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APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART I - GENERAL GUIDELINES

Agency for International Development

September 1971

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REMARKS OR ADDITIONAL ROUTING

Reference Handbook No. 3 - Project Assistance

The attached "Appraisal Guidelines for Development" was cited in reference handbook as a reference.

Although the attached appraisal guidelines are still in draft state, they are being used by many missions to assist in their appraisals of feasibility of projects.

Two copies of the appraisal guidelines are accordingly furnished for your library files.

FROM: (Name and Org. Symbol)	ROOM NO. & BLDG.	PHONE NO.
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APPRAISAL GUIDELINES FOR DEVELOPMENT

Agency for International Development

January 1974

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FOREWORD

Appraisal Guidelines for Development of AID assisted activities set forth recommended methods for accomplishing an appraisal to explore and substantiate the need for an activity or project. The activity may include improving an existing organization or facility, adding a new organization, or constructing and installing new facilities or systems.

The guidelines are designed to help planners accomplish an early appraisal, or evaluation, to determine whether or not the activity being considered warrants the expenditure of time and money to render the assistance, or in some cases to undertake a more detailed study. The detailed study may involve performance of field examinations to glean further information, or undertaking a preliminary project proposal or a feasibility study.

Ideal planning conditions exist when an initial proposal can be singled out as an element of a scheme of development often referred to as a sector plan. This plan embraces a group of related activities that may or may not include any construction, to improve the social, economic, and political life of a country or region. However, activities involving large projects and programs, although part of a particular sector plan, affect more than one sector. For example, a telecommunication management improvement program would have impacts on agricultural, economic, and social development of a country, although initially proposed for the purpose of improving the industrial sector. A complete appraisal would examine these collateral sector impacts and benefits.

An important phase of the appraisal is the examination of promising alternate methods of meeting the developmental needs and identifying the most suitable for closer evaluation. For example, a complete appraisal of a proposal to improve the safety on the highway and street transportation system requires examination of alternate physical facilities, patrol schemes, and other measures that could satisfy the basic traffic demand possibly at much less cost and have the minimum adverse social effect. In this case consideration of alternatives involves reviewing previous studies or making brief field studies of secondary road systems as well as proposals deemed practical for the development of safety systems for railroads, coastal shipping, barge canals, or other alternatives.

Activities or projects to be initiated under a program already underway may in some instances prevent the realization of some or all of the benefits of a newly proposed activity or project. Both may be economically justified but when they are undertaken at the same time the drains on the economy might act to delay the development of a needed undertaking in another sector. For example, the total of the foreign exchange amounts required to buy fuel for a fossil fuel oriented agricultural program already under development and for a proposed new highway building program may seriously upset other plans that require foreign exchange. A delay in the availability of foreign exchange for importation of materials and equipment needed to foster mining and industrial development could delay an expected rise in earning foreign exchange by sale of ores or industrial products.

In summary, the early steps in assessing project development involve finding answers to these kinds of questions:

a. Is the proposed activity or project appropriate to foster national or institutional aims and how does it relate to and meet the apparent need?

b. Is the course proposed realistic in terms of financial, physical, and human resources that would be made available for accomplishment?

c. Is there an organization in being within the country with a demonstrated capability to bring to bear the potential of the proposed activity?

d. What are the economic and social benefits to be gained relative to the costs?

e. What are the beneficial and adverse effects to further development in the country and region?

The work requires the combined efforts of specialists and skilled experts. The study is highly important as it considers courses that can have a lasting impact on a society and country development.

The need for this handbook has long been recognized. Too many AID supported projects and activities were not as successful as hoped for because the application for financing was not consistently based upon the early assessment planning principles covered in these guidelines. Many such projects showed favorable benefit cost ratios in the feasibility study but have been unsuccessful due to limiting factors arising in other sectors. It is vital that a feasibility study not be developed if the project is considered out of phase with the more desirable program activities.

The project appraisal, to be useful, should fully answer the question on why the project or course of action should be pursued further or dropped.

It is a basic reference document for review during periodic project evaluations and program reviews.

INTRODUCTORY STATEMENT

GENERAL

1A. Introduction

1. Purpose

The guidelines presented in this handbook cover the recommended techniques and methods for proceeding at minimum expense with preliminary planning of a developmental activity to satisfy a need. The principals which are universally applicable can be used effectively by a borrower or grantee from a developing country to support a request for assistance in developmental activities of any nature.

2. Objectives of the Development Appraisal

a. To examine the need for assistance expressed by the borrower or grantee to insure an understanding of the interrelationship with existing and planned organizational units and developmental projects, and national, institutional, or business aims.

b. To study singly or concurrently an engineering project, a skilled manpower endeavor, or any other activity acceptable to the borrower or grantee and agreed to by a financing source to satisfy the needs.

c. To show details of the basic information and analyses in a conventional form or as deemed appropriate; i.e., narrative, charts, graphs, drawings, etc.

d. To arrive at a judgment, based upon the foregoing, as to the probably worthiness of the activity or activities in fostering development acceptable to all concerned.

e. To give detailed instructions as to any additional planning needed such as feasibility studies or a preliminary project proposal for technical assistance activities, or other follow-up action for construction activities in order to provide the relatively firm estimate of costs needed to establish financing requirements.

3. Principal Features of the Development Appraisal

a. The appraisal is the first step and in some cases may be the only step in the process of identifying and checking the prudence of the proposed activity.

b. Qualified personnel are required to perform the appraisal; i.e., they must have appropriate experience and training and must come from each of the educational or specialist fields needed to cover all aspects of the activity to assure a dependable appraisal.

c. Readily available basic data often can be used in the appraisal to arrive at a decision to drop the proposed activity or to proceed immediately with a next phase such as the preliminary project proposal or a feasibility study. Meager basic data usually causes an appreciable time lag to either obtain or to synthesize the data.

d. It is recognized tha a special format or method of study is not practicable. However, the guidelines should serve as a convenient tool to promote thoroughness in the process of appraisal.

e. Important elements of developmental activities that often in the past have been checked at a later stage and found to adversely affect the planned activity are covered in the appraisal in time to avoid a problem. Outstanding examples of this nature are the lack of enough skilled managers or other professional people, as well as skilled workmen, technicians and accountants; the inadequacy of housing, transportation, handling and storage facilities; and inadequate recognition of the influences of social, ecological, or seismic forces on the proposed activity.

f. Alternative schemes to provide the assistance requested are studied in an effort to meet aims that are of the greatest importance to country, institution or business. For example, the accomplishment of work on an activity by the employment of people rather than using labor saving machines may be the most economical method of meeting the need, notwithstanding the financial advantage claimed for machine operations. Usually several alternate schemes of proceeding are studied and covered in some detail in the appraisal document.

g. Advisory type assistance to improve organizations or institutions can be appraised in those instances where the need is difficult or impractical to fully define or where judgment as to the wisdom of the proposed activity cannot be based upon an analysis expressed only in monetary terms. As one example, such a situation would exist where trained or experienced local people are not available within the required time limits to effectively manage a new agricultural produce marketing plan. The five objectives of the appraisal, enumerated in paragraph 2 above, are applicable.

h. Appraisals that meet the five objectives become a valuable source of information for the preparation or review of forward-looking program of activities. Thus the "programming" of the human and financial resources of a country and of the assistance available from the various national and international sources can be better allocated in an overall plan for development of the country, institution, or business within that country.

4. Arrangement of Guidelines

a. The basic study techniques are set forth in the guidelines and certain detailed studies or procedures are included by reference to other sources. Only those techniques that are unique or not commonly available to the user of the guidelines are fully identified as to source.

b. The complete guidelines consist of this main document and a series of annexes each of which covers a field of endeavor having characteristics that set it apart from all others for reasons that are readily apparent. Modifications may be made to the main document or annexes at any time and new annexes can be added as experience requires.

c. It is contemplated that the revised annexes might be:

(1) Advisory Assistance - Advice in any field without burden of activity responsibility; i.e., government agency or institution manages and directs the activity and advisors usually work with a counterpart person.

(2) Management - Assisting with actual operational details of a department, institution or business; usually trains managers.

(3) Education - All aspects of the fields of formal and vocational training programs and facilities for same.

(4) Agriculture - Covers all aspects.

(5) Transportation -- do.

(6) Water and Sewerage - do.

(7) Electric Power - do.

(8) Public Health - do.

(9) Telecommunications - do.

(10) Manufacturing - do.

d. Aspects of the development process such as environment and social considerations are treated in this document and in each of the annexes as appropriate to the subject matter.

e. It is recognized that many specific operational problems have needed special attention in the development of many of the assistance activities or projects needed by a country or a business. These problems which may arise in essentially all fields include accounting and auditing, taxes, customs, export promotion, public administration, foreign exchange rates, and many others. Technical assistance of these types needed usually are identifiable with one of the fields of endeavor covered in the annexes.

5. <u>Progressive Steps Followed in the Studies and Relationship to Follow-up Action</u>

a. The developmental activity to be assessed may or may not be mentioned in the forecast of needs for assistance or projects contained in the development plan of the country, institution, or business that desires assistance. The fact that an activity is mentioned in the plan does not necessarily mean that an appraisal has been made in the detail envisioned in these guidelines. A borrower or grantee may engage appraisers to assist in performing the studies needed. The important progressive steps that usually require attention are:

(1) Discussion with local officials and others.

(2) Collection of record data and information from all sources.

(3) Examination of record data and how it was compiled.

(4) Identification of alternative developmental schemes that might be used to fulfill the needs.

(5) Relation of the desired effect or product to the overall political, social and economic aims or needs (purposes to be served) of the country, institution, or business.

