts of benefit contribution, by their market prices, to obtain the total annual value of the benefit.

We repeat that, in every case, the definition and measurement of costs and benefits is performed by incremental analysis, that is, by the appraisal of the difference of situations "WITH" and "WITHOUT" PROJECT.

Three of the most common types of indicator used in cost-benefit analysis are:

1. Present Net Value (PNV), also called Current Net Value (CNV)
2. Internal Rate of Return (IRR)
3. Benefit/Cost Ratio (B/C)

We will proceed to discuss each of these indicators.

9.3 Present net value (PNV)

1. Operational definition

This is defined as the Actualised Value of the Benefits, less the Actualised Value of Costs, discounted at an accepted rate (In PROINSOL projects, the discount rate accepted as reflecting the opportunity cost for public investments is 12%).

2. Example:

Consider an alternative whose flow of costs and benefits is summarised in the following table:
### ESTIMATE OF PRESENT NET VALUE

**BENEFITS AND COSTS ACTUALISATION TABLE**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>BENEFITS</th>
<th>COST</th>
<th>FACTOR ( r = 12% )</th>
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**SUM PV BENEFITS**  
44242.8

**SUM PV COSTS**  
40609.3

**PRESENT NET VALUE (PNV) IN THOUSANDS OF Bs:**  
\[ PNV = 44243 \text{ MINUS } 40609 = 3634 \]

\[ PNV = 3634 \text{ THOUSANDS Bs.} \]

3. **Decision criterion**

a. **The alternative (project) in itself**

Basic criterion: the discounted benefits flow should be greater that the discounted costs flow. Because observation is focussed on the result of Benefits minus Costs, **analysis is performed around zero**:
In this case, PNV x > 0, so the alternative is acceptable in itself.

b. Comparison among alternatives

Among several alternatives of equal duration, the higher PNV is decisive.

However, when the alternatives are of different lengths over time, PNV must be converted into Equivalent Annual Value (EAV), to obtain an expression which makes them comparable. EAV distributes PNV uniformly over the years of the use life of each alternative.\textsuperscript{16} The highest EAV indicates the best alternative.

9.4 The internal rate of return (IRR)

If PNV is positive at a given discount rate, this means that the benefits are greater than the costs at that rate and, therefore, the profitability of the alternative is greater than the discount rate. If PNV is negative, its profitability will be less than the discount rate. And, if PNV is zero, the profitability of the alternative is the same as the actualisation rate. This analysis gives rise to the concept of the Internal Rate of Return.

\textsuperscript{16} EAV is the PNV converted into an "annuity". Thus, it is obtained by multiplying the PNV by the factor "From P to A" for the operational duration of each alternative.
1. Operational Definition

This is defined as the rate which makes the Present Net Value equal to zero, that is, the actualised Benefits equal to actualised Costs.

2. Example:

INTERNAL RATE OF RETURN ESTIMATE ACTUALISATION TABLE OF COSTS AND BENEFITS FIRST TRIAL WITH DISCOUNT RATE OF 20%

<table>
<thead>
<tr>
<th>YEAR</th>
<th>BENEFITS (Bs.)</th>
<th>COSTS (1000)</th>
<th>NET FLOW (B-C)</th>
<th>FACTOR r = 20%</th>
<th>PRESENT NET VALUE</th>
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<td>1291</td>
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<td>12000</td>
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<td>4950</td>
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</tbody>
</table>

VNP AT 20% -2750

PRESENT NET VALUE NEGATIVE:
OPERATIONAL DECISION:
INCREASE DISCOUNT RATE
INTERNAL RATE OF RETURN ESTIMATE ACTUALISATION TABLE OF COSTS AND BENEFITS SECOND TRIAL WITH DISCOUNT RATE OF 14%

<table>
<thead>
<tr>
<th>YEAR</th>
<th>BENEFITS Bs. (COSTS 1000)</th>
<th>NET FLOW (B-C)</th>
<th>FACTOR ( r = 14% )</th>
<th>PRESENT NET VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>13600</td>
<td>-13600</td>
<td>1.0000</td>
<td>-13600</td>
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<td>2</td>
<td>5400</td>
<td>1600</td>
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<td>0.7695</td>
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<tr>
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<td>0.6750</td>
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</tr>
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<td>4080</td>
<td>4960</td>
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<tr>
<td>6</td>
<td>10200</td>
<td>4896</td>
<td>5304</td>
<td>0.4556</td>
</tr>
<tr>
<td>7</td>
<td>10500</td>
<td>5875</td>
<td>4625</td>
<td>0.3996</td>
</tr>
<tr>
<td>8</td>
<td>12000</td>
<td>7050</td>
<td>4950</td>
<td>0.3506</td>
</tr>
<tr>
<td>9</td>
<td>12000</td>
<td>7050</td>
<td>4950</td>
<td>0.3075</td>
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<tr>
<td>10</td>
<td>12000</td>
<td>7050</td>
<td>4950</td>
<td>0.2697</td>
</tr>
</tbody>
</table>

VNP AL 14% 1706

PRESENT NET VALUE POSITIVE:
OPERATIONAL DECISION: SINCE THERE IS A SIGN CHANGE, INTERPOLATE:

INTERPOLUATION

<table>
<thead>
<tr>
<th>Difference in the rate</th>
<th>r</th>
<th>PNV</th>
<th>Difference in the PNV</th>
</tr>
</thead>
<tbody>
<tr>
<td>6%</td>
<td>20%</td>
<td>-2750</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IRR</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14%</td>
<td>1706</td>
<td>4456</td>
</tr>
</tbody>
</table>

\[ 6\%\times\frac{1706}{4456} = 0.023 = \text{DIFFERENCE} \]

\[ \text{IRR} = 0.14 + 0.023 = 0.163 = 16.3\% \]
3. **Criterion for decision-making**

a. **The alternative (project) in itself**

The IRR measures the economic (social) profitability of the project. Generally, the public institution should compare the project’s IRR with the 12% rate (which is assumed to be the average opportunity cost for public social investment). For this reason, the analysis is performed around the difference between the IRR and the Social Discount Rate of 12%.

<table>
<thead>
<tr>
<th>RESULT</th>
<th>DECISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGHER (IRR &gt; 12%)</td>
<td>ACCEPT</td>
</tr>
<tr>
<td>EQUAL (IRR = 12%)</td>
<td>INDIFFERENCE</td>
</tr>
<tr>
<td>LOWER (IRR &lt; 12%)</td>
<td>REJECT</td>
</tr>
</tbody>
</table>

In the example, the alternative has an IRR of 16%, which is greater than the social rate of 12%, making it attractive.

b. **Comparison among alternatives**

Among alternatives, that with the highest IRR wins (as long as the IRR $> 0 = 12\%$).

In some cases, there are limitations on the calculation of the IRR and its usefulness as an indicator for the correlative analysis of alternatives, so it is recommended that, when it is used, it be supported by the calculation of the PNV.\(^7\)

\(^7\) The interested reader will find a more detailed discussion of this matter in the Appendix of Chapter XI.
9.5 The cost/benefit ratio (C/B)

1. Operational Definition
As its name indicates, it is defined by the coefficient between the Actualised Benefits and the Actualised Costs, discounted at the social rate of 12%.

2. Example:

<table>
<thead>
<tr>
<th>YEAR</th>
<th>BENEFITS Bs.</th>
<th>(COSTS 1000)</th>
<th>NET FLOW (B-C)</th>
<th>FACTOR r = 14%</th>
<th>PRESENT NET VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>13600</td>
<td>-13600</td>
<td>1.0000</td>
<td>-13600</td>
</tr>
<tr>
<td>1</td>
<td>2800</td>
<td>8200</td>
<td>-5400</td>
<td>0.8772</td>
<td>-4737</td>
</tr>
<tr>
<td>2</td>
<td>5400</td>
<td>1600</td>
<td>3800</td>
<td>0.7695</td>
<td>2924</td>
</tr>
<tr>
<td>3</td>
<td>5400</td>
<td>1600</td>
<td>3800</td>
<td>0.6750</td>
<td>2565</td>
</tr>
<tr>
<td>4</td>
<td>8670</td>
<td>3400</td>
<td>5270</td>
<td>0.5921</td>
<td>3120</td>
</tr>
<tr>
<td>5</td>
<td>9040</td>
<td>4080</td>
<td>4960</td>
<td>0.5194</td>
<td>2576</td>
</tr>
<tr>
<td>6</td>
<td>10200</td>
<td>4896</td>
<td>5304</td>
<td>0.4556</td>
<td>2416</td>
</tr>
<tr>
<td>7</td>
<td>10560</td>
<td>5875</td>
<td>4625</td>
<td>0.3996</td>
<td>1848</td>
</tr>
<tr>
<td>8</td>
<td>12000</td>
<td>7050</td>
<td>4950</td>
<td>0.3506</td>
<td>1735</td>
</tr>
<tr>
<td>9</td>
<td>12000</td>
<td>7050</td>
<td>4950</td>
<td>0.3075</td>
<td>1522</td>
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<tr>
<td>10</td>
<td>12000</td>
<td>7050</td>
<td>4950</td>
<td>0.2697</td>
<td>1335</td>
</tr>
<tr>
<td>VNP AL 14%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1706</td>
</tr>
</tbody>
</table>

COST/BENEFIT RATIO (C/B):

\[
\frac{C}{D} = \frac{44243}{40609} = 1.1
\]
3. **CRITERION FOR DECISION-MAKING**

a. The alternative (project) in itself

Since we are dealing with a coefficient, the analysis of the result is performed around one:

<table>
<thead>
<tr>
<th>RESULT</th>
<th>DECISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGHER (C/B &gt; 1)</td>
<td>ACCEPT</td>
</tr>
<tr>
<td>EQUAL (C/B = 1)</td>
<td>INDIFFERENCE</td>
</tr>
<tr>
<td>LOWER (C/B &lt; 1)</td>
<td>REJECT</td>
</tr>
</tbody>
</table>

In the example, the alternative yields a ratio of 1.1, that is, greater than 1, making it attractive.

b. Comparison among alternatives

The alternative with the highest C/B is chosen, as long as > 0 is equal to 1.

Nevertheless, C/B is limited, as an indicator for alternative selection, so that it should also be used jointly with PNV.\(^\text{18}\)

Generally, when the indicators analysed yield results in or near the "indifference" range, it will be necessary to examine other factors relevant to the proposed solutions with greater care and construct other complementary indicators which will enrich the analysis and lead to better decisions.

9.6 **Criteria and mechanisms to measure and appraise benefits**

Benefits measurement and appraisal depend on the nature of the benefits and how they are defined and

---

\(^{18}\) See the Appendix of Chapter XI.
visualised within the spectrum of project effects and in terms of the ease with which their price can be
determined. Benefit prices can be determined in various ways:

9.6.1 Current market prices

This is the most commonly used method: the good or service is traded regularly: there is a price associated
with the benefit and this can be taken from the local market.

Examples:

* the wholesale market unit price for a tonne of corn or tomatoes for a farm commercialisation
  project.

* the average value of housing will be equal to the average area constructed, multiplied by the
  market price for a square metre. An agreed upon percentage of this value can serve as the benefit
  attributed to canal construction, as the value of the damage prevented by the project.

9.6.2 Hedonic prices

There are cases in which (all or some) benefits generated by the project are incorporated into the value
be attributed to the project. This type of situation occurs in projects which increase the value of public
goods or improve the surroundings.

The purpose of the hedonic method is to estimate the implicit price of the project benefit incorporated into
another good, the overall value of which is increased by the project. The aggregate goods to which the
benefits of this type of project are incorporated are generally real estate.

When the project is implemented in a specific locality, the price which the beneficiaries of the situation
improved by the project will be willing to pay for the part of the benefit which they will supposedly enjoy
is not known "a priori". One commonly used method is to take representative surveys of land prices "with"
and "without" project, in localities already known and similar to the project site, ensuring that the other
variables of the situation remain the same or at least do not affect the price increase. These investigations of similar situations generate the "appraisal" components attributable to the project, as a percentage of the land value.

In this method, special care must be taken to isolate the effects of the alternative, in order to avoid evaluating benefits by including value increases accruing from other situational factors, different from the project.

Examples:
* The housing price increase as an anticipated result of a sidewalk and street paving project.
* The appreciation of land prices in an urban area, due to the draining of a fetid swamp.

9.6.3 Contingent prices

So-called "contingent appraisal" is an alternative methodology to hedonic pricing and is applicable to projects with characteristics proper to public goods.¹⁹ It is also useful for projects with a broad repertory of effects and a wide range of direct and indirect beneficiaries, which makes it difficult to measure benefits.

The contingent appraisal approach consists in taking stratified surveys in which those interviewed are asked about their willingness to pay for a certain good or service which would be delivered by the project in question. The distinction between direct and indirect project beneficiaries must be accounted for by the stratification criteria.

The surveys should be specially designed to gather information on three aspects:

¹⁹ So-called public goods have the following characteristics: a) common or collective availability; b) no one can be excluded from their use; and c) they cannot be traded in organised markets. Examples: national defense, the justice system, air.
a. the socioeconomic characteristics of the family and the person interviewed; this verifies the stratification of the sample;

b. Probe those interviewed (potential beneficiaries) for their degree of awareness of the gravity of the problem in question, its causes, and the validity of the alternative proposed to solve that problem;

c. Their willingness to pay for the supposed project product.

The main limitation observed in practise is that the interviewees tend to suggest under-valued prices, that is, scant willingness to pay.

Examples:

* Typical cases of contingent appraisal are for environmental sanitation projects.
10. The economic evaluation of projects - a first approximation

10.1 Purpose

This Unit has a double purpose:

1. to provide the basic reasons for socio-economic evaluation, in contrast to private evaluation;

2. to familiarise the reader with the concept and use of accounting prices, so as to convert market prices into economic prices.

It is hoped that the elements of this Unit will enable users without extensive formation in economic concepts to perform the economic evaluation of alternatives, a matter addressed in the next Unit. In function of that objective, this Chapter was developed in simple language, based on examples for didactic purposes.20

10.2 The financial evaluation and economic-social evaluation of projects

We will now discuss the essence of the distinction between private evaluation and social evaluation.

1. Private evaluation

From the individual point of view, each institutional agent has its own expectations vis-a-vis the project (or alternative).

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20 We refer interested readers, specially trainers who will use this methodological manual, to Unit XII, which contains a more detailed discussion of the economic and social evaluation of public investment projects.
a. the private agent considers the benefits to be the goods or services which the project should deliver and through which his particular interests will be served (for example, income from sales from which he will perceive financial profit);

b. entrepreneurial costs are those which must actually be made to prepare, install and operate the project;

c. thus, the financial balance, equal to benefits less costs, is the result of appraisal at market prices.

2. Social (economic) evaluation

Now, we ask: Is the balance generated by the project for the private entrepreneur the same if we view it from the perspective of the economy or society, as a whole?

We can answer that they are not necessarily the same. In most cases, there are differences in the way the balance is calculated (benefits less costs), given that the interests of the entrepreneur and the economy, as a whole, may be different.

a. Perception of benefits. When an entrepreneur builds and operates a road, in public concession, his benefits are measured in terms of his income from tolls. However, for the perspective of the economy, the benefits include a range of advantages which the farmers of the region derive from the situation "with project" (the road is operational, instead of having no road), such as the following:

* fewer harvest losses from lack of transportation;
* shorter transportation times;
* increased farm production because easier transportation justifies more intense land exploitation.
b. **Externalities.** There are also differences in costs. Suppose that an entrepreneur closes a road to construct a building (assuming the authorities allow it). A cost is incurred which he does not pay but which is caused to others, consisting in the inconvenience caused by the impossibility of using that road during construction: more time, greater distances, higher fuel consumption. Here, the individual agent does not incur a cost, but there is a cost for society, represented by the group of persons affected by the construction project.

c. **Appraisal.** Just as the private entrepreneur makes his estimates at "market prices", so, from the perspective of the economy as a whole, **prices which reflect what the resources allocated to a project cost society** must be determined. This is one of the issues discussed in this Unit.

### 10.3 Introduction to the economic evaluation of projects. The opportunity cost of productive inputs

On the basis of the preceding observations, we will now discuss the **economic evaluation** of projects, as that which expresses the **perspective of society as a whole** (in contrast to **financial evaluation**, which responds to the interests of the individual agent). Economic evaluation follows the trail of the **benefits and costs generated by the project for the economy in general, for aggregate society** (for this reason, it is also called **social evaluation**, in everyday language. In this Unit, we employ the terms "economic evaluation" and "social evaluation" without distinguishing between them).

Recall that the **objective of a society is to increase its welfare.** To this end, society expects its investments to maximise their contribution to its welfare and, therefore, the economic evaluation of projects should incorporate that goal into its analytical methodology. Social welfare can be achieved directly or indirectly.

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The terms "social-economic evaluation" and "socioeconomic evaluation" are also found in specialised texts. We return to these concepts in greater depth in Unit XII.

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ILPES/Project and Investment Programming Division
* It is achieved directly when goods or services are produced for consumption, because consumption increases welfare.

* It is achieved indirectly when a good is withdrawn from final consumption and is used to produce other goods which will increase welfare when consumed.

In this sense, all goods and resources allocated to projects are withdrawn from consumption (as a "good" or "service", so that social welfare is sacrificed); or they are diverted as resources, sacrificing their alternative contribution to the welfare which would be obtained by their use in another project or productive activity.

This leads us to the concept of "opportunity cost", understood as the sacrifice for society represented by the use of resources in projects: that which society does not receive as a result of the allocation of resources to the project, by withdrawing them -directly or potentially- from some alternative economic use. Society "sacrifices the opportunity" of using the resource in a different way, by employing it in the project (or alternative). Thus, its name.

### 10.4 Externalities

Socio-economic evaluation explores the relationships between the project and its surroundings. It seeks to discover the external effects caused by the project.

#### 10.4.1 Impact on direct users

On the one hand, it studies the positive (benefits) or negative (costs) effects on the immediate target group. Beyond the sale of the product, it investigates the relationships "in function of the goal", that is, the costs and benefits which the project may entail or induce by delivering the product to the target group.
Costs in function of the goal are those which the users must incur to adequately enjoy the project's products. Example: household installations to use drinking water connections.

Benefits in function of the goal are those which the users expect to obtain as a result of the use of the project's products. Example: increased farm production from the use of irrigation water delivered by the project to the farmers of the area.

10.4.2 Externalities

Economic evaluation also examines the so-called "externalities", that is the project's repercussions on other economic agents or social groups different from the users.

The project may also cause difficulties and inconvenience or may erode the welfare of non-users. These negative effects increase the social costs of the project, insofar as they diminish the standard of living of others or cause them additional costs as they avoid the undesired impact of the project. Classic examples: environmental deterioration and pollution.

There may also be positive repercussions from project implementation on groups other than the users, which increase overall welfare. Example: The increased value which accrues to neighbouring communities, caused by a project to improve a shantytown.

Another concern in the analysis of externalities is the exploration of relationships "back toward the source", which are "derivative" connections with other projects or economic agents whose products serve as inputs into the project in question. An example of this chain effect is the probable impetus imparted to activities to classify and recycle solid wastes arising from the installation of a scrap iron foundry.

The alternatives' externalities should also be examined, together with the economic evaluation indicator employed, to improve comparative analyses and the decision-making process.
10.5 Accounting prices

As the private entrepreneur uses market prices, socio-economic evaluation employs so-called accounting prices, to adequately appraise public investment project inputs and products (Also called "economic prices" or "social prices").

Accounting prices seek to measure the real value of the contribution of the resources to community welfare-being.

10.5.1 The accounting price of goods and services

For any economic or institutional agent, costs are appraised at the price which must usually be paid in the market for the corresponding resources. Thus, for economic agents considered independently, it is said that their costs are assessed at market prices.

But what is the real value of the costs which society -as a whole- must incur? We already know that they are not the same for society as for the entrepreneur. In short, there are differences, caused by "institutional interventions" and other factors which hinder the free play of the market.

* Consider an example: Suppose that the investment item "Machinery and Equipment" has a cost of Bs500,000, and that Bs100,000 correspond to indirect taxes. The market price for the entrepreneur will be the total, because that is what he must actually pay for those resources.

And what is the price for society as a whole? First, we must understand that the diverse members of society, both entrepreneurs and the State, are parts of the same set or system. And when financial transfers are made among agents of the same system, without adding new value to the economy, those transfers cancel out and their global effect on the economy is zero. It is like passing money from the right pocket to the left: the value level is the same.
This occurs with taxes: they are transfers among agents of the same system (from the entrepreneur to the State, and from there, to other members of society, as salaries and services). In conclusion, the tax component has no effect on the social cost of "Machinery and Equipment" and, thus, in a first and simplified approximation, the Social Price will be less than the market price = Bs400,000.

In this example, the so-called "Accounting Price Ratio" (APR) is produced by the formula:

\[
APR = \frac{Social\ Price}{Market\ Price}
\]

As this example demonstrates the effects of indirect taxes, there are other types of governmental intervention and measures which distort market prices, such as those resulting from tariffs, subsidies, diverse exchange rates, price controls, etc.

The Accounting Price Ratios have already been calculated for a range of goods (inputs or products) and are found in the Annexes of the sector methodologies.\(^{22}\)

Thus, when inputs are assessed and the market price for a good is known, it is only necessary to discover its APR in the table to obtain its social price, accounting price or so-called economic price.

\[
SOCIAL\ PRICE = MARKET\ PRICE \times APR
\]

In the example:

\(^{22}\) We have employed a simplified methodology here for didactic purposes. The calculation of accounting prices is based on more complex models, which take into account the internal composition of prices and those elements which mark the distance between market and economic prices. This is discussed in greater detail in Unit XIII.
Another example. A project involves fuel costs (gasoline) of Bs380,000, at market prices. In Venezuela, which exports oil, each gallon of gasoline used as a project input implies that its export value, measured at the international price, is sacrificed. The (domestic) market price for gasoline is protected and is lower than the international price. Thus, the APR is 2.236, higher than one: for each Bolivar allocated for gasoline, a social value of Bs2.236 is forfeited.

10.5.2 The social price of labour

If a project uses labour already employed in other economic activities, social costs measured in terms of what that labour ceases to produce are incurred. Consider two extreme situations.

If the labour used in the project was fully employed in another activity, its “social opportunity cost” —what it ceases to produce— is equal to its total social remuneration for that production, that is the entire salary. In this case, the Accounting Price Ratio is equal to 1, because its market price is equal to its social price: it costs the entrepreneur the same as society as a whole. This is generally the case for Skilled Labour, the APR for which is 1.

If, on the contrary, labour is unemployed, its contribution to social production “without project” is zero, so that its social cost is zero, although the entrepreneur must, according to labour laws, pay minimum wage (market price), when hiring for his project.23

The usual situation for Unskilled Labour is that an unemployed percentage is combined with under-employed and employed “without project” segments. The combination of these weighted segments,

---

23 In practice, it is greater than zero, due to the “reserve wage”. This point is developed in Chapter 13.
averaged for the whole country, yields a Accounting Price Ratio of 0.55, since it is obvious that, in an economy with unemployment and under-employment, the market price of unskilled labour will be higher than its social price.

10.5.3 The social discount rate

Recall our earlier analysis: society postpones present welfare (sacrifices consumption today) in exchange for the expectation of greater welfare in the future, converting the value withdrawn from consumption into investment.

This exchange of present welfare for greater welfare in the future implies a "social weighting" of values over time. This is the "social discount rate" which is used in socio-economic evaluation.

The social discount rate weights the "opportunity cost of public investment" made by the State in the different projects it finances with public funds, over time. The social discount rate for Venezuela, as for other Latin American countries, is 12% annually. Therefore, that rate is taken as the average opportunity cost rate for public social investment.
11. Evaluation of alternatives

(Social) economic prices are, for society as a whole, what market prices are for the individual agent. "PROINSOL"—in function of its objective to co-finance projects to satisfy community needs—is concerned with the rational use of social investment funds. Thus, in fulfillment of this objective, its project elaboration and evaluation methodologies must include the appraisal of the cost and benefits flows of the alternatives in terms of economic prices.

This Unit presents the entire process for configuring cost and benefits flows at economic prices and elaborating indicators for the comparative evaluation of alternatives so as to choose that which entails the most efficient use of the resources involved.

11.1 Cost/efficiency indicators at economic cost

For didactic purposes, we will review a simplified case, on the basis of an alternative for which we already have a basic technological notion.
### 11.1.1 Beneficiaries

**TABLE NO 1 ACTUALISED BENEFITS FLOW**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>M3/ YEAR THOUSANDS</th>
<th># BENEFITS</th>
<th>P.V. FACTOR</th>
<th>RODUCT ACTUALIS (1000 M3)</th>
<th>BENEFIT ACTUALIS. (P)</th>
<th>M3 DAY</th>
<th>URBAN M3/DAY</th>
<th>M3/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>488</td>
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<td>1.9090</td>
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<td>969</td>
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<td>16106</td>
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<td>2899017</td>
<td>43883</td>
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<td>1150</td>
<td>17510</td>
<td>0.4039</td>
<td>465</td>
<td>7072</td>
<td>3152</td>
<td>3151786</td>
<td>45288</td>
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<td>46737</td>
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<td>20455</td>
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<td>6586</td>
<td>3682</td>
<td>3681847</td>
<td>48232</td>
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<td>12</td>
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<td>27314</td>
<td>0.2875</td>
<td>516</td>
<td>7852</td>
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<td>4916599</td>
<td>94583</td>
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<td>13</td>
<td>1896</td>
<td>28857</td>
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<td>487</td>
<td>7407</td>
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<td>5194264</td>
<td>50971</td>
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<td>14</td>
<td>2000</td>
<td>30443</td>
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<td>6977</td>
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<td>5479703</td>
<td>52399</td>
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<td>0.2046</td>
<td>431</td>
<td>6563</td>
<td>5773</td>
<td>5773135</td>
<td>53860</td>
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<td>16</td>
<td>2190</td>
<td>33333</td>
<td>0.1827</td>
<td>400</td>
<td>6090</td>
<td>6000</td>
<td>6000</td>
<td>55374</td>
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<td>17</td>
<td>2190</td>
<td>33333</td>
<td>0.1631</td>
<td>357</td>
<td>5437</td>
<td>6000</td>
<td>60924</td>
<td>11385</td>
</tr>
<tr>
<td>18</td>
<td>2190</td>
<td>33333</td>
<td>0.1456</td>
<td>319</td>
<td>4855</td>
<td>6000</td>
<td>6000</td>
<td>56518</td>
</tr>
<tr>
<td>19</td>
<td>2190</td>
<td>33333</td>
<td>0.1300</td>
<td>285</td>
<td>4335</td>
<td>6000</td>
<td>6000</td>
<td>60157</td>
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<tr>
<td>20</td>
<td>2190</td>
<td>33333</td>
<td>0.1161</td>
<td>254</td>
<td>3870</td>
<td>6000</td>
<td>6000</td>
<td>61841</td>
</tr>
</tbody>
</table>

Total Actualised Benefits: 8839 134538
11.1.2 Investment Cost Flows

This is elaborated on the basis of the works budget at market prices (TABLE N° 2).

The flow is distributed over time according to the installation time-table. In this case, the entire investment is made in what we have opted to call "year zero". It is assumed that this will be the case in most small-scale social investment projects. The investment cost flow is actualised with the discount rate for determining Present Market Price Values (P.M.P.V.).

**TABLE N° 2**

**AQUEDUCT PROJECT. ACTUALISED BENEFITS FLOW**

<table>
<thead>
<tr>
<th>CONCEPT/ITEM</th>
<th>UNIT</th>
<th>QUAN.</th>
<th>PRICE (Bs.)</th>
<th>TOTAL COST</th>
<th>INV. YEAR</th>
<th>LIFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICAL WORK</td>
<td>UNIT</td>
<td>1</td>
<td>450000</td>
<td>450000</td>
<td>0</td>
<td>0.942</td>
</tr>
<tr>
<td>INTAKE</td>
<td>UNIT</td>
<td>1</td>
<td>420000</td>
<td>420000</td>
<td>0</td>
<td>0.942</td>
</tr>
<tr>
<td>SAND STRAIN</td>
<td>UNIT</td>
<td>1</td>
<td>460000</td>
<td>460000</td>
<td>0</td>
<td>0.942</td>
</tr>
<tr>
<td>ADDUCTION</td>
<td>UNIT</td>
<td>1</td>
<td>985000</td>
<td>985000</td>
<td>0</td>
<td>0.942</td>
</tr>
<tr>
<td>STORAGE TANK</td>
<td>UNIT</td>
<td>1</td>
<td>310000</td>
<td>868000</td>
<td>0</td>
<td>0.942</td>
</tr>
<tr>
<td>DISTRIBUT. NETWORK</td>
<td>KM</td>
<td>28</td>
<td>60000</td>
<td>900000</td>
<td>0</td>
<td>0.942</td>
</tr>
<tr>
<td>DISTRIBUT. TANKS</td>
<td>UNIT</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* MACHIN. AND EQUIP.: 840000

| PUMP                | UNIT | 1     | 840000      | 840000     | 0         | 0.93 |

* LABOUR:          # PERSONS | GROSS SALARY |

| SKILLED:             |       |       |             |            |           |      |
| CIVIL ENGINEER      | 1     |       | 900000      | 900000     | 0         | 1    |
| SUPERVISORY ENG.    | 1     |       | 600000      | 600000     | 0         | 1    |
| WORKS CHIEF         | 1     |       | 450000      | 450000     | 0         | 1    |

| UNSKILLED           |       |       |             | 4840000    | 0         |      |
| WORKERS             | 22    |       | 220000      | 4840000    | 0         | 0.55 |

TOTAL (Bs.)          |       |       |             | 23665000   |           |      |
Accounting Price Ratios (APR) are used as factors to convert market prices into economic prices. Each item has been identified with a UIIC "sector", to assist comprehension or by affinity. This yields Present Value at Economic Prices: “P.V.E.P” (TABLE N° 3).