(6) Estimation of the worth of the most promising developmental plan or schemes in meeting the overall purposes to be served. This step includes the special economic and financial analyses suggested in the guidelines.

(7) Formulation of conclusions and plan of action, if warranted to proceed with follow-up activities.

b. Any project plan or activity that is found to be worthy of further consideration will require follow-up action by the borrower or grantee. The plan of action then usually falls into one of the following categories:

(1) Continuation of detailed examination and analyses to more fully define the activity or project in the detail required to meet exacting requirements, as appropriate, of interested parties; i.e., the country, institution, or business and any outside

financing source. This may be a Feasibility Study for a Capital Project, a Preliminary Project Proposal for a Technical Assistance Project, or a Sector Plan covering a group of interrelated projects and activities.

(2) The initiation of work on implementation of the plan or project can be done only when:

(a) All interested parties agree that the Assessment covers the important points required to support the Assistance Project and sufficient detail to proceed with the procurement of the specialists and related materials, equipment and supplies; and,

(b) The nature of the development involved and in some instances the acceptability of previously prepared preliminary plans make it possible for the financing to be approved in principle and for the borrower/grantee to proceed with the detailed engineering plans and specifications phase on some part or all of the construction work. This engineering work may be temporarily "self-financed" by the borrower or grantee and later reimbursed from the loan or grant when made. If self-financing is not possible because of a lack of necessary foreign exchange a loan or grant can be made to cover the engineering only. In either case the amount of the loan for the construction work undertaken can be more accurately arrived at as bid prices can be solicited as a basis for establishing the expected cost of construction, thus eliminating much of the uncertainty that exists in establishing the amount of financing needed for the total project.

6. Information and Personnel Needed to Perform Appraisal

The importance of good information and expert personnel as components in the appraisal process cannot be overemphasized. Access to good information along with the expertise necessary to appreciate its worth in the required studies and in the performance of those studies will assure sound and consistent appraisals. The fact that the quality of available information is best judged by each expert engaged on an appraisal strongly emphasizes the need to look for certain educational and experience qualifications in the individuals that will be used in performing the appraisal. These are:

a. Educational background, whether formal or informal in nature, should pertain specifically to the principal field under study by that individual.

b. Experience background should be such that he has familiarity with most aspects of the activity to be assessed. He may be the expert appraiser in one of the fields because of his education and experience background and also serve as appraisal leader because of his actual past experiences on other appraisals.

c. He should also know how to examine and if appropriaté, test the validity of record data and other information, synthesize data and information using analagous source material, and how to establish the systems appropriate to fill the continuing needs for information in his field of expertise.

d. He should have the ability to communicate at all social levels and as appropriate, when available, proficiency in the language of the borrower or grantee's country.

e. He should have an appreciation of the qualities required in himself and in other members of the assessment team and of the need for each member to arrive at a judgment in his aspect of the appraisal based upon all of the pertinent information regardless of source.

1B. Examining the Development Needs

1. Borrower or Grantee Identification of the Purposes to be Served

Agreement must be reached among borrower/grantee authorities in identifying the broad purposes to be served. At a national level and among the great number of possibilities a Purpose to be Served might be stated as, opening up for development an unsettled area of the country or improving agricultural production. At the institutional level possibilities may be improvement in management, marketing, accounting, etc., and for a business the foregoing or production of a new resource or items of manufacture. Each of these will require a number of needed activities which are interrelated and may be competitive in terms of available personnel and funds, not only to ultimately accomplish the purpose, but to study needed activities within the purpose.

2. Techniques of Weighing and Defining Purposes to be Served.

a. In order to weigh and define purposes to be served there must therefore, as mentioned above, be an agreement on the development strategy of the country, institution, or business. Elements to be considered in accomplishing the purpose will be the availability of essential manpower, services, supplies, equipment and machinery. One or more of these usually is insufficient and must be augmented. The availability of financing, credit, economic and technical assistance with which to initiate the expressed purposes must be considered. Information on these items may exist in varying degrees of quantity and quality and must be assembled.

(1) Reports prepared for similar activities or even those with a different objective may contain useful information. Case histories of experiences of other countries faced with similar problems will be helpful. Expert guidance will have to be sought in order to identify deficiencies and to marshall data in usable form for consideration.

(2) Advisers may be obtained from international lending agencies and from foreign assistance agencies of the industrialized countries.

b. There are no prescribed formulas or procedures to be followed in defining the national or business purposes. However, there is a host of literature published by international lending agencies, foundations and universities which deal exhaustively with methods and procedures.

c. Each Purpose to be Served will yield benefits and incur disadvantages as compared to another Purpose as well as within itself.

Not all can be achieved within the same time limits. It will be necessary to select Purposes which will be mutually supporting, will offer the least competition for scarce funds, personnel and raw materials, and will yield positive benefits at an early date.

3. Expressing the Purposes to be Served in Terms of a Needed Activity

   a. Accomplishment of a purpose will be brought about by a number of necessary activities of different types. As a rule such activities, particularly in technical fields are costly. It is essential, therefore, that the activity be well considered for the acuteness and urgency of its need in order to justify its competition for funds.

   b. Such an activity will usually contribute to two or more of the Purposes to be Served, and will therefore contribute to or support another sector of the national economy.

   c. The demand for more detailed information on which the interested parties can base decisions increases with each successive level of refinement in analysis. For this reason programs of data collection occur early among Needed Activities. Examples are establishment or improvement of networks for collection of information on the availability of natural resources, their use or sale, on industry and commerce and on meteorological and hydrological data, their analysis and tabulation. The compilation of maps on geology, soils, topography and land ownership are also important aspects of data collection records. These data, the end products of Needed Activities, are useful to nearly all sectors.

d. Similarly the need for technical and managerial personnel to carry on the activities will appear early in considerations. Training of people to staff the activity will be an early and high priority needed activity. It may be possible to obtain, during an interim period, expatriate staff to initiate the activity and conduct on-the-job training of local people. It must be recognized that strenuous efforts must be put forth by the interested parties to keep this interim period as short as possible because if it is prolonged it is costly and has an adverse effect upon developing institutional competence. Also, the laws or customs of the country must be examined closely to avoid training to meet an immediate need, then finding that the trainee cannot be utilized until other obligations such as prolonged military service are satisfied.

e. Formal education, as well as vocational training and technical assistance, which will be beneficial across sectoral lines, often will be required. Also, this requirement may include the need for equipment and buildings to house the activities. Organizations or individuals to assist in carrying out these activities can be sought from international agencies and assistance granting countries. There must be good coordination to minimize time and financial expenditures and maximize the capabilities and availability of those trained.

4. Relating the Needs to National or Institutional Aims

At this point it is well to reconsider the "Needs" and whether they are truly needs or merely desires. Alternative methods such as the following of accomplishing the established national purpose must be considered:

a. Improvement of the organization handling water borne transport on irrigation canals and rivers may be encouraged and improved rather than the organization handling the network of farm-to-market roads. Or, this may be an interim measure until a more rapid and sophisticated transport system such as high speed highways or railroads can be justified. The sophisticated transport system is the national aim in this example. It cannot be adequately satisfied by either the canals or farm-to-market roads.

b. The educational program may require construction of school buildings. If so, modern teaching and sanitation facilities would be desirable. As an alternative, at least on an interim basis, school houses with acceptable but simple facilities may meet the immediate need and be more in harmony with the social and cultural pattern of the country.

c. A need may exist for iron and steel products in the country and a deposit of iron ore exists in the hinterland. Alternatives would be continued importation of the commodities, negotiating concessionary development of the deposit, as well as the production facilities to a foreign firm or firms, or developing the resource to the extent possible with the country's own capabilities and either importing or granting concessions for the rest. Each alternative will present a different array of needs to be met.

5. Developing Appropriate Methods of Studying Whether and How the Needs can be Satisfied.

a. The simplest method of studying how a need that can be satisfied only by government action and can be met is to assign the task to the suitable government ministry or the planning organization to undertake the work with its own staff. Usually, for government developmental activities more than one ministry or sector is involved or the professional expertise is not available in the staff of the ministries or the planning organization. An effective method of studying needs involving more than one ministry or sector is to establish a commission, government corporation, or appoint a planning group and charge it with making the study. Often it is necessary to either procure specialist services from other local or outside sources.

b. Where the developmental need is to be satisfied by a business activity with or without financial support by the government the appraisal should be performed by qualified personnel.

c. Performance of studies to examine needs for services or physical development will likely require experienced personnel in a number of professions who, if available in ministries, or a business hoping to expand, normally would be fully occupied doing routine duties. Hence, the employment of a firm of private consultants qualified to undertake the task should be considered. Alternatively, the aid donating countries, various U.N. agencies or international lending agencies can be requested to undertake the study. If the need is concerned with exploitation of a resource one method of securing a study is to contract with a commercial firm on the basis of granting certain concessionary rights to the developed resource. The seriousness of this aspect of the assessment studies to the borrower/grantee's long-term interests or aims illustrates why persons performing the appraisal must be exceptionally well qualified.

d. Whether the need can be satisfied will depend on its profitability and its priority, as mentioned in paragraph 2, in commanding scarce national funds and credit, manpower, services and commodities. Other factors will be the existence or passage of suitable legislation favoring investment, favorable tax structures and transport or realistic markets for the service or commodity and the cultural and social patterns. As an example of the last two, efforts to persuade nomadic herdsmen to abandon their ancestral way of life and to become irrigation farmers, within a foreseeable span of years, has not been a wholly successful enterprise.