### TABLE N° 3

**INVESTMENT FLOW AT MARKET PRICES AND ECONOMIC PRICES**

<table>
<thead>
<tr>
<th>CONCEPT/ITEM</th>
<th>YEAR (0)</th>
<th>FACT. P.V.</th>
<th>P.V.(0)</th>
<th>YEAR (1)</th>
<th>FACTOR P.V.</th>
<th>P.V. (1)</th>
<th>P.V.M.P (0)+(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>* PHYSICAL WORKS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTAKE</td>
<td>450</td>
<td>1.00</td>
<td>450</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>450</td>
</tr>
<tr>
<td>SAND STRAIN</td>
<td>420</td>
<td>1.00</td>
<td>420</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>420</td>
</tr>
<tr>
<td>ADDUCTION</td>
<td>4600</td>
<td>1.00</td>
<td>4600</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>4600</td>
</tr>
<tr>
<td>STORAGE TANK</td>
<td>985</td>
<td>1.00</td>
<td>985</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>985</td>
</tr>
<tr>
<td>DISTRIB. NETWORK</td>
<td>8680</td>
<td>1.00</td>
<td>8680</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>8680</td>
</tr>
<tr>
<td>DISTRIB. TANKS</td>
<td>900</td>
<td>1.00</td>
<td>900</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>900</td>
</tr>
<tr>
<td>MAACH. AND EQUIP.</td>
<td>840</td>
<td>1.00</td>
<td>840</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>840</td>
</tr>
<tr>
<td>PUMP</td>
<td>840</td>
<td>1.00</td>
<td>840</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>840</td>
</tr>
<tr>
<td>* LABOUR:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* SKILLED:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIVIL ENGINEER</td>
<td>900</td>
<td>1.00</td>
<td>900</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>900</td>
</tr>
<tr>
<td>SUPERVISORY ENG.</td>
<td>600</td>
<td>1.00</td>
<td>600</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>600</td>
</tr>
<tr>
<td>WORKS CHIEF</td>
<td>450</td>
<td>1.00</td>
<td>450</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>450</td>
</tr>
<tr>
<td>*UNSKILLED:</td>
<td>4840</td>
<td>1.00</td>
<td>4840</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>4840</td>
</tr>
<tr>
<td>WORKERS</td>
<td>4840</td>
<td>1.00</td>
<td>4840</td>
<td>0</td>
<td>0.8929</td>
<td>0</td>
<td>4840</td>
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<tr>
<td>OTHER</td>
<td>23665</td>
<td></td>
<td>0</td>
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<td></td>
<td></td>
<td>23665</td>
</tr>
</tbody>
</table>

P.V.M.P. = PRESENT VALUE AT MARKET PRICES
P.V.E.P. = PRESENT VALUE AT ECONOMIC PRICES

### 11.1.3 Replacement Cost Flows

In the example, the item “EQUIPMENT” has a use life (10 years) less than the operational life of the alternative (20 years), so that “re-investment” or “replacement” will be necessary at the end of its use life, that is, at the end of the tenth year. (TABLE N° 4). The value which may remain as “unspent” in the project

---

at the end of the alternative’s use life is placed in the “Residual Value” column. In this case, there are no residual values, because the termination of the use-life cycles of all items coincides with that of the alternative.

TABLE N° 4
RESIDUAL VALUE REPLACEMENT FLOW AT MARKET AND ECONOMIC PRICES

<table>
<thead>
<tr>
<th>CONCEPT/ITEM</th>
<th>YEAR (10)</th>
<th>FACT. P.V.</th>
<th>P.V. (0)</th>
<th>YEAR (20)</th>
<th>FACTOR P.V.</th>
<th>P.V. (1)</th>
<th>P.V.M.P (0)+1</th>
<th>APR</th>
<th>P.V.E.P</th>
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</thead>
<tbody>
<tr>
<td>* PHYSICAL WORKS</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAACH. AND EQUIP.</td>
<td>840</td>
<td>0.32</td>
<td>270.5</td>
<td>0</td>
<td>0.1037</td>
<td>270</td>
<td>0.930</td>
<td>252</td>
<td>252</td>
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<tr>
<td>PUMP</td>
<td>840</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* LABOUR:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* SKILLED:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* UNSKILLED:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL VALUE</td>
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<td></td>
<td></td>
<td>270</td>
<td></td>
<td>252</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>TOTAL PRESENT VALUE OF INVESTMENTS</td>
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<td></td>
<td>23035</td>
<td>20750</td>
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</tr>
</tbody>
</table>

P.V.M.P. = PRESENT VALUE AT MARKET PRICES
P.V.E.P. = PRESENT VALUE AT ECONOMIC PRICES

The figures from the preceding table are added at the ended of the replacement flow, to express the PRESENT TOTAL INVESTMENT VALUE (including replacements and deducting residual values).

11.1.4 Operations and Maintenance Flows

TABLE N° 5 contains the operations flow and calculates Present Value at Market Prices.

The flow and Present Value of Operations Costs at Economic Prices is obtained by multiplying by the corresponding APRs (last column of TABLE N° 6).
### Table No. 5: Operations Cost Flow at Market Prices

<table>
<thead>
<tr>
<th>Concept/Item</th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
<th>Year 8</th>
<th>Year 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Item and Mat.</td>
<td>1014</td>
<td>1168</td>
<td>1327</td>
<td>1491</td>
<td>1660</td>
<td>1835</td>
<td>2015</td>
<td>2201</td>
<td>2393</td>
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</tr>
<tr>
<td>Chemicals</td>
<td>390.1</td>
<td>419.3</td>
<td>510.4</td>
<td>573.5</td>
<td>638.5</td>
<td>705.7</td>
<td>775</td>
<td>846.5</td>
<td>920.3</td>
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</tr>
<tr>
<td>Fuel</td>
<td>624.2</td>
<td>718.9</td>
<td>816.7</td>
<td>917.5</td>
<td>1022</td>
<td>1129</td>
<td>1240</td>
<td>1354</td>
<td>1473</td>
<td></td>
</tr>
<tr>
<td>* Labour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Skilled</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1300</td>
<td>1300</td>
<td>1300</td>
<td></td>
</tr>
<tr>
<td>Engineer</td>
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<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>900</td>
<td>900</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>Plumber</td>
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<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>* Unskilled</td>
<td>400</td>
<td>440</td>
<td>440</td>
<td>440</td>
<td>440</td>
<td>440</td>
<td>660</td>
<td>660</td>
<td>660</td>
<td></td>
</tr>
<tr>
<td>Workers</td>
<td>440</td>
<td>440</td>
<td>440</td>
<td>440</td>
<td>440</td>
<td>440</td>
<td>660</td>
<td>660</td>
<td>660</td>
<td></td>
</tr>
<tr>
<td>Total O.C.M.P</td>
<td>2454</td>
<td>2608</td>
<td>2767</td>
<td>2931</td>
<td>3100</td>
<td>3275</td>
<td>3975</td>
<td>4161</td>
<td>4353</td>
<td></td>
</tr>
<tr>
<td>Factor at P.V</td>
<td>0.893</td>
<td>0.797</td>
<td>0.712</td>
<td>0.636</td>
<td>0.567</td>
<td>0.507</td>
<td>0.452</td>
<td>0.404</td>
<td>0.361</td>
<td></td>
</tr>
<tr>
<td>O.C.M.P. at P.V</td>
<td>2191</td>
<td>2079</td>
<td>1970</td>
<td>1863</td>
<td>1759</td>
<td>1659</td>
<td>1798</td>
<td>1681</td>
<td>1570</td>
<td></td>
</tr>
</tbody>
</table>

**Total Present Value of Operation Costs at Market Prices (Rs. thousands)**

### Table No. 5: Operations Cost Flow at Market Prices (Years 10-20)

<table>
<thead>
<tr>
<th>Concept/Item</th>
<th>Year 10</th>
<th>Year 11</th>
<th>Year 12</th>
<th>Year 13</th>
<th>Year 14</th>
<th>Year 15</th>
<th>Year 16</th>
<th>Year 17</th>
<th>Year 18</th>
<th>Year 19</th>
<th>Year 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Item and Mat.</td>
<td>2591</td>
<td>2795</td>
<td>3733</td>
<td>1043</td>
<td>4160</td>
<td>4383</td>
<td>4555</td>
<td>4555</td>
<td>4555</td>
<td>4555</td>
<td>4555</td>
</tr>
<tr>
<td>Chemicals</td>
<td>996.5</td>
<td>1075</td>
<td>1436</td>
<td>1517</td>
<td>1600</td>
<td>1686</td>
<td>1752</td>
<td>1752</td>
<td>1752</td>
<td>1752</td>
<td>1752</td>
</tr>
<tr>
<td>Fuel</td>
<td>1594</td>
<td>1720</td>
<td>2297</td>
<td>2427</td>
<td>2560</td>
<td>2697</td>
<td>2803</td>
<td>2803</td>
<td>2803</td>
<td>2803</td>
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<td>* Labour</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>1300</td>
<td>1300</td>
<td>1300</td>
<td>1300</td>
<td>1300</td>
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<td>Workers</td>
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<td>880</td>
<td>880</td>
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<td>Total O.C.M.P</td>
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<tr>
<td>Factor at P.V</td>
<td>0.322</td>
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<td>0.205</td>
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<td>1099</td>
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<td>875.8</td>
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**Total Present Value of Operation Costs at Market Prices (Rs. thousands)**

---

ILPES/Project and Investment Programming Division

Page 132
### TABLE 4 OPERATIONS COST FLOW AT MARKET PRICES

<table>
<thead>
<tr>
<th>CONCEPT/ITEM</th>
<th>YEAR 0</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
<th>YEAR 6</th>
<th>YEAR 7</th>
<th>YEAR 8</th>
<th>YEAR 0 (0)</th>
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<tr>
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<td>5105</td>
<td>5752</td>
<td>6317</td>
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<td>7521</td>
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<tr>
<td>CHEMICALS</td>
<td>433.4</td>
<td>495.2</td>
<td>567.1</td>
<td>637.1</td>
<td>709.4</td>
<td>784</td>
<td>861</td>
<td>940.5</td>
<td>1022</td>
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<td>FUEL</td>
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<td>5959</td>
<td>6470</td>
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</tr>
<tr>
<td>* LABOUR</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
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<td>TOTAL O.C.E.P</td>
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<td>4404</td>
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<td>5916</td>
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<td>FACTOR AT P.V</td>
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<td>0.712</td>
<td>0.636</td>
<td>0.567</td>
<td>0.507</td>
<td>0.452</td>
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<td>3760</td>
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<td>3558</td>
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O.C.E.P. = OPERATIONS COSTS AT ECONOMIC PRICES

### TABLE 5 OPERATIONS COST FLOW AT MARKET PRICES

<table>
<thead>
<tr>
<th>CONCEPT/ITEM</th>
<th>YEAR 10</th>
<th>YEAR 11</th>
<th>YEAR 12</th>
<th>YEAR 13</th>
<th>YEAR 14</th>
<th>YEAR 15</th>
<th>YEAR 16</th>
<th>YEAR 17</th>
<th>YEAR 18</th>
<th>YEAR 19</th>
<th>YEAR 20</th>
</tr>
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<tbody>
<tr>
<td>* ITEM AND MAT.</td>
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<td>8763</td>
<td>11702</td>
<td>12363</td>
<td>13042</td>
<td>13741</td>
<td>14281</td>
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<tr>
<td>CHEMICALS</td>
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<td>1595</td>
<td>1485</td>
<td>1778</td>
<td>1873</td>
<td>1946</td>
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<td>12334</td>
<td>12334</td>
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<tr>
<td>* LABOUR</td>
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<td>1300</td>
<td>1300</td>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
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<td>363</td>
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<td>363</td>
<td>363</td>
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<tr>
<td>TOTAL O.C.M.P</td>
<td>9735</td>
<td>10426</td>
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<td>15525</td>
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<td></td>
</tr>
<tr>
<td>FACTOR AT P.V</td>
<td>0.322</td>
<td>0.217</td>
<td>0.257</td>
<td>0.229</td>
<td>0.205</td>
<td>0.183</td>
<td>0.163</td>
<td>0.146</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O.C.M.P. AT P.V</td>
<td>3151</td>
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<td>2577</td>
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<td>1830</td>
<td>1630</td>
<td>1460</td>
<td>130</td>
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</tr>
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</table>

O.C.M.P. = OPERATIONS COSTS AT ECONOMIC PRICES

TOTAL PRESENT VALUE OF OPERATION COSTS AT MARKET PRICES (Rs. thousands)
11.1.5 Summary of the Costs and Benefits of the Alternative

The values obtained by the actualisation of the cost and benefit flows are used to construct the cost/efficiency indicators: TABLE N° 7.

**TABLE N° 7 AQUEDUCT PROJECT. ALTERNATIVE 1**

**SUMMARY OF COSTS AND BENEFITS ESTIMATION OF COST/EFFICIENCY INDICATOR**

<table>
<thead>
<tr>
<th>CONCEPT</th>
<th>PRICE MARKET</th>
<th>PRICE ECONOMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PRESENT VALUE OF INVESTMENT COSTS</td>
<td>23935</td>
<td>20750</td>
</tr>
<tr>
<td>2. PRESENT VALUE OF OPERATION COSTS</td>
<td>29102</td>
<td>62255</td>
</tr>
<tr>
<td>3. TOTAL COST AT PRESENT VALUE = 1 + 2</td>
<td>53037</td>
<td>83005</td>
</tr>
<tr>
<td>4. ACTUALISED BENEFIT (1): 1000 M3 WATER</td>
<td>8839</td>
<td>8839</td>
</tr>
<tr>
<td>5. ACTUALISED BENEFIT (2): # BENEFICIARIES</td>
<td>134538</td>
<td>134538</td>
</tr>
<tr>
<td>6. COST PER M3 (Bs.) = 3/4</td>
<td>6.00</td>
<td>9.39</td>
</tr>
<tr>
<td>7. COST PER BENEFICIARY (Bs.) = 3 * 1000/5</td>
<td>394.22</td>
<td>616.96</td>
</tr>
</tbody>
</table>

**TABLE N° 7 EDUCATIONAL PROJECT. ALTERNATIVE 1**

**SUMMARY OF COSTS AND BENEFITS ESTIMATION OF COST/EFFICIENCY INDICATOR**

<table>
<thead>
<tr>
<th>CONCEPT</th>
<th>PRICE MARKET</th>
<th>PRICE ECONOMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PRESENT VALUE OF INVESTMENT COSTS</td>
<td>1216</td>
<td>1079</td>
</tr>
<tr>
<td>2. PRESENT VALUE OF OPERATION COSTS</td>
<td>9337</td>
<td>9662</td>
</tr>
<tr>
<td>3. TOTAL PRESENT VALUE OF COSTS (PVC)</td>
<td>10553</td>
<td>10741</td>
</tr>
<tr>
<td>4. EQUIVALENT ANNUAL COSTS</td>
<td>1413</td>
<td>1438</td>
</tr>
<tr>
<td>5. SQUARE METRES CONSTRUCTED AND EQUIPPED</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>6. ANNEAL AVERAGE OF STUDENTS ATTENDED</td>
<td>254</td>
<td>254</td>
</tr>
<tr>
<td>7. TOTAL COST PER SQUARE METRE = PVC/M2</td>
<td>131.91</td>
<td>134.26</td>
</tr>
<tr>
<td>8. COST PER BENEFICIARY = EAC/STUDENT</td>
<td>5.56</td>
<td>5.66</td>
</tr>
</tbody>
</table>

11.1.6 Evaluation and selection of the most efficient alternative

In the example, suppose that, simultaneously, the economic flows for two other alternatives have been calculated, with the following cost/efficiency indicators per product, at economic prices:
11.2 Cost-benefit indicators at economic cost

Here, we examine the calculation processes in an example, again simplified for didactic purposes: A Small-scale Drainage Project.

11.2.1 Benefits flow

In this case, benefits are appraised in terms of the value added by the drainage works. At hedonic prices, they have been assessed at 10% of the rent value of the housing affected by the works.25 Future growth of the number of dwellings benefited is not calculated. Actualised benefits are given by the current value of the annual series of rent increases (TABLE XI.B.1). Recall that the factor “from A to P” converts a uniform series (annuity) into current value.26

11.2.2 Summary of the Costs and Benefits of the Alternative

The values obtained by the actualisation of the cost and benefits flows are used to construct the cost/benefit indicators at market and economic prices.

---

25 See Unit 9.
26 See Unit 7.
11.2.3 Evaluation and selection of the most efficient alternative

Suppose that the alternative is confronted with two others, with the following cost/benefit indicators, at economic prices, expressed in Present Net Value:

<table>
<thead>
<tr>
<th>ALTERNATIVE</th>
<th>C-B INDICATOR: PNV</th>
<th>ORDER/DECISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Bs. 6,134 thousands</td>
<td>1st. THE MOST EFFICIENT. CHOSE IT.</td>
</tr>
<tr>
<td>A3</td>
<td>Bs. 4,043 thousands</td>
<td>2nd. LESS EFFICIENT</td>
</tr>
<tr>
<td>A2</td>
<td>Bs. 3,256 thousands</td>
<td>3rd. THE LEAST EFFICIENT</td>
</tr>
</tbody>
</table>

The comparison can also be performed with other indicators, such as IRR or C/B. In principle, the relative order for decision-making is not changed, although it may be necessary to take the aspects indicated in the Appendix of this Unit into account.