CONTENTS

I. NATURE AND CHARACTERISTICS OF A CAPITAL PROJECT APPRAISAL (CPA)

Foreword

A Capital Project Appraisal (CPA) as described herein is an economic/technical feasibility survey with primary emphasis on non-technical aspects. These aspects include economic and social benefits, technical and managerial capabilities required, etc. Secondary emphasis is given to the engineering analysis in that it is geared, at this stage, to obtaining order-of-magnitude estimates of project costs and a general determination of technical feasibility. The major objective of a CPA is to afford those concerned with project identification, formulation and development the opportunity and analytical framework within which to explore and analyze investment alternatives at an early stage in the capital project decision process. For capital projects that require substantial engineering, the CPA may be supplemented by additional engineering analysis.

The guidelines are presented in two parts. The distinguishing features of a CPA, its relations to other types and stages of analysis and the basic principles and appraisal techniques applicable to all projects, are presented in Part I, General Guidelines. Part II comprises eight volumes, which present guidelines that deal in a more specific fashion with the factors to be considered in the preparation of CPA's in the following sectors:

Agriculture
Education
Electric Power
Health
Manufacturing
Telecommunications
Transportation
Water Supply and Sewerage

Most of the material included in these Guidelines were prepared by Robert R. Nathan & Associates (RRNA) under contract to A.I.D. Some revisions in the RRNA final report were made by AID/W. In the General Guidelines (Part I), Chapter IV (Social Criteria) was added to the RRNA final report by AID/W, portions of Chapter 1 (Foreword) were reorganized and rewritten and some revisions were made in the Appendices. AID/W inputs into the Part II volumes were relatively minor.

It will be readily noted that the economic analysis appears to have received more emphasis in the CPA guidelines than other types of non-technical analysis. This is more apparent than real. Economists have progressed further than other social scientists in developing acceptable quantitative measures critical to the CPA. Economic analysis is only one segment of the CPA. Managerial competence, institutional development and social consequences are other aspects which require careful consideration and weighting in the presentation of alternatives to decision-makers. Serious deficiencies in these areas can readily offset the apparent economic benefits and the financial profitability derived in the CPA. The CPA requires a multi-disciplinary approach in which both engineers and social scientists actively participate.

Analysts of the types envisaged in the preparation of the guidelines may be USAID Mission personnel engaged in the development lending program, consultants, economic and technical personnel in the governments of LDC's, and private organizations interested in lending to or investing in LDC's. The guidelines are not directed primarily to the atypical analyst with extensive experience in the variegated aspects of project appraisals. Yet such analysts may find the guidelines useful in suggesting ways in which a capital project appraisal may be conducted to provide an earlier (and possibly less expensive) basis for staged decision-making. For the highly specialized analyst -- in a certain type of project, or a narrow aspect of the overall appraisal process -- the present document may provide useful guidelines in areas outside his own field of specialization.

It cannot be over-emphasized that the guidelines for CPA's do not provide a set of formulas which can be applied mechanically. Rather, the guidelines are intended to provide the analyst with a suggested approach that will be generally useful -- a way of thinking about projects in relation to the project objectives, the functions to be performed, the concepts, logic and tools to be applied in appraising alternatives, and the critical elements to be considered in the CPA. No two projects are amenable to exactly the same treatment, or are influenced by the same set of factors. Thus, there is no set of hard, fast and inflexible rules that can substitute for judgment, based on training and experience, in selecting those aspects of the CPA that are of major significance in appraising a specific project. The scope and depth of the CPA for any specific project cannot be determined in the abstract or by incorporating these guidelines by reference in designing the times of reference or scope of work for a CPA. It requires professional competence, common sense and adequate knowledge of the capital project to use these guidelines intelligently.

Sequence of Steps in Project Appraisal

In the typical sequence of steps leading to the implementation of capital projects, the CPA follows the identification of a need to be met, or an economic function to be performed in order to facilitate or accelerate economic or social development. The identification may come in a number of ways: from a country review by an international organization, from economic studies conducted within the LDC by government with or without the assistance of foreign consultants, macroeconomic planning or sectoral studies and/or plans, or from prospective private investors seeking government approval for specific projects. The approval sought may, for example, be for tax concessions, government guarantees for foreign loans or subsidies of various kinds.

Proposed projects will show a wide range of variation in the extent to which analysis has been undertaken prior to the point at which a CPA is to be made. In some cases, a proposed project may represent little more than an intuitive judgment, or hunch, that the proposed capital investment will make a significant contribution to national economic development or provide a profitable investment for the promoters. In other instances, a proposed project may have been developed on the basis of a more detailed examination of the physical requirements and the economic and financial prospects. Obviously, projects in the former category will require a somewhat different approach in the CPA than will be appropriate in the case of projects in the latter category. The latter may require only the verification of earlier analyses, an examination of alternatives and, most importantly, the application to the proposed project of criteria and standards that will permit its evaluation, relative to other projects, in terms of its contribution to national economic development. Regardless of the degree of background information with which the CPA begins, one of its major objectives is to bring the analysis to a point that will permit decision-makers to make sound comparisons among the various projects under consideration.

A CPA will come early in the life cycle of a project, after the identification of an economic function, or need. At this stage, the results of the CPA will serve as the basis for the decision on future action on the project. The results may take one of the following forms:

1. Available information will have been shown adequate to establish that the project is economically, socially, and financially beneficial and technically feasible and it is the best available alternative to meet the need, or perform the identified function; that the project offers a rate of return superior to the minimum standard set for the economy; and that margins of error in CPA estimates of costs and benefits are so small that more detailed engineering cost analysis will not materially alter the measure of economic returns from the project. In these circumstances, the appropriate recommendation, might be to proceed to the final design and appraisal stage.

2. On the basis of the available data, the project will have been shown to be desirable; but only conditionally so. Critical parameters affecting costs or value of outputs cannot be ascertained with certainty in the CPA. In these circumstances, the project should be submitted to further study if serious consideration is to be given to project implementation. In this case, the CPA should make explicit the data requirements or conditions and recommend a scope of work for the additional study.

3. The CPA may have disclosed that the proposed project fails to meet minimum standards by a margin sufficiently large to indicate it should be rejected without further analysis.

An expansion of the conditions under which item 2 above is likely to occur would include the following situations:

1. The discounted real net economic benefits (the internal rate of return) of several mutually exclusive projects differ by such small amounts that margins of error in the data could influence the ranking of the projects. Therefore, more precise data, particularly engineering cost data, are probably required in order to make the final project recommendation.

2. When the discounted real net economic benefits of the "best" available project are only [illegible] than the real economic costs, <u>and</u> the cost data used in the CPA are deficient.

3. When the project in question is a highly complex one, or involves a large capital outlay for which more precise (than available from the CPA) cost data are required in order to obtain financing.

In other circumstances, it is feasible to reach a decision to go directly from a CPA to the detailed engineering and final design stage of project preparation. The three exceptions noted above are likely to be encountered fairly frequenly in CPA's.

Relation to Traditional A.I.D. Feasibility Study

A CPA is a feasibility study which differs from the traditional A.I.D. feasibility study (see M.O. 1221.2 - Feasibility Studies, Economic and Technical Soundness Analysis, Capital Projects) in the following respects:

1. The CPA is undertaken as an initial stage in the consideration of a project. The traditional feasibility study, as outlined in M.O. 1221.2 may or may not follow a CPA, depending on conditions discussed earlier;

2. The CPA permits greater consideration of various alternatives at a much less cost than could be done in the traditional feasibility studies;

3. Greater flexibility in modification of projects is possible at the CPA stage, and;

4. The CPA must be based on sufficiently comprehensive engineering and technical analysis to permit reliable order-of-magnitude estimates of project costs. The major emphasis in the CPA, however, is on the analysis of economic, social and other non-engineering factors that enter into the project appraisal. In contrast, feasibility studies as prescribed in M.O. 1221.2 place much heavier emphasis on engineering and technical analysis.

The Steps in Capital Project Appraisal

A CPA may be further explained by a brief description of the steps involved in such an analysis, and by noting certain limitations of the CPA. The CPA:

1. Ascertains and investigates the principal technical and engineering requirements for the project and determines that there is a reasonable prospect that these requirements can be met. If questions of technical feasibility are not resolved, the CPA specifies the nature of the investigation required to resolve them.

2. Identifies, quantifies and places a value on inputs including construction, machinery and equipment as well as labor, materials, and supplies for operations; and major outputs, including intangible, indirect and external benefits insofar as these can be quantified or at least evaluated in meaningful terms.

3. Determines the technical manpower and managerial capabilities required to implement the project and ascertains the availability of the skills and experience available to meet the requirements.

4. Establishes the relationship of the project to other projects -- backward and forward linkages, multibusiness complexes, and infrastructure. It establishes what must be done in related fields if the project under review is to succeed. It also makes clear what benefits the project will bring to related activities.

5. Indicates the rough order of financing needed for the project -- in domestic and foreign currencies.

6. Makes explicit the principal public policy decisions relevant to the project, e.g., tax exemptions, tariff protection, export subsidy, commitments to financing and infrastructure.

7. Examines the political and social context in which the project must be appraised insofar as they are likely to affect the implementation of the project, as well as the social consequences of the outcome.

8. Assesses technological and environmental effects of the project; indicates those aspects requiring more thorough study; and estimates the costs required to eliminate or minimize adverse environmental effects.

9. Examines alternative means of meeting the economic and technical functions specified in the project, including modification in scale or timing of the project.

10. Draws a conclusion regarding the project's soundness based not only on the analytical techniques employed to determine technical, economic and financial feasibility, but also on the analyst's perception of other critical factors. Qualitative judgments are called for in preliminary appraisals, e.g., in appraisal of managerial capabilities, institutional constraints, etc.

11. Based on the nature of the conclusions, the reliability of the data base, and the characteristics of the project, formulates recommendations for the "next step" in the process of project selection.

A CPA demands clarity and preciseness in the comprehensive approach to the project: what costs, policies, timing, inputs and outputs, and linkages must be considered; what key hurdles have to be identified; what impact will the project have; which groups are most likely to be affected; and which methods of analysis are most relevant? It does not demand a high order of precision of the engineering aspects of projects. It does require some measures of sensitivity -- what margins of error can be tolerated without upsetting the conclusion of the CPA?

Advantages of the Capital Project Appraisal

The major advantages of the CPA are several. The possibility of analyzing alternative ways of meeting the project objective is one of the most important. Project definition and formulation under the CPA permits various options to remain open. More expensive technical study inputs are delayed in the CPA, permitting alternatives to be compared without the financial pressures imposed by the commitment to justify technical study expenditures. Early readouts of project soundness may also result from the adoption of the CPA. The other advantages of the CPA would include the following:

1. A sound basis is created for selection among the many candidates for subsequent studies. A project promising a 15-percent return normally merits further consideration sooner than one promising a 10-percent return--other substantive matters being equal, of course--provided the numbers mean the same thing. Use of a consistent methodology--the CPA methodology in these guidelines--will help to assure such comparability.

2. The CPA facilitates consideration of a wider range of alternatives than would be practical with feasibility studies (as traditionally defined by A.I.D.); the scope of the investigation can be more broadly drawn, and more projects analyzed with given inputs of time and expenditures. Thus, the CPA is a valuable means for screening projects and concentrating feasibility studies on only those projects for which the circumstances discussed above require such refinement.

3. The critical considerations involved in a project appraisal become clear sooner to the interested parties -- the progenitor and the decison-maker, the borrower and the lender. A dialogue can then develop more quickly on what additional information is needed and what policies need to be settled.

4. The CPA can help remedy a common failing of some feasibility studies -- the failure of the scope of work to define realistic objectives and the appropriate work programs, the depth of exploration required, and the order of precision needed. The knowledge developed by the CPA is useful in putting these matters into proper perspective, and in providing a better basis for allocation of scarce technical personnel and financial resources to feasibility studies (as traditionally defined by A.I.D.).

Relation of Capital Project Appraisals to Macro Economic and Sector Studies

A CPA is made in the light of the ongoing development process and of general economic, political, and institutional factors. Annual budget messages, economic development plans and programs, input-output studies, national income and GNP data, and reports of Ministries and government departments can provide much of the general background material useful in a CPA. Political and sociological studies can also provide relevant background.

The analyst must consider how the project will be affected by general economic developments, politics, and by cultural patterns in the country. A reasonably detailed macroeconomic plan or a good sector plan in which the project falls can be most useful. But frequently such plans are not available; the analyst may himself have to make estimates of past and prospective economic data vital to the project appraisal.

Macroeconomic Studies/Plans

What kinds of macroeconomic data and guidance should the project analyst be looking for? They are of two kinds:

. Past and projected measures of economic aggregates

.. An understanding of the development strategy for the country.

The CPA should examine only key aggregative data. Examples are:

1. Fiscal, monetary, and foreign exchange data. These will point to tax burdens, credit availability, ease of access to foreign exchange, exchange controls, and so on.

2. GNP and national income data. Such data are useful as a basis for estimating market demand for many final products and services. If input-output (or interindustry relation) studies are available, these can be useful in estimating future requirements (demands) for intermediate goods, e.g., raw materials, machinery, equipment, supplies and services used in production.

3. The size, content, and deficit or surplus position of the budget. These will affect th availability of government funds to finance public projects.

4. Regional development plans as they influence the location and size of projects.

5. Policies affecting the "openness" of the economy -- tariffs, licensing, investment controls.

The strategy of development must also be considered in the CPA, as it will establish conditions and constraints that will affect how projects can be put together and be implemented. How does the project fit into the strategy?

Some important elements of strategy that affect sectors and projects are:

- Import substitution, export emphasis
- Inflation
- Incentives and disincentives for new activities
- Relative emphasis on industry, agriculture, infrastructure
- Reliance on market prices or price controls, fixed and overvalued exchange rates
- Domestic and foreign borrowing
- State ownership of enterprises
- Nationalization of enterprises, diminution of foreign control over local enterprises
- Emphasis on creation of employment opportunities, extent of unemployment, underemployment.

A few examples will point up the significance of the elements of development strategy for the CPA:

. The strategy on "prices." Will the government let the free market point the way to decisions by consumers and investors, or will it seek to shape those decisions by price ceilings, subsidies, fixed exchange rates, allocations of foreign exchange, etc.? Can the effects of such shaping be predicted? And what will be the impact on the project if the government should take a greater or lesser hand in the shaping of such decisions than the analyst foresees?

. Foreign exchange rate policy. If the government follows a policy of maintaining an official rate of exchange that overvalues the domestic currency -- perhaps in the hope that such a policy will restrain domestic prices of imports or make it easier for borrowers to repay foreign loans -- the analyst must take this into account. Where foreign exchange is rationed, there will be great uncertainty regarding supplies of imported materials and equipment unless the industry concerned is accorded high priority. Such policies will also make it more difficult to develop export markets on a long-term basis.

. Incentives and disincentives for projects will affect their viability. Is the project of the kind to merit exemption from import duties, tariffs, limits on imports of competing goods, easy credit, subsidies, etc.?

. Does the strategy favor concentration in certain fields? Is agriculture a heavily emphasized sector? Does the irrigation or livestock project fit well into the overall strategy for agriculture?

. Regionalism. Does the industry project reflect the country's strategy to engage in regional integration as in Central and Latin America and in East Africa?

To the extent that the policies underlying the government's development strategy can be known, they should be regarded as part of the socioeconomic framework into which a project must fit if it is to have a reasonable chance for survival.

The Sector Study

The term "sector," as applied to economic studies or plans, means a part or component of the economic system identified in terms of the nature of the output of the units comprising the sector. In the simplest sectoral studies, the economy may be broken down into only two subaggregates: (1) agriculture, forestry, fishing and hunting, and (2) all other activities. Two-sector analysis may provide some limited insights into the economy not available from the aggregates. As disaggregation is carried further, the number of sectors increases, and the analyst is usually able to have more knowledge of the operations of the various economic sectors.

Typically, sectoral studies include:

1. Demand-supply estimates, including analyses of the determinants of demand, existing and planned capacity and constraints on increases in supply.

2. Unit cost and price information.

3. Import-export relations in the sector.

4. Intersectoral relationships, e.g., sources of supplies of raw materials and intermediate goods, and sources of demand for output by other producing sectors, final consuming units and by foreign buyers.

Where satisfactory sectoral studies have been made, they may constitute sources of directly useful information, e.g., estimates of future demands for a relevant category of goods, cost and price data, and the more important backward and forward linkages. In fact, a careful examination of sectoral studies, particularly if such studies have incorporated intersectoral demand-supply relationships, may provide the "identified economic functions" for which sound projects can be designed.

Sectoral studies and plans are especially useful in a CPA as a guideline in the systematic examination of alternatives. Should the proposed project be postponed to a later stage in development? Should a proposed chemical plant be modified to produce more raw materials for man-made fibers, and less for fertilizers? The existence of unutilized capacity in a sector may suggest a project that can provide a (socially) profitable alternative to idle plant and equipment. Sectoral projections may suggest the modification that will enhance the contribution the project can make to economic growth.

While sectoral studies are receiving increasing attention in LDC's, the analyst is not likely to find a relevant study of the sector in which the project falls. If this is the case, it will be necessary to resort to whatever data are available, e.g., records of imports (exports) of goods similar to those to be produced by the project; or surveys, samples, or census enumerations that may provide at least a limited basis for estimates. Chapter II outlines, in general terms, the nature of these data requirements and possible data sources.

II. FUNDAMENTALS OF PROJECT PREPARATION AND APPRAISAL

Project preparation requires essentially three sets of estimates:

1. Estimates of annual outputs over the life of the project, based on the planned capacity of the project, the levels of future "demand" for the output, and the existing sources of supply.

2. The estimated annual flow of resources, or inputs, required to produce the estimated outputs.

3. The physical quantities of inputs and outputs, multiplied by appropriate unit prices to obtain an estimate of annual money flows, or annual costs and benefits expressed in monetary terms.

From the economic and financial point of view, projects are evaluated in terms of their rates of return.1/ In order to receive further consideration, a particular project must not only meet a specified minimum rate of return, it must also offer the best rate of return of any available alternative form of the project to supply the good or service.

Estimation of Output for Salable Products or Services

In general, projects fall into two categories:

> Those producing outputs of goods and services that can be sold for a price to buyers who can take or leave the good as their individual preferences dictate, and

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1/ Various measures of "rates of return" are discussed in Appendix A; the rates of return recommended in these guidelines are defined and explained in Chapter III.

Those producing goods and/or services for which the demand is determined through some form of collective decision -- usually through government, e.g., public education and health projects. Decisions with respect to the quantities and kinds of these services to be produced are not based on market price demands. Rather, such demands or needs are based on population trends, the ability of the country to provide the service, and the decision-makers' views of the society's ranking of priorities.

Market Demand for Output

Estimation of future market demands for particular outputs must begin with data (or estimates) of quantities demanded in relevant past periods. These can usually be obtained from one, or some combination, of the following sources:

1. Domestic producers and/or importers and other middlemen

2. Tax records, if the article is one on which taxes are imposed and collected

3. Import statistics, if in sufficient commodity detail, and if there are not too many exemptions from duties and nonrecorded imports

4. Household budget studies

5. Requirements of industrial and governmental users. (This source of information is essential for intermediate goods.)

6. If other sources are inadequate, estimates may be made from data available for other countries having similar industrial structures, per capita incomes and population, and political and cultural characteristics that would affect demand for the product in question.