11.3 Other indicators to reinforce comparative analysis. Environmental analysis and other criteria

Once the most economically efficient alternative has been pre-selected, complementary analysis must also be performed, in at least three areas:

1. **To verify that it is an adequate and feasible solution to the problem identified.** Do not forget that this is a central concern in the analysis.

2. **To analyse its environmental impact,** according to the methodological and procedural orientations presented in an Annex, at the end of this guideline.

3. **To consider other qualitative and quantitative indicators** which complement those already discussed and enrich the basis for decision-making. For example, to account for externalities (apart
from ecological externalities) not incorporated into the primary costs and benefits dealt with in the socio-economic evaluation. Institutional, cultural, temporal advantages-or disadvantages-may improve resource allocation analysis.

11.4 Appendix: investment criteria

(Taken from DNP/IDB/ILPES (1991): Metodología del Banco de Proyectos de Inversión Nacional, Tomo II, Anexo 5)

Introduction

Project evaluation is performed to decide whether an investment project should be implemented, or not. To this end, we should not only identify, quantify and appraise its costs and benefits, but should also gather data for the coherent comparison of diverse projects. Likewise, we need criteria for selecting among mutually exclusive projects, when it is necessary to ration funds. Project evaluation theory (the theory of investment decision-making) provides a set of criteria for this type of analysis.

It should be noted that these criteria can be used in both the private and social evaluation of projects, because it is the appraisal of the resources generated by and allocated to projects which determines whether the evaluation is private or social. Present Net Value, for example, may be either private or social.

Present net value (pnv)

The Present Net Value criterion (also known as Current Net Value) is based on the general principle that a project is worthwhile as long as the income associated with the project is at least equal to, if not greater, than its costs. According to this general criterion, given two projects B1 and B2, the first is worthwhile, because an investment of Bs1,000 generates total income of Bs1,100, while it is not worthwhile to invest in “project” B2, because its investment of Bs2,000 (distributed in two periods) yields total income of only Bs1,700. It could be said that “project” B1 has a Net Value of Bs100, while project B2 has a Net Value of -Bs300.
In this type of simple analysis, the criterion for evaluating projects is equally simple: Accept those projects whose Net Value is greater than or equal to zero (because they generate income greater than or equal to their costs) and reject those with negative Net Value. This type of general criterion is adopted when the Present Net Value criterion is employed. However, there is a significant difference: in the examples presented above, the value of money over time is not incorporated and it is well known that this is a central element in Present Net Value.

The value of money over time (or the intertemporal opportunity cost of money) is incorporated when cash flows are “discounted”. That “discount” depends on when those flows occur.

The central idea of the “value of money over time” concept is linked to the fact that a given amount of money has different values, depending on when that amount is produced or spent. This idea is unrelated to the concept of inflation or devaluation (assuming that neither of these situations occurs), but rather with the fact that the money can be invested and earn interest. If you are owed Bs100 and you are offered a choice between immediate payment or the payment (of Bs100) within one year, you would intuitively chose immediate payment. This is the case because, within a year, the Bs100 will be of less value than today’s Bs100, given that, if you accept immediate payment, you could invest the money in a time deposit (for example) at 10% annually and obtain Bs110 in one year. If your debtor offered to pay you Bs100 immediately or Bs110 in one year, you would be indifferent in the choice between the two options. Thus, we can conclude that Bs110 in one year have a Present Value of Bs100, if the interest rate is 10%.
The mathematical process for this concept operates according to the formula for compound interest:

\[ P \times (1 + r)^n = 100 \times (1 + 0.10)^1 = 100 + 10 = 110 \]

in which \( P \) is the initial investment made or deposited, \( r \) is the interest rate (in this case, annual), and \( n \) is the number of periods (in this case, years) during which \( P \) is invested.

Reversing the "order" of this formula, we can discover that, to receive Bs110 in one year, the amount of investment is:

\[ 110 \times \frac{1}{(1 + 0.10)} = \frac{110}{1 + 0.10} = \text{Bs}100 \]

Therefore, Bs100 is the Present Value of Bs110 to be received in one year, and Bs110 is the Future Value of today's Bs100. Likewise, if we assume that Bs100 remains deposited for two years, at an annual interest rate of 10%, at the end of two years its value will be:

\[ 100 \times (1 + 0.10) \times (1 + 0.10) = 100 \times (1 + 0.10)^2 = \text{Bs}121 \]

and those Bs121 received in two years are equal to:

\[ 121 \times \frac{1}{(1 + 0.10) \times (1 + 0.10)} = \frac{121}{(1 + 0.10)^2} \]

Thus, the Future Value of Bs100, in two years, is Bs121, and the Present Value of Bs121, received in two years, is Bs100.

In general terms, \( P \times (1 + r)^n \) is the Future Value of an amount \( P \) deposited for \( n \) periods, at \( r \) interest rate.
In the same way, \( F \cdot [1/(1 + r)^n] \) is the Present Value of an amount \( F \) (Future) which is to be received (or paid) in \( n \) years. Generally, this expression is presented as: \( P \cdot (1 + r)^n \).

The Present Net Value (PNV) method expresses flows in their present value equivalents. However, those flows could be expressed in terms of their Future Value. For convenience, Present, and not Future, Value is employed here.

To reconsider project B1, instead of calculating the net value of its flows, we first convert (discount) cash flows at Present Value to incorporate the fact that money has an opportunity cost over time and, then, we calculate the Net Value, in Present Value (Present Net Value). At a rate of 8% (for example), the PNV of project B1 is -Bs74.96.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow Factor</th>
<th>Present Value</th>
<th>Cash Flow at Present Value</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>-1.000</td>
<td><em>(1 + 0.08)^0</em></td>
<td>= -1,000.00</td>
</tr>
<tr>
<td>1</td>
<td>+ 200</td>
<td><em>(1 + 0.08)^1</em></td>
<td>= 185.19</td>
</tr>
<tr>
<td>2</td>
<td>+ 400</td>
<td><em>(1 + 0.08)^2</em></td>
<td>= 342.94</td>
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<tr>
<td>3</td>
<td>+ 500</td>
<td><em>(1 + 0.08)^3</em></td>
<td>= 396.92</td>
</tr>
</tbody>
</table>

Net Value: + 100

PNV : -74.96

This analysis reveals that, although the project seemed attractive at first, when we incorporate the opportunity cost of money over time, the project ceases to be attractive. To compare flows from different moments in time, we convert them all to one moment; in this case, year 0.

Once it is accepted that money has an opportunity cost over time, it must be accepted that amounts generated in different moments are not directly comparable. One Bolívar today cannot be compared, much less added, to one Bolívar tomorrow. For this reason, all flows must be converted (discounted) to one common moment in time.
Generally, we can express the Present Net Value of an investment project as the sum of all its discounted cash flows:

\[ VPN = \sum_{t=0}^{n} \frac{P_t}{(1 + r)^t} \]

in which \( P_t \) is the project cash flow (positive or negative) at time \( t \), \( n \) is the use life of the project (or total number of relevant periods) and \( r \) is the annual discount rate. If the PNV is equal to or greater than 0, the project is profitable and worthwhile and, if PNV is less than 0, the project should not be accepted.

The PNV criterion indicates when to invest (or not) in a project. Again, if we analyse project B1, we see that it requires an initial outlay of Bs1,000 and produces cash income for the coming three years. If, on the other hand, Bs1,000 are not invested in the project and we deposit (or invest) them in a fixed deposit at 8%, in three years we will have obtained Bs1,000 \( \times (1 + 0.08)^3 \) = Bs1,259.71.

If we actually invest in the project and the positive cash flows generated by the project are invested (at 8% annually), how much will we have in three years? As can be seen in the following box, in three years, we will have obtained Bs1,165.28 (Bs200 invested for two years, plus Bs400 invested for one year, plus Bs500 at the end of the third year).

<table>
<thead>
<tr>
<th>Project B1 (cont)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

Future Value: 1,165.28

Thus, investing in a fixed deposit gives us Bs1,259.71, at the end of three years, while, if we invest in the project and deposit the resources generated by the project, we will have Bs1,165.28. Observing both alternatives, we see that it is not worthwhile to invest in the project, because, within three years, we would lose Bs94.43 (Bs1,165.28 - Bs1,259.71). However, those Bs94.43 are Bolívares three years from now. If
we express them in Present Value \( (94.43 \div (1.08)^3) \), that loss is equal to Bs74.96, which is exactly the PNV calculated earlier.

As can be deduced from this exposition, the PNV criterion evaluates projects, by implicitly analysing the alternative to the investment: Investing at the current interest rate. Therefore, PNV reveals the increase (or loss) in the value of capital, as a result of the project.

Herein, we have assumed that the cash flows in each period may be positive or negative and are expressed in terms of Present Net Value. In the expression, Net refers to the difference between income (benefits) and costs. That is, the benefits attributable to the project are added together and all attributable costs are subtracted. In synthesis, PNV is:

\[
PNV = \sum_{t=0}^{\infty} \frac{S_t}{(1 + r)^t} = \sum_{t=0}^{\infty} \frac{B_t - C_t}{(1 + r)}
\]

in which \( B_t \) is income (or benefits) in each period \( t \) and \( C_t \) are costs in each period \( t \).

**Equivalent annual value and equivalent annual cost**

As seen above, any sequence of net benefits (benefits, less costs) can be expressed in terms of Present Net Value. The PNV criterion automatically incorporates the value of money over time. That is, every income or outlay can be expressed in its Present Value equivalent at any time. Likewise, that Present Net Value can be expressed in equivalent uniform annual amounts for the use life of the project. In other words, the Equivalent Annual Value distributes the amount of the Present Net Value uniformly over the number of periods (years) of the project's use life. This indicator is useful when it is necessary to compare project alternatives which have different use lives. According to this criterion, the project (or alternative) with the highest EAV should be chosen. Mathematically, the relation between PNV and EAV is expressed as:

in which "n" is the use life of the alternative.
Evaluation of Alternatives

\[ EAV = \text{PNV} \times \frac{(1 + r)^n \times r}{(1 + r)^n - 1} \]

To illustrate this criterion, suppose that a highway is to be built (Project C1), for which one alternative is to build it of concrete, with a use life of 20 years, and another alternative of asphalt, with a use life of 10 years. In box C1, the PNVs for each alternative are presented, taking their use lives and a discount rate of 10% (r) into account.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Use Life</th>
<th>PNV</th>
<th>EAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>10 years</td>
<td>10,000</td>
<td>1,627</td>
</tr>
<tr>
<td>Concrete</td>
<td>20 years</td>
<td>20,000</td>
<td>1,409</td>
</tr>
</tbody>
</table>

It is clear that the PNV of the highway construction alternative with specifications for concrete is higher than that of the other alternative. However, the alternative which uses concrete has the longer use life (nearly double, in this case). Thus, it has twice as long to generate benefits. Since the two alternatives have different use lives, the PNV indicator cannot be used, because they are not comparable, given the bias introduced by the difference in their use lives. When we analyse PNV, we observe that, in each year, the alternative for concrete (with the higher PNV) generates greater annual wealth and, therefore, should be preferred over the option to use asphalt.

When we face various alternatives which would satisfy a need, each generating identical benefits, we can estimate their Equivalent Annual Cost (EAC), which only involves project costs. That indicator can even be used when two project alternatives generate the same benefits, even though they have different use lives.

This criterion indicates that the alternative with the smallest EAC should be chosen. Mathematically, the relation between PCV (Present Cost Value) and EAC can be expressed as:
\[ EAC = PCV \cdot \frac{(1 + r)^n \cdot r}{(1 + r)^n - 1} \]

In which "n" is the use life of the alternative.

**Internal rate of return**

As discussed in the Section on Present Net Value, if PNV is positive at a certain (discount) interest rate - for example, 8%-., this means that project profitability is greater than 8%, while, if PNV is negative, project profitability is less than the discount rate and, if PNV is exactly zero, the discount rate is equal to project profitability. The Internal Rate of Return (IRR) can be defined as that discount rate which, when applied to project cash flows, produces a PNV equal to zero. Generally, the IRR is the value for \( r \) in the equation:

\[ PNV = \sum_{(i=0)}^n \frac{S_i}{(1 + r)^i} = \sum_{(i=0)}^n \frac{B_i - C_i}{(1 + r)} \]

It should be noted that IRR is independent of the investor’s discount rate and is exclusively proper to the project. Generally, if the IRR is higher than the discount rate, the project is worthwhile, while, if it is lower, it is not worthwhile and, if they are equal, the investor will be indifferent to the decision to undertake the project, or not.

To estimate the IRR of a project, it is necessary to solve a polynomial equation which may be very complex. However, the IRR can also be estimated by the so-called "lineal interpolation" method.

The lineal interpolation method consists in estimating an approximate value by selecting a discount rate for which PNV will be positive. In the following Box, PNV is estimated at rates of 2% and 8%. These estimates make it possible to approximate IRR as:

in which \( R_1 \) is the discount at which PNV is positive, \( R_2 \) is the discount at which PNV is negative, PNV,
$$\text{IRR} = R_1 + \frac{PNV_1}{PNV_1 + PNV_2} (R_2 - R_1)$$

is the positive Present Net Value and $PNV_2$ is the absolute value of the negative Present Net Value.

For project B1, select a discount rate which yields a positive PNV and another, which yields a negative PNV:

### Project B1 (cont)

**At an 8% discount rate:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
<th>PV Factor</th>
<th>PV Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1,000(1 + 0.08)^0 = -1,000.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-200(1 + 0.08)^1 = 185.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>+ 400(1 + 0.08)^2 = 342.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+ 500(1 + 0.08)^3 = 396.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PNV: -74.96

**At a 2% discount rate:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
<th>PV Factor</th>
<th>PV Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1,000(1 + 0.02)^0 = -1,000.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>+ 200(1 + 0.02)^1 = 196.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>+ 400(1 + 0.02)^2 = 384.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+ 500(1 + 0.02)^3 = 471.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PNV: 51.71

Applying the interpolation formula to the data for Project B1, we obtain:
**General Methodological Manual for the Preparation and Evaluation of Social Investment Projects**

\[
IRR = 0.02 + \frac{51.71}{51.71 + 74.96} \times (0.08 - 0.02) = 0.0445
\]

IRR = 4.45%

However, the IRR criterion involves serious difficulties, so that it should always be employed jointly with PNV.

First, since the IRR is the solution of a polynomial, equal in degree to the use life of the project \((n)\), there may be several real positive or negative solutions, or even complex solutions.

Generally, if there is more than one sign change in the flows, more than one solution may exist. In the following box, project E1 is presented, which, at a discount rate of 14%, is profitable, but which yields two IRRs: 12.3% and 23.6%.

![Project E1 Cash Flow Graph](image)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-720</td>
</tr>
<tr>
<td>1</td>
<td>1,699</td>
</tr>
<tr>
<td>2</td>
<td>-1,000</td>
</tr>
</tbody>
</table>

Second, the IRR criterion assumes that the funds made available by the project are reinvested at that same rate, when it is logical to assume that the would be reinvested at the rate of the investor’s opportunity cost, that is, at his discount rate. Finally, the IRR criterion may lead to erroneous decision-making by recommending projects which, at the investor’s discount rate, are less attractive than other available alternatives.
that is, at his discount rate. Finally, the IRR criterion may lead to erroneous decision-making by recommending projects which, at the investor's discount rate, are less attractive than other available alternatives.