Estimation of future demands for specific products, or groups of products, is difficult under the most favorable statistical circumstances. The difficulties are compounded in most LDC's by the lack of historical data and especially by the discontinuities in demand relationships that occur in a rapidly developing economy. Nonetheless, the task must be undertaken. The following approaches are suggested:

1. Projection of past trends, with adjustments for anticipated changes that are expected to alter historical relationships. Extrapolations of time trends are notoriously hazardous; past relationships between the demand for a particular good and some other economic variable, such as projected GNP, total consumption or industrial production, usually provide a better base for extrapolation than projection of a time series.

2. If available, coefficients derived from an input-output matrix can be used in the projection of demand, particularly for intermediate and primary goods. It is well to bear in mind, however, that economic development implies new technologies and changing structure of the economy. Both can affect the reliability of coefficients derived from historical interindustry relationships.

3. For consumers' goods, family budget studies by income groups and by rural-urban categories can be used to extrapolate present patterns of consumption, providing projections of future income patterns and the rural-urban composition of households are available.

4. International comparisons may also be helpful in projecting future demands. The future level of demand for particular goods in the subject country, say, in 1990, may be inferred from the demands in other comparable countries that reached -- in the recent past -- the level of economic development (per capita GNP, industrial structure) projected for the subject country in 1990. Several countries, rather than one, should be used in such comparisons.

5. Total demand should also reflect potential foreign demand if the project is one having an export potential. The quality, price and reliability of delivery are critical factors in appraising the potential for exports.

When projections of total demand for the product(s) have been made, the "share of the market" that can be expected to be available to the project must be estimated. From the total projected demand, the projected quantities to be available from existing and definitely planned sources of supply should be subtracted. The remainder is the supply gap which the project is to fill, in whole or in part.

If current demands for the product are being met by imports, the feasibility of import substitution requires to be considered. Can the project under consideration produce a substitute for the imported product that will be competitive in quality and price? In terms of the economy as a whole, what will be the real costs of subsidies, tax concessions, tariff and nontariff restrictions on imports required to make import substitution viable?

Projections of Requirements for Nonmarketable Outputs

As noted previously, many projects will involve outputs which are not sold for a price, or are assigned only nominal charges that are not expected to cover total costs. Typically, such projects are public projects -- education, health facilities, public amenities and some economic infrastructure, such as roads and communications facilities.

Estimates of the "demand" for such outputs are generally based on:

- Estimates of the number of future users of the service, e.g., the school-age population, projected traffic, population densities, etc.
- The required level of service, e.g., the quality of education; the speed, safety and economy of vehicle operation provided by a road, etc.

The level of service is generally determined in the light of budgetary constraints, availability and terms of borrowed funds, prevailing attitudes in the society, and the competing requirements for public expenditures.

The particular method for estimation of the demand or need for services of this type will be different for most services. The following are illustrative rather than exhaustive.

1. Education services. Projected school-age populations, percent of the projected population expected to attend (based on location of population, emphasis placed on education in the society, economic constraints on attendance), anticipated employment opportunities for school leavers, and expected changes in income. Medium-term forecasts of school-age population are relatively simple if present population by age levels is known and reasonably accurate mortality tables are available. Attendance ratios are less readily predicted. In projecting the current attendance rates into future years, effects of anticipated rural-urban population shifts, improved transport facilities and rising income levels, especially among lower income families, should be taken into account.

2. Public health facilities. In most LDC's, the availability of health services is far below acceptable standards. Evaluation of the "demands" for such services is more properly focused on the government's ability to finance, staff and operate the proposed facility, and the "appropriateness" of the proposed facility for the accomplishment of the program.

3. Transportation facilities. While the use of publicly provided transport facilities -- such as roads and ports --frequently involves a payment in the form of a toll or other user charge, the determination of the "demand" for such facilities is not made through conventional market channels. Rather, projects are appraised in terms of such factors as: anticipated increases in the demand for transport services; their contribution to reductions in costs of passenger and freight transport, including -- where relevant -- savings in time; economic development, where lack of transportation is a critical constraint; and political, social and economic integration.

The valuation of outputs of this type presents very difficult problems. These are discussed in greater detail in chapter VI and in the individual sector guidelines. Here it is noted that CPA's for projects of this type are sometimes confined to a determination of the least-cost alternative capable of supplying the quantity and level of service required; or, preferably, a cost estimation for a range of quantities and/or service levels should be prepared by the analyst. On the basis of such estimates, decision-makers can evaluate alternative scale of projects to provide a given service, and the opportunity costs, to the public authorities, of different services.

Physical Resource Flow Plan: Estimating Inputs

The study of the "market" or the "need" for the goods or services, utilizing one or some combination of the approaches described earlier, will indicate the nature and sizes of projects meriting further analysis. The next step involves the preparation of a physical resource flow plan indicating the physical inputs and outputs during each year over the life of the project. The composition of inputs will be determined by the nature of the good or service to be produced, the technology selected for application in the project, the method and time schedule for construction, etc.

Cost Estimation

Although CPA's require significantly less detailed and extensive engineering data than a feasibility study, the data base must be adequate to permit at least order-of-magnitude estimates of construction and operating costs. The amount of engineering required in the PPA will depend, in part, on the type, quantity and reliability of data already available.

Cost estimates should be prepared in such a manner as to show separately the foreign and domestic currency costs. The checklist presented in Appendix D cites the principal factors to which engineering expertise should be directed in the CPA.

Estimation of operating and maintenance costs during the life of the project should also be based on engineering assessments of physical inputs and probable requirements for repairs, overhauls and general maintenance. In order to obtain reasonably accurate estimates of these inputs, it is essential that engineers familiar with the proposed production or operating process be available for consultation on the physical input schedules.

In a CPA, the units for estimation of costs should be in the form of modules or aggregates that lend themselves to short-cut estimation, e.g., costs per mile of road construction, by type of terrain and by service standard. However, great care must be exercised in converting module costs to local conditions. The usefulness of modules for estimating purposes will vary considerably from sector to sector.

Construction costs in LDC's are sometimes estimated by applying "country correction factors" to unit costs compiled from actual experience in other countries.

[illegible] of detailed [illegible] which is beyond the scope of the CPA -- the most reliable basis for estimation of costs is from similar projects that have been carried out within the country in the recent past. Even dissimilar projects may contain many common components for which unit cost comparisons will be valid, e.g., excavation, land clearing, grading, erection of general purpose buildings, supplies of gravel, sand, cement and other local building materials. Since it is the local element of costs -- not the unit cost of imported materials, machinery, equipment and supplies -- which shows the greatest country-to-country variation, the degree of accuracy required in CPA cost estimation can frequently place comparatively heavy reliance on local, in-country relevant cost experience.

Pricing Inputs and Outputs

If a project is being appraised from the standpoint of the profitability or rate of return to the enterprise, all inputs and outputs are priced at market prices.[1/] Taxes paid are treated as costs, while subsidies received are entered as receipts (benefits) in computation of the rate of return.

1/ Averaging of prices may be undertaken to avoid distortions. See appendix B.

To determine the net benefit, or rate of return to the economy inputs and outputs are measured in terms of "real costs" and "real benefits". These may or may not be measured accurately by market prices. If not, "shadow" or accounting, prices are used in place of market prices.[1/] Computation of the rate of return which projects contribute to the national economy excludes taxes from the costs of inputs and subsidies from the value of outputs -- both being regarded as "transfer" payments rather than payments for the use of productive factors, or for benefits flowing from the output.

In LDC's, markets for many products are highly imperfect as a result of limited number of buyers or sellers, price determination by administrative action, and compartmentalization of markets because of inadequate transport and communication. Prices in such markets are an imperfect guide, at best, to the estimation of the national economic value of output from prospective projects. By using accounting prices rather than actual prevailing prices, estimates can be improved in these circumstances.

Where output will consist of marketable products (i.e., divisionable goods which can be sold for a price) and such goods are traded in world markets, the c.i.f. price (exclusive of duties) provides a satisfactory base for valuation of domestic output -- if a "correct" exchange rate is employed in converting the foreign to the domestic currency value. If both nonlabor inputs and outputs consist largely of goods traded in world markets, it may be desirable to use world prices for the computation of a project's rate of return to the economy, with labor and other domestic inputs converted to world prices by use of the accounting rate of foreign exchange.

In general, inputs and outputs should be valued at constant prices over the life of the project. But it is important to make allowance for probable future price changes that will result if the project under review will provide a large addition to the short supply of a good having an inelastic demand. For example, the value of output of large-scale agricultural projects can all too easily be overestimated by failing to take into account the effects of increased agricultural output on prices during the life of the project.

1/ The estimation and use of shadow, or accounting, prices are discussed in appendix B. The concepts "rate of return to the enterprise" and "rate of return to the economy" are contrasted in the following chapter.

External Costs and Benefits

There are certain inputs (discussed in detail in a later section) the costs of which are not actually paid by an enterprise. The inclusion of such costs is appropriate if the project is being appraised from the standpoint of the rate of return to the economy, because these costs are borne somewhere in the economy. For example, air and water pollution may impose real costs on the population in the form of loss of production through illnesses and medical expenses.

An analogous situation exists with respect to outputs (benefits) on which an enterprise is not able to impose a price and, therefore, collect revenues. In some types of projects, e.g., development roads, the external benefits may be so important that the proposed road can be properly evaluated only by consolidation with the land development schemes or other development it will serve.

III. APPLICATION OF ECONOMIC-FINANCIAL CRITERIA

The ultimate purpose of project evaluations is to provide a basis for the selection for implementation of those projects that will make the maximum contribution to development objectives. The process of identification and selection is facilitated to the extent that quantifiable costs and benefits attributable to projects -- differing in size, duration, type of output and technology employed -- are expressed in terms of a common measure or measures. This will permit meaningful comparisons of the financial and economic aspects of projects having widely varying characteristics.

The pricing of physical inputs and outputs, discussed in chapter II and in appendix B, is the first step in the process of providing a common basis for aggregating inputs and outputs and for comparison of dissimilar projects. Unlike physical inputs, e.g., man-hours of unskilled labor, tons of cement, transformers and office machines, aggregate inputs can be added to a meaningful total only if each is multiplied by a price to obtain a value. The same basis for aggregation is applicable to outputs.

A second step in the development of a "common denominator" in terms of which projects can be compared involves discounting.

Discounting

Discounting is the process by which the monetary values of inputs and outputs, or the differences between inputs and outputs, occurring at different points in time are expressed in terms of a common denominator: their present values.

An output (receipt) this year is more valuable than the same output 10 years hence. Similarly, a cost incurred 10 years hence is less burdensome than today's. Discounting provides measures of the present value of inputs and outputs no matter when they occur during the life of a project. In essence, discounting makes it possible to answer the question: How much is a specified net earning x years hence worth today?

The distribution of the values of inputs and outputs through time will be different for various projects. Projects yielding a surplus in the near future are more desirable than those yielding the same amount of surplus in the more distant future. Therefore, the discounting procedure is essential if two or more projects are to be ranked, or if a particular project is to be compared with an economy-wide standard of acceptability.

Discount rates are based on the compound interest concept relating present and future values. Letting V_o represent present value, and V_n the value of V_o n years in the future, the following relationships may be noted:

$$V_n = V_o(1+r)^n$$

then

$$V_o = \frac{V_n}{(1 + r)^n},$$

or present value = value n years in the future divided by the "discount rate," i.e., $\frac{1}{(1+r)^n}$.

In practice, the values of $\frac{1}{(1+r)^n}$, the discount rate, are read from standard tables for the selected r and number of years. The discounting technique is applicable to any series representing a flow of values (inputs, outputs or outputs minus inputs) over a period of time. For convenience, it is suggested that a one-year time period should be used in the analyses. Two such tables are presented in appendix E: table E-1, "Single Payment Present Worth Factors"; and table E-2 "Continuous Flow Present Worth Factors at Annual Rates".

Selection of Discount Rate

The appropriate discount rate depends upon the context in which a project is to be appraised. If the appraisal is in terms of the discounted benefit-cost relationship viewed from the standpoint of the national economy as a whole, the appropriate discount rate is the accounting or shadow rate of interest, i.e., the marginal opportunity cost of capital in the economy (see appendix B). On the other hand, if a project is being evaluated from the standpoint of its "profitability" as an enterprise, the discount rate should be the rate required to attract the required capital. In the examples that follow, it is assumed that the discount rate represents the marginal opportunity cost of capital.

The discount rate must be selected in advance in the application of the discounted benefit-cost ratio, and the discounted present value of net benefits criteria; in principle, it is not necessary to select a discount rate in order to compute the internal rate of return on a project.

Project A: An Illustration

The application of discounting, and computation of internal rate of return, are illustrated in the following paragraphs. More detailed illustrations of computational procedures and descriptions of the criteria generally employed in project appraisals are presented in chapter VIII and Appendix A.

Assume the following annual values for inputs, outputs and surpluses (deficits) for a proposed project, A:

Project A

(in thousands of dollars)

Year	Inputs	Outputs	Surplus	Discounted surplus a/	
				at 10%	at 12%
1	300	0	-300	-272.73	-267.87
2	400	0	-400	-330.56	-318.88
3	75	150	75	56.35	53.39
4	70	150	80	54.64	50.84
5	75	200	125	77.61	70.93
6	85	225	140	79.03	70.93
7	90	250	160	82.11	72.37
8	110	300	190	88.64	76.74
9	110	300	190	80.58	68.51
10	110	350	240	92.52	77.28
Total	1,425	1,925	500	8.19	-45.76

a/ The discount rates, expressed as $\frac{1}{(1+r)^n}$, are shown for various values of r in appendix D.

In Project A it is assumed that all investment of $700,000 occurs in the first and second years, with no output in either year; that the expected life of the project is 10 years; and that the plant and equipment will have a scrap value of $50,000 at the end of the tenth year. This amount has been added to revenue from sales of output ($360,000) in the final year. It is also assumed that the capacity of the project at the projected unit price is $300,000 per annum; and that in the initial year of operation (third year of project life) production reaches only 50 percent of capacity, rising gradually to reach full capacity in the sixth year of operation.

Over the life of the project, the total value of undiscounted inputs, is $1,425,000; total revenues, including scrap value, are $1,925,000. The undiscounted surplus flow is $500,000 -- with a present value of only $8.19 thousand if discounted at 10 percent, and a negative present value of $45.76 thousand if the discount rate is 12 percent.

Several features of the procedure illustrated above merit comment.

- It is not necessary in this analysis to draw a distinction between capital outlays and current outlays, both being treated as inputs in the year in which the occur.
- Interest paid and depreciation are not recorded as inputs, i.e., as costs.
- If the economically useful life of the project will extend beyond the period for which the discounting is being done, the estimated value of assets at the end of the final discounting period can be entered as a negative input or as an addition to output.

<u>The Internal Rate of Return</u>

The internal rate of return (IRR) is the discount rate which equalizes the present values of the streams of inputs and outputs. If the algebraic sum of the flow of discounted surpluses and deficits is zero, the internal rate of return on the project is equal to the discount rate; if negative, the internal rate of return is less than the discount rate; and if positive, the rate of return is higher than the discount rate.

On the basis of the hypothetical flows, Project A is worthy of further consideration if the marginal opportunity cost of capital is 10 percent per annum or less. The approximate internal rate of return on the project is just over 10 percent, as shown by the interpolation below:1/

$$r_i = .10 + .02 \left(\frac{8.19}{(8.19 + 45.76)} \right) = .103$$

Project B: An Alternative

Hypothetical data for Project B, assumed to be an alternate project producing the same product, are presented below for comparative purposes.

Note that total inputs, total outputs and total (undiscounted) surpluses are identical in Projects A and B.

Project B

(in thousands of dollars)

Year	Inputs	Outputs	Surplus	Surplus discounted at 10%	Surplus discounted at 12%	Surplus discounted at 15%
1	200	0	-200	-181.82	-178.58	-173.92
2	330	0	-330	-272.71	-263.08	-249.51
3	75	150	75	56.35	53.39	49.31
4	100	225	125	85.37	79.44	71.48
5	120	250	130	80.72	73.76	64.64
6	120	250	130	73.37	65.86	56.20
7	120	250	130	66.72	58.80	48.87
8	120	250	130	60.64	52.51	42.50
9	120	250	130	55.13	46.88	36.96
10	120	300	180	63.39	57.96	44.50
Total	1,425	1,925	500	93.16	46.94	-8.97

1/ The values in the equation are the algebraic sums of the discounted values of the streams of surpluses in Project A, i.e., \$8.19 at r_i = 10 percent and -\$45.76 at r_i = 12 percent.

At a discount rate of 12 percent, the present value of the stream of surpluses from Project A is negative; for Project B it is positive. Thus, Project B promises a higher internal rate of return than Project A.[1/] The higher internal rate of return from Project B arises from the difference in the timing of the annual flow of surpluses. The discounting procedure measures in terms of present value -- or, alternatively, in terms of an internal rate of return -- the differing pattern of distribution of surpluses and deficits on all potential projects being appraised.

The Criteria for Project Appraisal

There are several criteria in terms of which the economic and financial returns or benefits of capital projects may be measured and compared. Three of the more commonly used criteria have been noted earlier. These are discussed, contrasted and illustrated in appendix A.

In the guidelines, it is recommended that the internal rate of return criterion be employed and that projects be appraised from the standpoint of the national economy and from a business enterprise point of view. The former will be referred to as the net national rate of return (NNRR), and the latter as the business enterprise rate of return (BERR).

The Profit and Loss Rate of Return and the BERR

Before considering the technical distinctions between the two criteria recommended in the guidelines, it is desirable to note that the BERR differs in some important ways from rates of return calculated from annual statements of profit and loss, or income statements. The analyst may be confronted with project proposals showing rates of return that have been calculated from annual profits in a "normal year." In any case, in presenting the results of the EPA, the analyst will very likely find in his audience individuals whose way of thinking about rate of return matters will run in terms of conventional accounting profit and loss statements, rather than the criteria recommended for the CPA. For these reasons it is important to note the principal differences between the BERR and the profit and loss statement rate of return.

1/ The interpolated internal rate of return on Project B is approximately 14.5 percent per annum.

The annual profit and loss statement reflects an allocation to discrete (annual, semi-annual, quarterly, or monthly) time intervals the net income of an economic unit over its entire life. Briefly, this is done by charging as inputs the economic values used up during each period, subtracting these from outputs during the period. This requires that assets lasting over several accounting periods be gradually "used up" i.e., the input for a period is the depreciation, depletion, or other allowance measuring the value of the asset charged against the output of the period. It is, therefore, an expense (reducing profit). But it may also be a source of funds -- to be used to pay for purchase of other assets; for investment in securities; and for debt retirement.

Conversely, in conventional accounting a machine that will last several years is not considered as an expense when purchased, but as an asset to be written off (depreciated) as an expense over its useful life.

Annual interest payments on borrowed funds are an expense, a charge against output in the profit and loss statement. Neither depreciation nor interest payments are recorded as charges against output in computing the BERR; rather, outlays for assets are treated as inputs in the year in which the outlay is made, while interest is treated as a part of the rate of return on total assets.