Imagine that we must chose between the two alternatives presented for Project E2. According to the IRR criterion, we would chose alternative II, given its higher IRR. However, if the opportunity cost rate for the investor's money is 10%, the PNV of the second alternative is lower than that rate.

<table>
<thead>
<tr>
<th>Year</th>
<th>Altern. I</th>
<th>Altern. II</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-10,000</td>
<td>-10,000.00</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>6,545.50</td>
</tr>
<tr>
<td>2</td>
<td>13,924</td>
<td>6,545.50</td>
</tr>
<tr>
<td>IRR</td>
<td>18%</td>
<td>20%</td>
</tr>
<tr>
<td>PNV&lt;sub&gt;(10%)&lt;/sub&gt;</td>
<td>1,506</td>
<td>1,363</td>
</tr>
</tbody>
</table>

Cost efficiency indicators

Finally, the purpose of so-called "cost efficiency" indicators is to obtain an alternative's average cost, per unit of benefit. Cost/efficiency indicators link an indicator of total costs (in present or annual equivalent values) to a "proxy" of project benefits.

It should be noted that the cost indicator used should incorporate all the project's operational and investment costs. In practise, cost efficiency indicators can be taken as average costs per unit of service. For example, cost per cubic metre of water delivered, cost for an additional aqueduct hook-up, cost for an additional visit at a clinic, cost of a telephone line in a telephone network expansion project, cost for an additional kilometre of highway, etc.
12. Economic and social project evaluation: conceptual development

12.1 Object

We believe that the matters dealt with so far (conceptual elements and practical instruments) constitute an adequate basis for the comprehension and implementation of the elaboration-evaluation process for small, local social investment projects, at the profile level.

However, since this manual was created for didactic purposes and seeks to serve as reference material for instructors in training activities, this Unit has been introduced to offer those instructors further conceptual development and more detailed information to reinforce their capacity to explain -if necessary- the material related to economic-social evaluation.

In this sense, the Unit was designed to provide information on the theoretical bases of the LMST method. Given its diffusion by organisms such as the IDB, "LMST" is becoming a commonly employed tool (and is unifying language) in national planning institutions for the determination of national parameters for project evaluation, together with other uses, such as so-called accounting prices which express the economic value of products and inputs. For this reason, the contents of this Unit have been based mainly on the text "El cálculo de los precios de cuenta en la evaluación de proyectos", of the Interamerican Development Bank - IDB.27

12.2 Alternative methodologies for the economic and social project evaluation: idb approach (LMST)

Various approaches have been developed to configure "national parameters" or "accounting prices". The LMST accounting price system is the result of the integration of the methodological efforts of two schools which have addressed these issues: 1) Ian Little and James Mirrlees, and 2) Lyn Squire and Herman van der Tak. It takes its name from the fusion of their initials.

The distinctive characteristic of the LMST methodology is, perhaps, its concept that international trade is an opportunity available to every country and, therefore, can serve as the basis for the determination of the economic value of national production, inputs and productive factors.

International trade, which must always be considered in public investment policy, is always available to the country. The prices of imports and exports are adequate reference points for decision-making related to production, given that much of the country’s domestic economic activities are related to international trade, moreso in recent times as economic openness is the rule and trade abroad is becoming more intense.

For project evaluation, foreign trade is an alternative "industry" which transforms inputs (exports sales) into products (imported goods and services) and, therefore, the true values of imports and exports (CIF and FOB prices, respectively) serve as reference prices for domestic estimates and decisions.

The CIF price includes product cost, plus insurance and shipping charges. FOB is the cost of the product in its port of origin; it does not include insurance and shipping charges.

One of the main characteristics of the approaches developed for the definition of "national parametres" is the accounting unit assumed for the appraisal of economic costs and benefits. One group of approaches employs national currency denominations, as the appraisal unit. For example, this group includes the so-called "UNIDO" approach. This approach facilitates the appraisal of goods not traded internationally, in domestic currency, but involves conversions for the true value of that currency for the analysis of imported inputs and exportable goods.

In contrast, LMST estimates accounting prices in terms of international, and not domestic, prices. Its accounting unit is public income, expressed in currency, instead of private consumption at domestic prices, as is the case in traditional methods. This change facilitates and simplifies the estimate of the accounting price of goods traded internationally, which tend to be the majority in advanced processes of economic openness. However, this method involves special processes to convert those goods and services.

---

not traded internationally, that is, which are neither importable nor exportable, into economic prices. We will discuss these issues in this Unit.

12.3 Economic evaluation: efficient prices of goods and services

1. Price levels

According to where commercialisation occurs, we can distinguish three levels of market prices:

* The level of basic prices, at the production point. Here, neither indirect taxes nor commercialisation and transportation cost are included.

* The level of producer prices. Includes indirect taxes at the producer level.

* The level of user price. Transactions are appraised at the delivery point and include the other factors: indirect taxes and commercialisation and transportation margins.

The LMST methodology considers mainly user prices.

2. The commercial classification of goods

For methodological purposes, goods are divided into two opposing groups:

a. Commercialised goods. These are those goods directly or indirectly related to foreign trade. They can be divided, in turn, into two groups:

   (1) Tradable supply goods:

   (a) Exportables (FOB)

   (b) Import substitutions (CIF)

   (2) Tradable supply goods:

   (a) Imports (CIF)

   (b) Those which reduce exports (FOB)

---

29 Also called "traded" or "tradable" goods.
b. Non-tradable goods. Their production is not related to foreign trade. They can be divided into two categories:

(1) Non-tradable by nature or physical restriction (labour, transportation)

(2) Non-tradable due to institutional restrictions (quotas established, prohibitive tariffs, etc.).

Between these two groups lies a third, partially tradable goods, the treatment of which, therefore, involves a combination of the conversion methods of the two groups.

3. Accounting prices of tradable goods

A good is defined as internationally tradable, or not, in function of its impact on exports or imports.

We will consider a good internationally tradable when the commercialisation of that good generates marginal movements in international trade. Two situations may arise:

Imported tradables:
* greater domestic demand is met by increasing imports;
* additional production substitutes imports;
* if the consumption of the product lowers domestic availability so that other consumers import an equivalent quantity, it is also a tradable good, given its effect on the marginal increase of imports.

Exported tradables:
* additional internal demand is covered by domestic production which is no longer exported;
* additional production increases exports.

The accounting price of a tradable good is a function of three factors: a) the direction of the international market: imported or exported; b) the transaction level used as reference point; and
c) the volume traded: if small, it will not affect the price.

For the purposes of this methodological guideline, designed for small local public investment projects, the most interesting category of goods consists in those traded marginally at user prices which do not affect the market price, due to the small scale of their transaction levels.

a. **Imported goods**

With regard to resources, a project may require an imported input. With regard to production, it may substitute an imported product. In both cases, there is additional import trade and the accounting price will be based on the CIF price (cost, insurance, transport) of the good. The additional costs of transportation and distribution necessary to place that imported (or potentially imported) good at the delivery point should be included.

Since these domestic costs are expressed in domestic market prices, they should first be converted into accounting prices, to then be added to the CIF cost:

\[
APIG = CIF + APTD
\]

In which:

- **APIG** = Accounting Price of the Imported Good;
- **APTD** = Accounting Price of Transportation and Distribution, to the delivery point.

**Example:**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>US$</th>
<th>EXCHANGE RATE</th>
<th>VALUE IN Bs.</th>
<th>P.M.V. (Bs.)</th>
<th>APR</th>
<th>P.V.C. (Bs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIF</td>
<td>50</td>
<td>70</td>
<td>3500</td>
<td>3500</td>
<td>1.00</td>
<td>3500</td>
</tr>
<tr>
<td>TARIFF</td>
<td></td>
<td></td>
<td>350</td>
<td>350</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>TRANSP.</td>
<td></td>
<td></td>
<td>300</td>
<td>300</td>
<td>1.14</td>
<td>342</td>
</tr>
<tr>
<td>DISTRIB.</td>
<td></td>
<td></td>
<td>200</td>
<td>200</td>
<td>0.85</td>
<td>160</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>4350</td>
<td></td>
<td></td>
<td>4002</td>
</tr>
</tbody>
</table>
b. **Exported goods**

As noted above, this involves goods required by the project which otherwise would be available for export; it also includes goods produced by the project for exportation.

In the case of **actual exportation**, the accounting price is determined by the formula:

\[ APEG = FOB - APTDE \]

In which:

- **APEG** = Accounting Price of the Exported Good;
- **FOB** = Free on Board (price at embarkation port);
- **APTDE** = Accounting Price of Transportation and Distribution of Exports.

With regard to an exportable good removed from domestic consumption, its accounting price is its FOB, modified by the effects of transportation and commercialisation: the costs saved by not exporting the good are subtracted and the domestic costs to the delivery point are added:

\[ APEG = FOB - APTDE + APTDD \]

In which:

- **APEG** = Accounting Price of the Exported Good;
- **FOB** = Free on Board (price at embarkation port);
- **APTDE** = Accounting Price of Transportation and Distribution of Exports foregone;
- **APTDD** = Accounting Price of Transportation and Distribution to point of Delivery.
### Example:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>US$</th>
<th>EXCHANGE RATE</th>
<th>VALUE IN Bs.</th>
<th>P.M.V. (Bs.)</th>
<th>APR</th>
<th>P.V.C. (Bs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOB</td>
<td>+ 100</td>
<td>70</td>
<td>700</td>
<td>1.00</td>
<td>700.0</td>
<td></td>
</tr>
<tr>
<td>IMPTO X</td>
<td>0</td>
<td></td>
<td>180</td>
<td>0.00</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>TRANS X</td>
<td>(-)</td>
<td>10</td>
<td>10</td>
<td>1.14</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>TRANS I</td>
<td>(+)</td>
<td>20</td>
<td>20</td>
<td>1.14</td>
<td>22.8</td>
<td></td>
</tr>
<tr>
<td>DIST I</td>
<td>(+)</td>
<td>50</td>
<td>50</td>
<td>0.8</td>
<td>40.0</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL EXPORTED</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>688.6</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL EXPORTABLE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>751.4</td>
<td></td>
</tr>
</tbody>
</table>

4. **Accounting price of non-tradable goods**

A good is considered non-tradable when importing it would be too expensive and domestic production is not sufficiently inexpensive to export it. In this way, its domestic price is higher than its FOB export price (it is not competitive as an export) and lower than the import CIF price of a comparable product (importing it is not attractive for the domestic consumer).

The accounting price of a non-tradable good is determined by its supply cost, for which the appraisal of all its component inputs (marginal production cost) are added together. However, in a case of fixed supply, the accounting price is determined by the accounting price value of the foregone consumption (marginal value of less consumption).

a. **Marginal cost of production**

If the product consumed by the project comes from additional domestic production, its accounting price is determined by the sum of all its component inputs, appraised at accounting prices.

As a good or service is broken down into its inputs, it may be found that they are either tradable or non-tradable. Tradables are appraised by the procedures already discussed. Non-tradables are appraised at
accounting prices, breaking them down further into their tradable and non-tradable components. This process continues until the non-tradable set of inputs is so insignificant that further appraisal is unjustified. Grouped together (an "others" item), they become a sector APR or a conversion factor. This factor is a weighted average of several APRs, in function of a pre-determined basket.

**Example**

To illustrate this procedure, we will examine the example prepared by Powers.\(^{30}\) Suppose that the electricity needed for a project will be supplied by the construction of an additional thermoelectrical plant. The accounting price of the electricity is the value of all inputs used to produce the electricity, each appraised at accounting prices.

The cost of the additional electricity, at accounting prices, has two components: (1) the corresponding capital costs of the thermal plant and relevant constriction works; and (2) the plant’s operations costs. First, the value of the capital and operations costs are calculated at accounting prices and, then, both are expressed as costs per kilowatt/hour (kwh). In the first series of cost breakdowns, the thermoelectric plant is an imported tradable input. The installation works are broken down into tradable and non-tradable inputs. And so on. The following box gives the information of the relevant breakdowns.

---

Accounting price of electricity, appraised at marginal production cost (Bs. thousands)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>C.D.P.</th>
<th>APR</th>
<th>C.A.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAPITAL COSTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+Thermoelectric Unit</td>
<td>3,000</td>
<td>0.89</td>
<td>2,678</td>
</tr>
<tr>
<td>+Installation and construction works</td>
<td>1,800</td>
<td>1.00</td>
<td>1,800</td>
</tr>
<tr>
<td>ØImported materials (CIF)</td>
<td>1,200</td>
<td>0.73</td>
<td>878</td>
</tr>
<tr>
<td>ØLabour</td>
<td>500</td>
<td>1.00</td>
<td>500</td>
</tr>
<tr>
<td>ØIndustrial taxes and tariffs</td>
<td>250</td>
<td>0.60</td>
<td>150</td>
</tr>
<tr>
<td>ØOther expenditures</td>
<td>200</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>'Imported materials (CIF)</td>
<td>250</td>
<td>0.91</td>
<td>228</td>
</tr>
<tr>
<td>'Labour</td>
<td>180</td>
<td>1.00</td>
<td>180</td>
</tr>
<tr>
<td>'Other expenditures</td>
<td>40</td>
<td>0.60</td>
<td>24</td>
</tr>
<tr>
<td>+Taxes and tariffs</td>
<td>30</td>
<td>0.80</td>
<td>24</td>
</tr>
</tbody>
</table>

| **ANNUAL OPERATIONS COSTS**    | 1,000  | 0.83| 831    |
| +Fuel (CIF)                    | 800    | 1.00| 800    |
| +Maintenance                   | 40     | 0.78| 31     |
| ØSpare parts (CIF)             | 15     | 1.00| 15     |
| ØLabour                        | 20     | 0.60| 12     |
| ØVarious                       | 5      | 0.80| 4      |
| +Taxes and tariffs             | 160    | 0.00| 0      |

C.D.P. = Cost at Domestic Prices
C.A.P. = Cost at Accounting Prices

"Other expenditures" and "various" are miscellaneous items of scant importance which are converted by a "standard conversion factor" (SCF), which is a weighted average of the APR of a basket of goods; it is a conversion factor representing average expenses for final and intermediate goods used to transform those miscellaneous items (in the example, it is 0.80).
Annual operations costs are based on an assumed use of 7,000 hours a year (80% of capacity) and cost 1 million Bolívares a year, equivalent to 0.831 million at accounting prices, obtained by a similar procedure. The plant has a capacity of one megawatt (1,000 kilowatts).

To combine operations and installation costs, it is necessary to translate the latter into equivalent annual costs, to reflect the declining value of the currency. The currency’s LMST discount rate, at efficiency prices, is the marginal productivity of the public sector investment = 12% annually. The use life of the capital outlay has been set at 25 years, so that the factor "From P to A", that is, the annualisation factor, is 0.1275.

*ANNUAL COST OF THE INVESTMENT

2,678 thousand Bolívares x 0.1275 = 342 thousand Bs.

TOTAL EQUIVALENT ANNUAL COST:

*ANNUAL COST OF THE INVESTMENT: 342 thousand Bs.

*ANNUAL OPERATIONS COST: 831 "

TOTAL: 1,173 thousand Bs.

To express the cost of electricity in kilowatt(hours), we divide by the total kwh generated during the year (7,000 hours x 1,000 kw) = 0.17 Bolívares per kwh.

The energy cost for the project is calculated at this price and not at the rate collected by the electricity company, because the value of 0.17 Bs/hour is the opportunity cost of the electricity for the economy, which is usually different from financial charge actually collected. If the electrical system had additional electrical energy available (excess generation capacity), the project would consume what is available and new installations would not be necessary, with the result that the imputable cost would be the accounting price of the plant’s annual operations costs (approximately 0.12 Bs/hour).

b. The marginal value of reduced consumption
The accounting price of a non-tradable good is normally estimated by the method outlined above, by
calculating its marginal production cost at accounting prices. However, when supply is fixed, a better basis for the accounting price is the value of demand and not production costs. If supply is fixed, the project consumes inputs at the expense of other consumers who must reduce their consumption.