The Net National Rate of Return and the Business Enterprise Rate of Return

Both the NNRR and the BERR are internal rates of return, computed in the manner illustrated earlier in the present chapter, and in appendix A. The two criteria differ in respect to: (1) the prices used in valuation of inputs and outputs; (2) the items included in inputs and outputs, and (3) the treatment of taxes, subsidies and certain other transfers.

The principal differences are as follows:

. The BERR is computed from inputs and outputs valued at actual market prices; in the computation of the NNRR, accounting, or shadow, prices are employed in lieu of market prices if the latter are clearly inaccurate measures of real costs and/or the real value of output.

• Accounting or shadow prices are most likely to be required as substitutes for actual prices in the case of unskilled labor, capital and foreign exchange. The circumstances giving rise to the need for shadow pricing are discussed, and suggestions for estimation of accounting or shadow prices are put forward in appendix B.

• Internal taxes, as well as customs duties paid by the enterprise, are treated as costs (inputs) in the computation of the BERR, and subsidies received are treated as benefits (receipts), or are netted out against the cost of an input; in computing the NNRR, taxes and subsidies are omitted, being regarded as transfer payments rather than payments for current factor inputs or outputs.

• In certain instances, real costs and real benefits attributable to projects may not appear as inputs or outputs of the enterprise, and therefore are excluded from the computation of the BERR because there is no explicit market transaction for them. However, where substantial amounts of real costs and real benefits are omitted from enterprise outlays and receipts, respectively, and where there is some means of placing a value on the costs and/or benefits, they should be included in the value of inputs and outputs used in computation of the NNRR.

• The NNRR is a measure of the national economic rate of return; the BERR is a measure of the financial commerical enterprise rate of return from a project. Decision-makers need both measures to select projects that will yield the optimum contribution to development, and also to provide a guide for the design of appropriate measures for meeting the financial requirements of the project.

A project that is financially profitable -- from the enterprise point of view -- may be less than the "best" project from the standpoint of the national economy for a number of reasons, the most important of which follow:

• If the exchange rate overvalues the domestic currency, projects utilizing significant amounts of imported inputs to produce for domestic markets may result in an unacceptable NNRR but a relatively high BERR.

. While the actual cost of capital funds to be used in financing the enterprise does not enter into the computation of the BERR, if the rate of interest on funds employed in the enterprise is below the marginal efficiency of capital, the project appears to the prospective entrepreneur to offer a more profitable prospect than its rate of return to the economy justifies. This situation may arise when government, for whatever reason, sets interest rates at artificially low levels; when foreign capital is available at rates lower than the marginal efficiency of capital in the country; and when serious rigidities and/or imperfections exist in the domestic capital market.

. There may be important real costs arising from the project which are not reflected in the costs borne by the enterprise, e.g., adverse effects on the health of the workers; air, water and other environmental degradations; and real costs attributable to the project but borne by other economic units -- public and/or private. In the latter category, the cost of supplying publicly financed infrastructure required to implement the project is a common source of understatement of total economic costs attributable to projects. Through taxation, governments may attempt to bring the financial costs incurred by the enterprise closer to the real costs of the project to the economy.

. There are also possible instances in which projects that are unprofitable, from an enterprise viewpoint can be demonstrated to be very beneficial in terms of a net rate of return to the national economy. These occur, most commonly, where the market value of inputs is substantially above the marginal opportunity cost of applying the input in the project in question.

. For example, the money wage rates of unskilled labor in developing countries (typically experiencing serious unemployment in urban areas and underemployment in both urban and rural areas) are frequently above the marginal opportunity cost of this type of labor. Since it is market wages -- rather than the marginal opportunity cost of unskilled labor -- at which the enterprise must value labor input, the enterprise rate of return will be less than the rate of return to the national economy, all other things being equal.

. Where project output includes benefits for which the enterprise is unable to charge a price equal to the full social value, the enterprise net rate of return will be less than the net national rate of return to the project.

. If substantial excess (idle) capacity exists in another industry supplying an important project input such as transport, electric power, or a raw material, the rate of return to the national economy may be higher than the rate of return to the enterprise. If the market price of the input is higher than the incremental cost of producing it, a benefit arising from the project accrues to the supplier.

. On the other hand, a project that removes a bottleneck in the supply of a raw material critical to the operation of another industry may make a greater contribution to national economic growth than is reflected in the market value of the project's output.

Linkages and Multiplier Effects of Projects

The preceding illustrations of external benefits arising from a project but accruing to suppliers of inputs and users of outputs arise from backward and forward linkages respectively. Linkage effects are the increases in income generated by the additional activity occasioned by a project in the industries which supply the project's inputs and process its outputs.

Normally, it is not considered necessary to make a special allowance for linkage effects in calculating the NNRR.

Such effects will normally have been taken into account by the method of valuing inputs described above.

For one thing, comparable linkage effects may be expected to flow from a number of similar projects; therefore, explicit consideration of the linkage effects would not add any important measure useful in differentiating the flow of net benefits from the projects. Also, if market prices are determined in a comparatively free, competitive manner, the benefits from forward and backward linkages attributable to a project will tend to be reflected in the market value of inputs and outputs of the project, and thus no special allowances for "external benefits" are required.

Explicit allowances for the linkage effects in a CPA would be justified only if:

. The funds available for investment in the project would not be available for investment in any other project, or

. The linkage giving rise to the benefit or cost, forward or backward, is uniquely attributable to the particular project under analysis, i.e., it would not occur at all, or in the same degree, if some alternate project is selected.

Multiplier effects are defined herein as the shortrun increases in income througout the economy in which there is surplus capacity brought about by the additional consumption caused by the initial construction of a project. The conditions under which an explicit measure of the multiplier effect should be included in the analysis are even more restrictive. In addition to the two conditions noted above for linkage effects, the inclusion of an allowance for the multiplier effect in the NNRR requires that the only factor preventing an increase of output in the economy is inadequate effective domestic demand and that there is some factor inhibiting an increase in demand by other means than this specific project

Reconciliation of Priorities: Business Enterprise and National Rates of Return

Projects promising an enterprise rate of return in excess of rates from alternative investments will generally be left to the private sector for implementation; i.e., prospective earnings will generally provide the incentive, and -- if the prospects have been correctly appraised -- revenues from the sale of outputs will provide the means to meet capital and operating costs. This result will be more likely if the projects are of modest size and prospective entrepreneurs are assured of access to the required foreign exchange. If the NNRR is also favorable, then the task of the financial-economic analysis is successfully concluded. If NNRR is unfavorable, then this fact should be emphasized and the reasons for such a divergence outlined and explained to those responsible for decision making.

There will also be projects on which a higher rate of return to the national economy is in prospect, but which offer an enterprise rate of return too low to attract private entrepreneurs or lenders. These discrepancies are most likely to be found in the following circumstances:

1. The project involves large inputs of unskilled or semiskilled labor for which the accounting wage rates (i.e., real wage costs) are substantially below the market wage rates.

2. The project will yield substantial indirect and/or intangible benefits for which a private entrepreneur cannot exact payments.

3. Output from the project is to be exported and the domestic currency is overvalued, and there is no special export subsidy.

4. Taxes comprise such an important element of cost to the enterprise that the BERR is unattractive.

The analyst engaged in a CPA should formulate, in broad terms, the measures required to induce implementation of projects for which the national rate of return indicates a high priority, but for which the enterprise rate of return is too low to attract an investor. The administrative skills and costs, and the general effects of the income transfers (from taxpayers to entrepreneurs) should be considered.

IV. SOCIAL CRITERIA

Introduction

Project appraisals normally require analysis of the economic, financial and technical feasibilities of the proposal. The primary emphasis in the economic area is on increases in gross national product and the attainment of minimum rates of return. Far less attention is given, however, to the systematic analysis of social and cultural elements which affect the implementability of the project or to the social and political consequences which flow from the project. This chapter will endeavor to outline these social criteria and their relationship in the CPA

It is recognized that the concepts discussed below represent an uncharted area in project analysis. Operating experience as to the most suitable methods of approaching this problem area are very limited. Quantification of the social benefits and costs of projects has hardly begun. Such difficulties indicate that proper caution and selectivity must be taken in analyzing social criteria and incorporating the results in the project report. They do not mean that social criteria are to be neglected and avoided because of such difficulties or complexities.

The incorporation of social criteria in the CPA does not mean that these criteria will necessarily determine the decision in favor of proposals which contribute most to the solution or least to the aggravation of social problems; what it does mean is that these social implications should and will enter into the CPA and will play a role in reaching a decision.

Preconditions

This range of questions is concerned with whether realistic assumptions are made about the behavior (or changed behavior) of the actors on whose activity realization of a project in physical terms and its success in economic terms depends. Projects have run into difficulties because they were posited upon unstated assumptions concerning values, attitudes, motivation, and social institutions which turned out to be wrong. In the absence of the type of social organization and behavior which had been taken for granted either projects have not been implementable or the economic returns which had formed the basis of the justification did not materialize.

An irrigation project may be taken as an example of the need for social organization on the part of its participants if the project is to work. An irrigation project consists of much more than supplying water to an area which previously depended on rainfall: it involves a physical system (water control); a social system (social control), and an economic system (production and marketing) the profitability of which depends on the efficient functioning of the physical and social system. Irrigated agriculture requires a high degree of social participation and social control to assure that (a) the tertiary water delivery systems and drainage systems are properly constructed and maintained, (b) fields are levelled, and relevelled when necessary, to permit efficient use of water, (c) water is properly allocated among users, and (d) water charges are assessed and collected. None of these is required in dry-land farming, yet all of them affect physical implementability and the economic rate of return.