This occurs specially when there are prohibitive tariffs or domestic supply cannot respond rapidly to new demand.

When supply is limited, the accounting price of the good is the value in cash of the foregone consumption caused by the project’s additional demand.

5. Accounting prices of non-tradable goods groups.
Matrix of inter-sector relations
Note that, in the previous exercises, the calculation of supply prices gives the impression of a vicious circle, in which everything depends on everything: in the chain of breakdowns, dependencies with regard to non-tradables keep appearing, the APR of which must be known beforehand. This apparent complication is resolved by input-product matrices, as a device for resolving systems of simultaneous equations which may arise in inter-sector dependencies.

Thus, the ratios of non-tradable product accounting prices are calculated by the following formula:

\[
APR = (I - A)^{-1} [F] [APRF]
\]

In which:

- \([APR]\) = the vector of the APRs of the sector analysed;
- \((I - A)^{-1}\) is the so-called "Leontief Inverse Matrix", in which:
- \(A\) = the matrix of the technical coefficients of the inputs which make up the gross value of production in the sector analysed;
- \(I\) = the identity matrix;
\[ F = \text{the matrix of coefficients of the per unit value added of the gross value of production in the sector analysed.} \]

Recall that added value is composed of the productive factors, including "non-produced inputs" (for example, labour), together with transfers, such as taxes.

\[ \text{APRF} = \text{the vector of the APRs of non-produced inputs and transfers.} \]

Input-product techniques are a tool for estimating the APRs of marginally produced goods, which account for most of the columns in the matrix.

To determine the sectors involved in the matrix, some selective criteria should be used, such as: a) if the goods are tradable, or not, and b) the importance of the sectors in the projects regularly evaluated in the economy.

The first criterion suggests limiting the application of the input-product matrix to produced goods, because the accounting prices of tradables is easy to calculate by following the procedures discussed in the preceding examples.

6. National accounts prices

The second criterion is related to the type of APR data required to evaluate the projects (or alternatives) proposed, which must be evaluated in terms of the different levels and areas of the national economy, specially the area of public investment.

APRs are the "national parametres" which always involve a degree of aggregate estimation. They are analysed to appraise project inputs. However, "although as many inputs as possible should be appraised directly, it is difficult to do so in all cases, given both the data and time limitations faced by the evaluator.
Thus, inputs should be organised in their order of importance in the project’s cost structures and the effort should be made to estimate the APRs of the most important costs directly.\footnote{Parot, R. Estimación de precios de cuenta para Venezuela. CORDIPLAN-IDB. 1990.} \footnote{Page 161}

Nevertheless, for small -and even mid-size- projects, which involve low levels of public investment, APR, aggregated by sector, may adequately satisfy the requirements of market price weighting.

Thus, at the national level, a list of accounting price ratios (APR), calculated for sectors and sub-sectors which cover like products, is available.

For Venezuela, there are 180 sectors which correspond to the UIIC, to five digits, which seems to be sufficiently refined information for the efficiency price requirements of smaller regional and local projects (CORDIPLAN-IDB. 1990).

It is also worthwhile to mention the so-called conversion factors generated to transform commonly used expenditure groups which need not be disaggregated: consumption, investment, intermediate goods, and the standard or global conversion factor.

Recall, finally, the equation for converting market prices into economic prices:

\[
\text{Economic price} = \text{Market price} \times \text{APR}
\]

### 12.4 Efficiency prices of labour

The economic price of labour is measured in terms of two components:

* what the economy forgoes by employing labour in the project, and
* the economic effect of that job change for the worker. For example, the effort level is not very traumatic for a worker who changes his job without moving his residence, while it may be very

great for one who moves from the countryside to the city. Thus, the concept of "effort disutility" comes into play, the influence of which is inversely proportionate to the worker's economic opportunities.

Full unemployment would not mean null costs for labour, but rather a value greater than zero, due to the so-called "reserve salary", below which no one in the region is willing to work. This amount expresses the value of the activities a person performs when not formally employed, such as work at home. Only for a wage above a certain level (reserve salary) will the person decide to accept formal employment. Expressed in currency, it is the minimum economic cost of hiring an unemployed person.

These two components (opportunity cost and disutility) are the basis for the equation to determine the economic cost of labour:

\[
APL = S_{a_i} m_{APR_i} + sFCC \quad [\Theta]
\]

In which:

APL = Accounting price of labour

\(a_i\) = Amount of time labour dedicates to activity i

\(m_{APR_i}\) = Economic value of activity i, at accounting prices

sFCC = Economic value of effort disutility, at accounting prices. This is the monetary cost to the worker who changes jobs, converted to its equivalent in cash by the consumption conversion factor.

1. The accounting price of unskilled labour
   a. Unskilled rural labour

The accounting price of unskilled rural labour expresses the degree to which project employment affects farm production and unemployment in the neighbouring area. Rural employment is usually seasonal: high during planting and harvest, and low during the rest of the year.
During the peak season, the economic cost of going without a worker is around the cash value of his salary. At that time, the worker receives a (gross) salary equal to his marginal productivity. Efficiency costs tend to coincide with the value of his gross salary.

During seasons of low activity, the economic cost of labour is a function of the tasks available to workers. The minimum cost is given by the cash value of the reserve salary. A reasonable measure of the cost of labour at that time is the salary paid to occasional labour during months of reduced farm activity.

**Example**

To illustrate the procedure for estimating the economic cost of unskilled farm labour, we have adapted the example presented by Powers.

A project needs labour for one year and will pay a daily (gross) salary of Bs300. The principal local crop is cotton. During the four months of greatest activity, a wage is paid of Bs250 + Bs50 for food and transportation = Bs300. Workers cultivate corn during the other months, for want of another more productive opportunity, receiving Bs100 daily. The APRs are: 1.13 for cotton, and 0.84 for corn.

Apply those values in the [equation] equation, with a null value for sFCC (effort disutility), by assuming that the participation of unskilled labour in the project does not entail significant difficulties and that the work is similar.

\[
APL = S_m APR_i + sFCC
\]

If sFCC = zero:

\[
APUL = (Us/Rs) S_m APR_i + sFCC
\]

That is, the market salary of each activity is weighted by the time dedicated to it during the year and its APR:
\[ APUL = (0.33) (300) (1.13) + (0.67) (100) (0.84) \]
\[ APUL = 111.9 + 56.3 \]
\[ APUL = 168.2 \text{ Bolívares per day} \]

b. **Unskilled urban labour**

When rural migration is not a significant factor, the accounting price of unskilled urban labour is the economic value of the activities forgone locally and is calculated by the formula \([@]\) presented above.

However, increased urban employment usually entails migration. Thus, migratory effects should be considered in the estimate of the cost of urban labour. There are two main economic factors involved in rural-urban migration: a) the expectation of better paying jobs, and b) the difference in the possibility of long-term income between urban and rural employment. These factors affect the real cost of urban labour and are incorporated into the formula through the following adjustment:

\[ APUUL = (Us/Rs) \text{Sa}_mAPR + s^{FCC} \]

In which: Us/Rs is the ratio between urban and rural salaries.

2. **The accounting price of skilled labour**

The same general formula is used for skilled labour, although now with null value for effort disutility (the second component), because job differences are usually minimal. Moreover, given that most skilled labour is urban, urban-rural distortions need not be considered.

3. **National accounting prices for labour**

National accounting prices are available for the three categories discussed above: rural, unskilled urban and skilled urban (CORDIPLAN-IDB), 1990, Table 23, non-produced inputs). This level of disaggregation is sufficient for the evaluation of local projects.
12.5 The marginal product of public investment

It has been stated that (economic) efficiency does not distinguish between a unit of savings (investment) and a unit of consumption. It follows from this that the marginal return on public investment, at efficiency prices \(q\), is equal to the consumer interest rate (CIR).

Thus, the \(q\) parameter fulfills two functions:

1. It serves to distribute public investment funds among solution alternatives of the same problem, or among projects competing for the same resources. The minimum acceptable return on a public investment project (IRR) is given by \(q\).

2. It may be used as the discount rate to determine the present value of cost and benefit flows in project alternatives.

Estimating "\(q\)" is not difficult:

"whatever the degree of refinement employed with regard to the national accounts figures, the overall capital return rate will continue to be a rough approximation of the value we are seeking, because the figures of both capital and capital return are very imprecise estimates."\(^{32}\)

In the awareness of these limitations, various methods may be employed to generate approximate estimates of "\(q\)":

* The lower bound of \(q\) is determined by the cost of government loans in the international private capital market. The LIBOR (London Inter-Bank Offered Rate) rate, adjusted by a premium which fluctuates in function of the government's credit rating, is applied.

* If adequate data are not available, national investment and income statistics can be used to estimate the overall return on capital.

---

An approximation of **overall return** \((q)\) can be generated by the following equation:

\[
q = \frac{NNPAC - LSAP}{VBMAP + LVAP + IVAP}
\]

In which:

- \(NNPAC = Y (AFB)\) = Net national product, at accounting prices
- \(LSAP = S (APR)\) = Skilled and unskilled labour salaries, at accounting prices
- \(VBMAP = K (AFB)\) = Value of buildings and machinery, at accounting prices
- \(LVAP = L (AFL)\) = Land values, at accounting prices
- \(IVAP = N (AFI)\) = Inventory values, at accounting prices

These methods constitute options for determining returns on public investment. "When the definitive source of financing is thought to be foregone public investment, the value of "q" most frequently used is between 10% and 12%."\(^{33}\)

For Venezuela, the rate to be used systematically to discount public investment projects has been defined as 12%.

### 12.6 Social evaluation: social prices

#### 1. Concept

In the introduction of this Unit, it was stated that the LMST system involves two sets of accounting prices: efficiency prices and social prices.

**Social prices** track the impact of the use or production of goods or services on income distribution.

Social prices seek to reveal two considerations for project evaluation:

* Increased consumption is more expensive for the poor than for the wealthy;*
* an additional unit of investment may cost more than an additional unit of consumption.

2. General commentary on the LMST methodology for social prices

Generally, the LMST methodology proposes to transform efficiency prices into social prices by means of certain adjustments, such as the introduction of a distributive weighting coefficient, which converts private consumption, at different income levels, into numerical figures. The coefficient is introduced into both the equation for net input cost at social prices, and that for net product benefit at social prices.

With regard to labour, the fundamental requisite for the existence of a social price different from the efficiency price is that changes in employment generate changes in consumption, at market prices, that is, that the new wage is higher than previously, implying financial advantage for the workers and a positive coefficient for net consumption change.

The social cost of the greater consumption generated by the project is offset by the social value of that consumption increase, which corresponds to the value of consumption at market prices, adjusted by the distributive weighting coefficient (D).

The project causes variations in consumption when: a) workers receive higher wages; b) investors receive higher returns on invested capital; c) beneficiaries pay only nominal -or no- charges for the use of the public infrastructure installed by the project.

In short:

* social prices punish projects which generate private consumption benefits for the wealthier social groups: the rates of return on those projects will be low, for two main reasons: a) the net benefits to private consumption are weighted less than those of public income or private savings, and b) the social cost of labour is higher for projects which link workers with consumption above the critical level.
* Social prices assign higher rates of return to projects which generate considerable reinvestment, as well as those which generate greater benefits for workers with incomes lower than a level of consumption defined as critical.

3. Distributive impact

The Distributive Impact Coefficient (DIC) indicates the proportion of private sector benefits to be perceived by low income persons.

Together with estimating the percentage of benefits transferred from the private sector to the low income population, the distributive impact coefficient may include, as additional benefits for the poorer population groups, the difference between the wage paid by projects and the opportunity cost of unskilled labour.

Exploratory techniques, such as socioeconomic surveys, are used to identify the number of project beneficiaries and their per capita income levels.

According to the objectives and criteria of distributive policy, an upper income bound is established for the groups defined as poor. For Venezuela, that limit has been established as the equivalent of US$885, per capita annually.

The distributive impact coefficient (DIC) is estimated by the following equation:

\[
DIC = \frac{(LIB/TB) \times TAB + (Lmp - Lep)}{TAB + (Lmp - Lep)}
\]

In which:

\[
\begin{align*}
LIB &= \text{Number of low income beneficiaries, that is, those with incomes of less than the equivalent of US$885, per capita annually.} \\
TB &= \text{Total number of project beneficiaries} \\
TAB &= \text{Total actualised benefits generated by the project.}
\end{align*}
\]
That is, the expression \((\text{LIC} / \text{TB}) \times \text{TAB}\) assigns benefits in proportion to the number of poorer beneficiaries.

\[
\text{Lmp} = \text{Unskilled labour cost at market prices} \\
\text{Lep} = \text{Unskilled labour cost at economic prices} \\
\text{Lmp} - \text{Lep}\] is the "salary differential", that is, what the project will pay unskilled labour, above its accounting price.

In short, the distributive impact coefficient is a measure of the proportion of the benefits produced by the project which goes to the poorest population groups, either as project target groups or as the lower-salaried workers employed by the project.

For social projects (education, health, recreation), in which benefits are not appraised explicitly, the DIC formula can be adjusted by substituting TOTAL ACTUALISED BENEFITS (TAB) with ACTUALISED COST VALUES. The quantitative assumption is that, in these projects, economic benefits are at least equal to actualised costs (investment, operation, maintenance and replacement), which constitute the economic appraisal of inputs and productive factors.

4. What is economic and what is social

Strictly speaking, then, the economic and social concepts, which earlier and in simplified language we used as synonyms, are both different in reference to an adjusted expression of market prices. The immediately preceding paragraphs make it clear that what is economic is, in turn, different from what is social, in the sense that the latter appraisal, although employed only recently, seeks to make project effects explicit within the economic system, in function of those specific social groups which perceive the consumer benefits derived from the project.
13. Project financing

13.1 Financing. Subject

The physical works budgets and investment cost and operations flows define the project’s resource requirements, distributing them over time. That information serves as the basis for the review of the possible sources of resources and the pertinent operations to secure them, within the most appropriate authorised channels.

It is also important to bear in mind that the way in which financing is structured may condition the institutional development of the project or company set up to execute it (in terms of organisation, legal constitution and managerial, administrative and control structures), making it necessary to perform a careful analysis of resource composition, including organisational and managerial needs.

Moreover, availability of financing for the project is a determinant or restrictive factor on the definition of the physical-technical components, such as size and technology. For this reason, the realistic analysis of the possibilities of financing may generate feedback to the analysis process and modify the original hypotheses, involving change and even substitution of the pre-selected alternatives. Thus, both the design of the financial scheme and the negotiation and management of the corresponding resources are key aspects of the success of the project.

13.2 Financial flows

The project’s (the alternative selected) financial tables should be based on the cost flows. It is necessary to define amounts in national currency (current prices), their distribution over time and the source of those resources. In some cases, it will be appropriate to distinguish among financial requirements, according to central concepts (for example, a corporation may only make loans for machinery and equipment and will wish to see that component, related to the others, in the tables).

1. Investment budget

The following table shows the project investment budget, with resource complementation among three levels of public administration.
TABLE XIII.B.1
Investment Budget and Finance Sources:
(Thousands Bs. 01/93)

<table>
<thead>
<tr>
<th>FINANCE SOURCE</th>
<th>AMOUNT</th>
<th>(%)</th>
<th>YEAR 0</th>
<th>YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROINSOL</td>
<td>14,199</td>
<td>60.0</td>
<td>14,199</td>
<td>0</td>
</tr>
<tr>
<td>REGION</td>
<td>3,550</td>
<td>15.0</td>
<td>3,550</td>
<td>0</td>
</tr>
<tr>
<td>MUNICIPALITY</td>
<td>5,916</td>
<td>25.0</td>
<td>5,916</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>23,665</td>
<td>100.0</td>
<td></td>
<td>23,665</td>
</tr>
</tbody>
</table>

2. Operations and maintenance budget
The operations and maintenance requirement flows can be elaborated for the entire operational life of the project. However, since the table's main purpose is to show how the annual requirements of the project's operational life will be financed, it may be more appropriate to simplify the table to an average or representative year. If project evolution involves various "stages of development", it may be appropriate to present data for typical years in each stage.

TABLE XIII.B.2
Operations and Maintenance Budget
(Thousands Bs. 01/93)

<table>
<thead>
<tr>
<th>FINANCE SOURCE</th>
<th>(%)</th>
<th>STAGE I</th>
<th>STAGE II</th>
<th>STAGE III</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME (TARIFFS)</td>
<td>100.0</td>
<td>2,920 a.</td>
<td>5,050 b.</td>
<td>6,450 c.</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0</td>
<td>2,920</td>
<td>5,050</td>
<td>6,450</td>
</tr>
</tbody>
</table>

Notes:

a. "Stage I" corresponds to the first 6 years, when it will operate with 2 workers. The amount indicated is the annual average for the stage.

b. "Stage II" covers years 7 to 14, when it will operate with 3 workers. The amount indicated is the annual average for the stage.

c. "Stage III" covers the last 6 years, when it will operate with 4 workers. The amount indicated is the annual average for the stage.
Annual operations budgets are the basis for determining the prices or tariffs which will guarantee sustainability. Together with covering real operations and maintenance resources, criteria for fixing tariffs may also involve other factors, such as: a) financial costs -when some resources are loans; b) the replacement cost of assets with use lives shorter than that of the project (re-investment), and c) the generation of a surplus for future expansions (to broaden coverage), improve quality or technological innovation. The level of tariff coverage should consider the users’ ability to pay and the political viability of their allocation and preservation in real terms.

13.3 Resource sources
It sometimes happens that certain special resource opportunities pass unnoticed, specially by mid-sized and small municipalities. This occurs for several reasons, such as the lack of information, communications difficulties or imperfections, or lack of institutional initiative.

However, when these avenues are explored, other administrative limitations appear which impede their timely and effective disbursement, either because the municipality does not have the necessary negotiations and management abilities, or because it does not have personnel able to identify, elaborate and sustain projects, or usually for both these reasons. This highlights the importance of intensifying and maintaining training activities in this regard within territorial entities.

State and local authorities should be concerned with the identification of possible sources of financing and the configuration of viable combinations for the execution of the projects required to satisfy the demands in their communities. Generally and as reference information, we list here a range of resource possibilities -monetary and non-monetary, conventional and non-conventional- which together may help to finance local development projects.

1. Municipal treasury funds
   a. Land (or territorial) tax
   b. Industrial, commercial and services (or the like) tax
   c. Appraisal of improvements
   d. Rates or tariffs for services
e. Capital resources
   Specially:
   * sale of goods
   * balance resources, and

f. Fiscal efficiency

2. Surplus funds and savings
   a. Unused surpluses
   b. Issuing municipal bonds

3. Non-municipal resources
   a. Regular State transfers
   b. Special national budget contributions
   
   c. Municipal participation in natural resource exploitation
   d. Supramunicipal entities

4. Credit resources
   Local institutions can obtain credit for their projects from diverse financial sources: national, international, public or private.

   a. In the national public category are:
      * Development Banks or similar agencies, specially those which grant loans for urban-local development
      * Pre-investment Funds, which finance studies, ante-projects and local development projects
      * Sectoral credit entities

   b. National Private Banks are a source of emergency or short term credit, given that their rates are usually higher than development rates. However, they may offer special
development lines of credit, with lower than commercial rates, through re-discount programmes authorised by the Central Bank.

c. Certain private Foundations or Corporations devote part of their resources to develop local projects, either through subsidised loans or specific contributions.

d. International Credit Banks are an important source. Their loans are usually made through programmes or project packages, negotiated by financial intermediaries of the receptor State. Direct loans to mid-sized or small municipalities are the exception and, when made, require State endorsement.\(^{34}\)

e. Supplier financing

5. International co-operation resources

a. Government agencies

b. Private foundations

c. Government subsidy funds

Several countries, through agencies, foundations or funds, offer co-operation to promote regional-local development and strengthen municipalities.

d. International organisms\(^{35}\) and International Development Banks, such as the IDB and the World Bank.

International co-operation usually takes various forms: contributions in the form of financing, equipment, technical aid and collaboration in the execution of specific projects.

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\(^{34}\) These organisms offer soft loans (at low rates) for relatively under-developed countries. They also grant non-repayable loans for special local projects and programmes to promote municipal development (training, diffusion, technical aid, and horizontal co-operation).

\(^{35}\) For example, included here are all United Nations organisations.
6. **Social and institutional forces**

   a. **The community**

   The community is the object of local action, but it may also participate as subject, as protagonist. Local authorities should stimulate community productive potential. The community is an eventual contributor of monetary and physical resources (land sites, buildings, equipment, etc., either donated or loans), or of labour (self-construction). However, its greatest potential lies perhaps in managerial capacity. Community participation may take different forms: identification of needs, solutions proposals, definition of project objectives, generation of initiatives, adoption of technology, organisation, management, administration and co-operation.\(^{36}\)

   b. **The private sector and business association forces**

   These important actors can be involved in local development in different ways. First, they represent a potential source of joint undertakings with the local government, through consortiums or mixed companies. Second, they may participate in civic campaigns for social development (urban cleans-ups and renovation, street signs, recreation, security, cultural promotion, etc.). They may also be concessionaires of public functions in those deemed pertinent by the municipality, for reasons of administrative efficiency or net economy in the cost of providing the service areas (urban transportation, for example).

   c. **Regional or local companies**

   These include large companies (specially those which are capital intensive) located in the municipality, which may even become its symbol (the refinery, paper mill, sugar plant, steel mill). Those companies should identify themselves with local values and may provide important support for local projects.

   d. **Associations or consortiums among municipalities**

   For economies of scale (example: cold-storage slaughterhouse), physical-technical limitations

---

\(^{36}\) Within the broad concept "community", it is necessary to identify the consensus required by a project which must be generated with the user or direct beneficiary group, as well as with those affected by the project. It is also necessary to note the importance which associations, such as municipal boards, neighbourhood groups, heads of family or volunteers, may have for participation processes.
(water supply), inter-dependencies (local roads) or momentarily inadequate resources, a group of
neighbouring municipalities may undertake a joint project, supported by mechanisms to share
resources, achieving, in turn, a broader base for securing loans.

e. **Stimulation of resource potential and economic growth**

Municipal efficacy is not limited to the execution of infrastructure projects, public services or
social welfare. In fulfilling its mission to promote social development and economic growth, it
should also consider private sector potential, promoting conditions favourable to productive
investment.

To this end, the municipality may promote mechanisms to attract investment, with tax incentives.
Those measures may involve short-term fiscal sacrifices, but may also imply important benefits
in the future, not only from the perspective of the expansion of productive and social resources
(increased local capital, more jobs, higher income for the population, greater wealth and social
welfare), but also for public income itself (increased fiscal potential and greater demand for public
services).

### 13.4 Credit resources

In the case of loans, evaluation is bi-directional between those who grant and those who receive the loan.

Those seeking loans must examine the comparative advantages and disadvantages of the available options.
The main elements to evaluate include:

1. **Net cost of the loan.** Commitment rates and administration or supervision charges, if any,
   must be added to the real interest rate.
2. **Capital amortisation rate.**
3. **Grace period.**
4. **Guarantee of timely payments.**
5. **Degree of the complexity of formalities, both for securing the loan and the activation and
   execution of installments.**
6. Type and volume of the guarantees required for granting the loan.
7. Additional advantages, such as technical aid, training, etc.

In turn, the credit agency, will analyse diverse aspects when studying a loan request:

1. The objective of the project, to ensure that it is coherent with a given line of development or its institutional priorities.

2. The general characteristics of the project (physical-technical, financial, institutional and administrative aspects) and their justification.

3. The amount requested.

4. The composition of the project’s and company’s investments and financial flows. The concern is to verify the project’s economic and financial solidity, as well as the capacity to repay the loan (the Net Financial Flow of the company involved in the project is useful for this purpose, because that balance is the margin available after loan amortisation and coverage of financial costs).

5. Financial performance indicators (Internal Rate of Return).
6. The financial structure and debt capacity of the institution or municipality (discussed below).
7. The institutional characteristics and history of the loan requester and of those responsible for its execution (these may be two different institutions).
8. Endorsements and guarantees offered.
9. Counterpart resources (which are complementary to the loan for project execution).
10. Other indicators useful for socio-economic analysis, such as the social benefit/cost ratio, the creation of new jobs, etc. These factors are specially important in the case of loans from development promotion institutions.
11. Tariffs and fiscal efficiency.
When future project income depends in large part on the level of tariffs and their evolution, the credit entity will analyse this aspect with care and may suggest criteria and mechanisms for their actualisation and may even condition installment execution to tariff increases.

Suggestions - and even conditions for granting the loan - may be derived from that analysis, together with the review of the debt capacity (of the company or municipality, as a whole), related to reforms of the municipal fiscal structure and financial system. This is a political aspect of the problem which must be examined carefully by local authorities.

13.5 Co-financing

Co-financing is a mechanism through which special funds are set up for specific social welfare objectives, in order to complement the contributions and efforts of the target entities responsible for executing projects related to objectives for sector, regional or local development.

Co-financing funds supply resources, subject to certain commitments made by the receptor entity, such as:

* investment in certain priority areas;
* counterpart contributions above a certain percentage;
* a receptor entity commitment to strengthen institutional, managerial and financial capacity, so as to advance toward project self-sufficiency.

The PROINSOL Local Social Investment Programme belongs in this category, with the basic guidelines and requirements for co-financing published separately.
14. The project: presentation and evaluation for the investment stage

14.1 Specification of the alternative selected

Once the most efficient alternative has been selected and it has been established that it is worthwhile and viable, it must be specified in greater detail. This involves precise definition of data and more detailed information on those characteristics of the project which will support resource requests, negotiations and management. Recall that sufficiently disaggregated data are not always available at the "gross" alternative comparison stage, or that project size may not justify detailed data generation costs at that stage in the process.

The elements involved in the specification of the alternative selected are mainly physical-technical in nature. It will still be necessary to develop project design in greater detail when evaluation has ended (end of the pre-investment phase) and resources have been allocated.

Here, we will give an overview of the aspects usually included in the specification of a project’s engineering and technological designs:

14.1.1 Design components

a. Review and specification of project objectives

This involves the review of the expected results of the project; verification of its dimensions, user preferences, tastes, values, etc., as well as accommodating the project to the environment, in terms of the criteria and restrictions which may affect it.

b. Product definition

Parameters for defining the type of product most adequate for serving the target population are derived from the previous data survey. Product definition involves the precise delimitation of its nature, characteristics, composition, quality, style of presentation, packaging and distribution, and the quantities and frequency with which it will be supplied. Product definition may imply use of an existing product or the design of a new one, more appropriate to the achievement of specific project objectives and the special requirements of users.
c. **Design and description of the productive process**

This is the crucial point for technology, because the process is the action modality, the set of inputs transformations which generate a certain product.

The concept of productive process is implicit throughout the entire project. Transformation itself will be more evident in some, than in others. Transformation occurs whenever there is change from an initial state to a final state of different characteristics (transit from input to product), deliberately achieved as an objective of the productive function. This is valid both for projects to produce goods and those for services.

Process design can be performed in different ways: original design, selection of existing technology without change or adaptation of technology to specific project conditions.

Graphic representations are useful for the visualisation, description and analysis of the processes.

d. **Definition and specification of physical inputs**

Physical inputs include various categories of materials:

* Raw materials, that is, those inputs or materials incorporated directly into the finished product (chlorine in drinking water).

Those used to package the product.

* Those consumed in support of the process, but not incorporated into the product (e.g. fuel, pencils, chalk, water, medicine).

Once the process has been defined, it is important to determine the so-called technical coefficients, that is, the amount of each input required to produce a product unit (liters of fuel need for generate one kilowatt, amount of chlorine needed per cubic metre of drinking water distributed; pieces of chalk needed annually, per student). Efficiency factors (losses, leaks, deterioration rates, etc.) should be estimated at this time.
It is also necessary to study the availability (in quantity, quality, timeliness, frequency, cost and guarantee of future supply) of the inputs required by the pre-selected process, because any restriction in this regard may justify the review of the alternative selected.

Technological processes which require an important input (in terms of volume and cost) unavailable in the region must be confronted with another process which would employ inputs available locally.

e. Equipment selection and specification

On the basis of the process and inputs required, the equipment to implement the operation is determined. By equipment, we mean the machinery, tools, furnishings and vehicles needed to implement the productive process.

Many judgment factors are involved in the choice of equipment: size, cost, quality, durability, performance, maintenance, spare parts availability, consumption, technical-economic obsolescence, flexibility, versatility, space, sophistication in use and ease of acquisition, among others.

f. Spatial distribution of equipment

This refers to how equipment should be placed in the plant, according to the productive process. The physical distribution of machinery and tools should be guided by criteria related to the economy of materials transportation, ease of manipulation, available space (if this is a restriction), storage requirements, process fluidity (whether or not congestions occur in the work place), environmental conditions, worker comfort and functionality (which is called "ergonomy", in modern language), flexibility in the production line (when the project calls for the production of several non-simultaneous products), special quality requirements, industrial security, the generation of sub-products and waste, the possibilities of future expansions, etc.

g. Labour requirements

These elements provide the basic data for determining the quantity and quality of the labour required. The level of knowledge, skill and experience required by the process and equipment, together with the
availability of local labour, establish the parameters for the selection, training and payment of the personnel needed for the different work posts.

h. **Buildings, construction and spatial distribution**

Buildings are the containers or clothing of the technological processes. Their size, shape and placement result from the review of the processes and their distribution in the plant. First, the process and equipment are defined, then the buildings, not vice versa.

To calculate the spatial requirements of buildings, the preliminary study of the processes will serve as the basis for adequately identifying functional areas, such as the following:

* production area, where transformation processes occur.
* Service areas, that is, treatment plants, parking lots, cafeterias, etc.
* Administration area: offices, meeting rooms, etc.
* Traffic and reception areas, for movement of personnel and materials.
* Storage and warehouse area for raw materials and other materials, spare parts, finished products and wastes.
* Area for future development, according to expansion plans for the coming years.

Another important factor is the versatility and multi-functionality needed in the installations of certain projects, specially those for community activities, in order to maximise their use for diverse purposes.

It is important to bear in mind that every project does not require additional installations. It may be implemented by using (or simply refurbishing or expanding) existing installations.

i. **Infrastructure and complementary works**

Matters related to ease of access, means of communication, traffic, the transformation or installation of public services (water, sewage, energy, telephone, waste removal and disposition, worker housing, parking lots, environmental adaptations, etc.) must be considered.
Infrastructure and complementary works requirements must be identified and calculated adequately and in timely fashion, because their costs are part of total project costs and, in some cases, may be a determinant factor in decisions about project location, size and the use of technology.

14.2 Technology selection

14.2.1 Importance

The choice of technology requires specialised data and information, which can only be replaced by adequate advisory services. Technology has important physical, economic and social implications which go beyond the solution of the concrete problem. This calls for careful consideration prior to the final decision, in order to reconcile two concerns:

* The specific objective of the project, in which the definition of technology plays a central role, because any design error will be expensive, sooner or later; and
* The effects of the project, in terms of national, regional or local development (technological externalities).

a. Sources of information and advisory services

- Science and technology organisms.
- Supplier companies.
- Technology directories and catalogues.
- Universities and technology research centres.
- Consultants and technologists.
- Professional associations.
- The Ministry of Industry, or the like.
- Patent Registry Offices.
- Quality control and technical rules Offices.
- Industrial or sector associations.
- Municipal associations.

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37 In terms of the creation of jobs, the industrial and technological development of the country or locality, cash savings, environmental control.
- Municipal promotion institutions.
- The experience of the Municipality itself.
- The experience of other Municipalities in similar projects.\textsuperscript{38}

### 14.2.2 Technological disaggregation for the project

Recall that technology is basically found in the productive processes and the instruments to implement them. Roughly speaking, we can state that the entire binomial process-equipment set is the "technological package", when it is provided by one supplier.

The lower the level of our knowledge, experience, information, advisory services and technological know-how, the weaker will be our negotiating power and the greater our dependence on the supplier. In those circumstances, the supplier will attempt to sell a closed, complete package, which is called "key in hand" negotiation.

The technological disaggregation of projects is a methodology which makes it possible to penetrate the technology package. Disaggregation means exploring what is inside the technology package, analysing it, and identifying its components and their functional interdependence. This, in turn, makes it possible to discern what parts can be produced nationally or locally and to seek acquisition in favourable terms, with a double simultaneous benefit: for the project and the national-local economy.

If project management opens the door to national or local engineering and industry (in process design, equipment and parts production, installation engineering, construction and civil works, in installation services and maintenance), a contribution is made to national, regional and local development, in terms of employment, cash savings, technological progress, investment and welfare, as well as by improving the capacity to negotiate and developing methods to achieve consensus and participation.

\textsuperscript{38} In this regard, two types of reference are recommended: those which have been successful (exemplary) and those with problems or which failed (to learn from those errors).
14.3 Establishing adequate technological standards

Technological standards should be adapted to user abilities and expectations. The technological standard (level of sophistication) adopted for a project determines the amount to be invested and operational costs which, in turn, affect the value of the contributions (quotas, tariffs) to be made by the users. Carelessness in this regard has led to the displacement of the most needy users (the poorest social groups) in many projects.

Adequate technological standards, consulted with the beneficiaries, may guarantee or improve the possibilities of community self-financing. Self-construction (self-management) projects have produced satisfactory results in the matter of standards definition, self-financing and even expand temporal horizons for project execution, as occurs in the progressive implementation of popular housing programmes.

14.4 Institutional solution

1. Subject

This is an important aspect to analyse during project elaboration. The institutional solution means designing the basic organisational structure, assigning managerial responsibilities and outlining the fundamental aspects of the project's administrative system, according to criteria of appropriateness and functionality.

2. Solution background information

In order to define the most appropriate administrative organisation, it is necessary to analyse the relevant background information, including:

a) Review of the capacity of the entity responsible for the project.

b) Study of the composition of the capital constituted for the project (nature and number of contributors, volume of their participation and their expectations with regard to their intervention in project management).
c) Distinction of project development stages (initiation, installation and operation), because it is possible to imagine either integral project execution in all phases or several successive institutional solutions, according to the characteristics and requirements of each phase.

3. Organisational alternatives

The study of these elements, among others, may result in the consideration of diverse alternatives. Generally, the following institutional modalities should be mentioned:

a. Institutional solution by assigning the project to an existing company, entity or (municipal or regional) dependency.

b. Inter-institutional co-ordination, that is, among various existing entities, by assigning responsibilities to each.

c. Creation of a specific entity for project execution and administration.

d. Contracting project execution (of some of its phases) to other entities. This alternative may be appropriate in combination with one of the other modalities.

The institutional environment of each project must be examined and the organisational solution which best responds to factors such as volume, technological complexity, the organisation’s (municipality, region) known capacity and efficiency, should be proposed. The criteria of minimum institutional cost and administrative efficiency should guide the organisational and managerial solution chosen for the project.

14.4.1 Calendar actualisation and resource activation

As soon as project authorisation has been secured, the installation stage should be prepared, which requires -as discussed at the beginning of its guideline- a number of operations, including three activity groups:
1. **Design specifications**
These should be defined in terms of project characteristics and the conditions of the finance contract. The diverse nature of the technology employed in different projects means that detailed engineering contents, specifications and norms must be defined for each sector. The discussion found at the beginning of this manual may serve as a general orientation.

2. **Resource management and installation programming**
The first concern is the negotiation and successful allocation of financial resources, which are a necessary condition for project execution. Agreement on all matters related to payments and counterparts is essential.

Moreover, it is necessary to ensure that the delivery of all foreseen resources (human, equipment, inputs, etc.) for project installation is timely, in function of the works time-table. Given the special care they require, two aspects warrant mention: licitations and work programmes.

a. **Licitations and contracts**
From the juridical perspective, project studies and design, advisory services and consultations, acquisition of technology, purchase and installation of equipment, the construction or purchase of buildings, contracting services or materials purchases are all processes generally regulated by national and municipal rules, which must be accepted and obeyed.

From the technical-economic perspective, licitation and contract processes should be made compatible with project objectives, with the desired technological parameters and investment time-tables. The terms of reference or lists of conditions must be elaborated very carefully, with juridical, technical and financial advice, in order to ensure maximum procedural transparency and security, avoid legal errors and guarantee the viability of offers which respond to the requirements.
b. Installation programming

Once the technical aspects have been defined, installation programming should be determined, that is:

1. The activities to be performed from the decision to implement the project until start-up (when the operation phase begins);

2. the interdependency of activities;

3. their distribution over time; and

4. the financial, human and material resources to be allocated to execute those activities.

In order to facilitate the process of programming, executing and controlling the installation, graphic methods, such as bar diagrammes or network methods, are very useful.

The duration of project installation must also be analysed prior to the decision, in order to ensure that it is coherent with the original goals set. A demand to shorten time periods implies reviewing work methods and resource allocation. It may also be necessary to reformulate technological processes to arrive at an engineering configuration which can be installed within the periods established.

14.5 Sustainability

Introduction

This Module, called the Sustainability Module, is the seventh of this Manual and the last one in which you should follow a group of precise instructions to fill-out its one Form. Once this Module is completed, you should collect the summarized project information to prepare the "Project Summary", which should be presented together with the BIS card. This summary, and the way to present it, is discussed in Annex 1, "How do we present the project?".
As in the other Modules of this Manual, we first describe the concept of Sustainability (of the selected project alternative). This is presented in the section called "What does the sustainability of a project mean?". In the section Instructions for the Form, we present the instructions on how to fill-out the Form correctly.

**What does the sustainability of a project mean?**

There are two definitions of the concept of sustainability. The first refers to the ecological sustainability of a process of global development. A common definition of sustainable development, in this sense, is "the development achieved with present purposes without compromising the capacity of future generations to satisfy their objectives of well-being". The focus of this type of sustainability is wide and long-term.

The second definition of sustainability, which we use in this Manual, concentrates upon analyzing the capacity of an investment project to continue producing benefits once it enters in its operation phase.

Suppose that two highways are built at the same time. If after 10 years, highway A continues to serve without problems, and highway B is deteriorated and unusable, we would say that the project of highway A was more sustainable than that of highway B.

The suggested definition of sustainability as the capacity of a project to maintain the flow of benefits during a long time period suggests two elements of analysis. First, the definition refers to an investment project. However, it is not the sustainability of the project itself that we want, but rather the physical maintenance of the investment, the long-term financial viability of the project, institutions capable of maintaining the project functions, and human resources that will sustain the project and not let it "decay".

Second, we should define an adequate level of benefits. Since in this Manual we do not put values on the benefits, it is reasonable to classify the sustainability of the project as high, moderate or low, in terms of maintenance of the level of benefits. For example, if the health care for which the project was designed will continue to be provided at the appropriate level.
Instructions for the sustainability form

Based upon the above definition of sustainability, Form SO-01 (Project Sustainability) checks to see if the project which has been evaluated complies with three basic conditions which will assure that it really does resolve the problem for which it was designed.

First, it is important to know if external factors exist, or might exist, that would delay the investment, such as the importation of required goods, etc. Second, if there is a high probability that the element required or operation will be available. Third, that the sources of financing, both for investment and for operation, have a reasonable chance of materializing.

For this purpose, you should answer at least the questions marked with the symbol √ in Form SO-01.

14.6 Environmental Impact

Most countries of the region have passed specific laws which incorporate environmental impact considerations into the design, preparation and execution of investment projects, as a key element in their strategies for a sustainable environment.

This chapter should include: a) check lists which identify the main environmental effects of each phase of the project cycle; b) cause and effect matrixes; c) standard research provisions for the verification of the main environmental effects and impact; d) recommendations with regard to the expected impact.

14.7 Annex: presentation of the "project document"

The structure and density of the "Project" document should be geared to diverse factors, such as its nature (sector) and complexity, the requirements of the entity for which the project is being prepared and the document’s function. Although certain types of project may face specific institutional requirements, general guidelines can be given for the presentation of project documents. Here, we present a generalised example of a request for investment resources:

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39 Its function may be multiple: request for credit, request for budget resources, to justify the authorisation of pre-defined resource installments, to demonstrate viability to planning organisms, etc.
SPACE FOR THE NAME OF THE PROJECT
FORM SO-01: PROJECT SUSTAINABILITY

Instructions: Try to answer at least the question marked with the symbol “✓”. Work in Form SO-01 of Annex 2.

✓ Verify if factors exist that could delay the execution of the project. For example, requirements of importation of goods, negotiation of finances with other entities, political changes in the different levels of government.

✓ Verify that you have considered all the requirements of operation and maintenance of the project during its useful life.

✓ What chance is there (high, medium, low), that each of the sources of financing of the project, both in the investment phase and in the project operation, will materialize? If the chance is low, have you identified alternative sources of financing?

Verify that the size of the project, and its future expansion, are in agreement with the demand for the good/service that will be produced. If the project will sell goods or services, what factors might cause changes in the prices contemplated in the project design?

Estimate, if appropriate, the sell price over unit cost and compare it to that of projects which are functioning and have worked well.

Classify (high, medium or low) the capacity of the entity which will operate the project. If it is low, have you considered alternatives?

Detailed data and the explanations of the methodologies followed in the research (studies, field work, community surveys, etc.) are placed in an Annex.

CHAPTER 1: EXECUTIVE SUMMARY

Purpose:
Present a global overview of the request and of the main characteristics of the project, with a brief, concise summary of the aspects analysed in greater detail in subsequent chapters.

* Names of the responsible entities
* Name of the project and locality
* Project objective, with a brief description of the current situation and that expected to prevail after project implementation.
* Summary of benefits and characteristics of the target population
* Summary of investment, operations and maintenance costs
* Results and indicators (cost/efficiency or cost/benefit) of the project’s (the alternative selected) social-economic evaluation
* Proposed sources of financing and their distribution
* Financial results (indicators), if the project seeks income from product sale or service delivery; demonstration of operational viability over time
* Summary of the institutional and managerial framework for project execution and operation.

CHAPTER 2: Problem or need identification and proposed solution

Purpose:
Justify the perception of a social problem or need which warrants attention and demonstrate that the project is a solution.

Basic contents:

* Background
Description of the context within which the need to undertake the project was discovered, with reference to at least the following elements:

- General overview of local difficulties (from diverse angles: social, political, economic, cultural, ecological, financial, institutional and technological).
- Explanation of the reasons for the identification of the social problem or need which the project seeks to solve.

* The proposal (alternative selected)
- Descriptive summary of the alternative selected, demonstrating why it is an adequate solution to the problem.
- Tables and graphs supporting the identification module of the alternative selected.
CHAPTER 3: Target population and demand analysis

Purpose:
Define and characterise the affected population for whom the project will satisfy a need by covering a determined service deficit - current and future.

Basic contents:
* Target population
  - Identification, delimitation, quantification and projection of the population with the need which gives rise to the project. The target population should be described in terms of those basic traits which help specify the problem: age, sex, socio-economic stratum, geographic distribution.
  - Deficit of the product (good or service) to be provided by the project.
  - The most relevant tables of background data and projections (target population and deficit).

CHAPTER 4: Technical aspects

Purpose:
Present information which facilitates comprehension of the project's technical objectives and characteristics.

Basic contents:
* Size
  - Indication of the size (current and future) chosen for the project (expressed in the most convenient units: number of units, of beneficiaries, geographic extension, etc.).
  - Justification of size option.

* Location

* Indication and description of the geographic area or site chosen for the project and its justification. Attach maps which illustrate macro and micro location decisions, indicating the proposal's advantages.
* Engineering and technological aspects:
  - Description of the current system
  - General description of the proposed system
  - Description of the product (good or service) to be produced by the project
  - Production process chosen and its technological characteristics
  - Raw materials and inputs
  - Machinery and equipment
  - Buildings
  - Infrastructure and complementary works
  - Possibility of future expansions
  - Labour requirements
  - Current stage in studies and design
  - The blueprints, graphics and flow charts which best explain or provide visual reinforcement for the interpretation of the technical aspects of the project should be included.

CHAPTER 5: Cost and benefit flows

Purpose:
Demonstrate benefits over time, together with the real resources which must be allocated to the project in accord with its investment and operations time-tables.

Basic contents:
* Summary of amounts
* Benefits flows. Actualised or annualised benefits.
* Investment flows, at market and economic prices. Actualised flows.
* Operations and maintenance cost flows, at market and economic prices. Actualised flows.

CHAPTER 6: Social-economic evaluation

Purpose:
Demonstrate that, according to economic and social criteria, the alternative selected is the most advantageous among those considered. Demonstrate, likewise, that the project is competitive, in terms of efficiency, with other projects.
Basic contents:

* Social-economic indicators (cost/efficiency and/or cost/benefit) of the alternative selected.
* Comparison of the indicators of the alternative selected with those of the other alternatives considered.
* Analysis of the project’s indicators, in themselves and in comparison with the available reference indicators: of the national economy, the relevant sector and/or the region.
* Summary of environmental evaluation. If the nature of the project or the project-environment relationship so require, this analysis may require special, detailed treatment and, in that case, should be included in a special chapter.
* Presentation and analysis of other quantitative and qualitative indicators to complement those already provided. Commentary on the overall evaluation of the project.

CHAPTER 7: Financing and financial evaluation

Purpose:

Present the resources required for the execution of the time-tables established and demonstrate the feasibility of finance source composition. Likewise, demonstrate that the financial possibilities for project operation and maintenance have been ensured (including those for generating the project’s own income for extending coverage, if that has been proposed as an objective).

Basic contents:

* Flow and sources of investment financing
* Flow and sources of operations and maintenance financing
* Demonstration of tariff viability
* Demonstration of operational viability over time
* When loans are involved: the requirements of the financial entity, specially:
  
  - demonstration of capacity to repay the loan;
  - financial capacity of the responsible institution; demonstration of its capacity to carry debt;
  - financial situation of the institution with and without the project.
CHAPTER 8: Institutional and administrative organization

Purpose:
Present a complete description of the institutional and administrative organization for the negotiation, contracting and management of the loan; the execution, operation and maintenance of the works; project financial management; authorisations for acquiring debt.

Basic contents:
* Responsible sector entities
  Entities responsible for the loan and project execution
* Administrative organization
* Legal authorisation for acquiring debt
* Requirements prior to project execution

CHAPTER 9: Environment impact

Most countries of the region have passed specific laws which incorporate environmental impact considerations into the design, preparation and execution of investment projects, as a key element in their strategies for a sustainable environment.

This chapter should include: a) check lists which identify the main environmental effects of each phase of the project cycle; b) cause and effect matrices; c) standard research provisions for the verification of the main environmental effects and impact; d) recommendations with regard to the expected impact.
Reference bibliography for economic evaluation


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