For capital projects in which the purpose is to reach a sector of the population which has not previously participated to any significant extent in the development process it is important to analyze the conditions which must be established and the types of policy and institutional change (e.g., land tenure arrangements) required to involve such groups, and assure that the resources made available actually reach them and that they are able to utilize them productively. If the purpose, for instance, is to assist isolated, subsistence peasants who have had little previous exposure to the national market, to financial institutions, and to improved inputs, caution should be exercised in making assumptions about the receptivity of such a target group to new ideas and technical advice, their ability to take risks, their preparedness to form and operate viable cooperatives, and the rate at which they are likely to adopt other types of changed behavior on which the technical and economic success of the project depends. Special measures will probably be needed to assure that the resources actually reach this group and are not diverted to other better prepared farmers.

Social and Political Consequences

Projects have differential benefits; they help some groups more than others and may reduce the welfare of some segments of the population, at least in relative and sometimes in absolute terms. A first step in extending the analysis to encompass social project consequences is to examine what social groups are affected, and how. Normally the primary group toward which the project is directed, and which is expected to reap the main benefits, is often identified, if at all, only in the most general terms, such as "small farmers"; more precise indication of what size operator is comprehended by this term is important. It is also important to analyze what other groups are directly affected, either positively or negatively -- and how.

Examples drawn from different sectors may help to illustrate the differential effects of a variety of projects with particular reference to (1) access to resources and opportunity (such as capital goods and operational inputs as well as credit with which to finance them plus markets, education, and technical advice) and the resulting consequences for the distribution of wealth and income, (2) employment, (3) and displacement, migration, and urbanization, and (4) the redistribution of power and the capacity to influence public policy.

Agricultural credit projects can in principle benefit any or all strata of farmers, but in practice the larger farmers tend to get a disproportionate share of loan resources unless special care is taken to assure access for other categories of cultivators. Yet they are normally the members of the agricultural community who, because of their greater financial strength, least need concessional credit. Moreover, loans to large farmers may indirectly contribute to increasing concentration of land holding and to the use of labor-replacing types of machinery thus furthering polarization in rural areas. It is, of course, more difficult, time-consuming and risky to work with small farmers, especially those in the lower deciles in terms of income, but it is this group for whom credit is likely to make the critical difference in the adoption of new techniques and improved inputs; without credit, such farmers are likely to have little or no access to improved inputs. Agricultural credit projects can identify target groups of potential borrowers and include ceilings of tenure conditions (e.g. tenants) on what types of farmers are eligible.

Loans for tractors and other types of equipment which replace labor encourage landowners to shift from tenancy and sharecropping arrangements to direct cultivation with minimal employment. The landowner's private rate of return may be high but the social rate of return should take into account the need that is thus created for capital to relocate and reabsorb the displaced tennants and landless laborers elsewhere in the economy and to house them and provide services for them in the urban communities to which they migrate. Moreover, the use of scarce capital to replace peasants detracts from the capital available to finance investment elsewhere in the economy. In such cases the costs of relocation and reabsorption should be taken into account (or at least discussed) in evaluating the overall economic and social benefits and costs of the project.

In sum, agricultural projects which make access to productive resources more unequal, promote the concentration of land in the hands of a few farmers, and encourage labor replacing mechanization tend to aggravate discrepancies in levels of living, reduce employment opportunities, and accelerate migration to the cities. All of these probable results involve social and often economic costs which need to be taken into consideration.

Industrial projects also have implications for access to resources, employment, and migration. Loans to finance capital intensive methods of production clearly have less employment--creating impace than those involving more labor intensive technologies.

Loans from industrialized countries, with their bias toward capital-intensive techniques, generally encourage factor proportions inappropriate for LDCs and thus have less employment creating effect than they might. The designation of target groups and appropriate loan ceilings in intermediate credit loans (ICI) might broaden access to industrial credit and at the same time encourage (given certain geographic limitations) the development of secondary industrial centers. Such decentralization of industry also has important implications for the geographic distribution of population and the rate of migration to the main commercial center(s).

Education offers one of the best means for increasing social mobility; as a major factor in the formation of human capital it can lead to significant redistribution of opportunity and income. Whether this in fact happens or whether, on the contrary, education serves to reinforce existing patterns depends largely on which groups have access to education at different levels and who pays for the schools.

Proposals in the education sector should therefore increasingly include analysis of what groups are expected to participate together with discussion of measures to broaden access to education on the part of the less previleged socio-economic groups and to finance education in more equitable ways.

Highways or road projects have consequences extending far beyond increasing the volume of goods moved and reducing ton-mile and passenger mile costs. These include integrating previously isolated regions and communities into the national, social and political system, broadening the horizons and range of experience of villagers, bringing politicians and political activity to villages, increasing the mobility of agricultural and health workers so they can cover more territory, expanding the access of villagers both to the supply of agricultural inputs and markets, and stimulating migration to towns and cities. The benefits of extending the road network are likely, however, to be unequally distributed among the socio-economic groups within a given region. These differential benefits should be considered in evaluating highway projects or in weighing alternative highway construction schemes. The employment implications of alternative (i.e., more labor intensive) technologies of highway construction and maintenance are also relevant.

At a minimum, pressing social problems such as income distribution, unemployment, and urbanization should not be inadvertantly aggravated. Recognition and analysis of the social implications would make it possible either to (1) reject the project if it ran hopelessly contrary to such objectives, (2) modify the project to make it more compatible with such objectives, or (3) devise appropriate compensatory devices to rectify the damage or losses to those who would be adversely affected. Such compensatory programs might properly be considered as an integral element in the cost structure of a project just as resettlement of those flooded out by construction of a dam is an element in the cost of the dam.

To some extent, the accounting price concept introduced in Chapter II of these General Guidelines provides a partial correction for some of the distortive items noted above.

The use of shadow rates to correct for the underpricing of foreign exchange and capital and for the overpricing of unskilled labor will increase the attractiveness of projects -- and of alternative versions of a given project -- which utilize less capital intensive techniques, and will thus encourage a more rational use of resources. In some country situations it may be appropriate -- and could be an explicit policy of governments -- to go a step beyond correcting for distortions in factor prices and specifically penalize the use of capital and foreign exchange and reward (subsidize) the use of unskilled labor. This would mean paying an economic price in order to achieve what is regarded as a desirable social goal, increased employment. Shadow prices are much less useful, however, in dealing with income distribution and migration/urbanization effects since these, unlike labor, are not factors of production and thus do not enter into the rate of return calculation.

It will, therefore, be ncessary to develop additional methods of analysis, largely in terms of individual projects, especially in determining institutional requirements for reaching target groups and analyzing social and political consequences of particular changes in the affected part of the economy. Missions may wish to draw on special social science expertise where these issues appear to be significant and where the relevant data is not readily ascertainable.

Summary

The most conspicuous need under preconditions is for those preparing or appraising the project to identify the type of involvement expected of the participants and the nature of the social organization and institutional mechanisms necessary to make such participation active, continuing and fruitful.

In dealing with social consequences it is most practical at this stage to select a limited number of criteria which seem especially important for assessing social costs and benefits and focus with as much precision as possible on how a capital project affects different social groups with respect to them. These criteria are as follows:

1. Access to resources and opportunities (e.g., land, capital, credit, education, markets) and in what ways and to what extent such access is broadened (or narrowed). The questions to be identified and analyzed under this heading would include, in the case of an agricultural loan, trends in land tenure arrangements and how they would be affected; the availability of improved inputs (seeds, fertilizers) and implements and of the credit with which to finance them to farmers with different sizes of holding, in different regions, etc.; access of such different groups to technical information and to markets, including the existence and extent of farm-to-market roads; and how price policy, including taxes and subsidies, affect different groups. This criterion measures the potential effect on the distribution of wealth and income.

2. Employment. In a sense this is a special case of access to resources and opportunities (i.e., productive work) but because of its special importance it deserves to be treated separately. Among the issues to be covered here are factor intensity and the related question of the amount and type of employment to be generated or eliminated as a result of the project, as for instance by the introduction of labor-absorbing or labor-replacing practices and equipment. It is especially important to consider the implications for those groups which are already characterized by serious unemployment/underemployment, such as both urban and rural unskilled workers and the educated unemployed.

3. Rural displacement, migration, and urbanization. This criterion is concerned with what groups might be pushed off the land or in other ways uprooted as a result of the project, where they would be likely to move to, and how they would be reabsorbed into the economic and social life of the country.

4. Changes in power and participation as between different socio-economic, regional, ethnic, and other groupings and the implications thereof for public policy. Each of the three preceding criteria is related to the redistribution of power and of opportunities for participation, but it is also necessary to recognize how such shifts affect the capacity of different groups to influence public policy.

In analyzing the social implication of a loan proposal under each of these four criteria, precision should be stressed and quantitative data should be developed wherever possible. Quantification is clearly easier for some criteria, such as the employment effect and the access to resources of target groups, than for say the effect on the distribution of power and influence. Despite the difficulties of measurement, quantification, even if only in orders of magnitude, remains important to support the qualitative analysis. Where quantification is not possible, specificity should still be stressed as much as possible.

V. SHAPING THE PROJECT

Decision-making implies the availability of alternative courses of action. If the scarce resources of a nation are to be used in a manner that will make the maximum contribution to growth, project selections must be made only after a reasonable range of alternatives have been examined. As noted earlier, one of the more valuable functions to be performed in the CPA is the systematic search for the best possible project to meet the objective.

The search for alternatives will probably cover a wide range in a sector study and a somewhat narrower range in a CPA. While the specific alternatives to be examined will depend on the nature of the objective to be met by the project, the following list suggests several ways in which projects may be shaped, or modified, to enhance their economic and/or financial feasibility:

- Changes in legal or regulatory framework affecting the operations of projects
- Variations in size or scale of projects
- Timing of project implementation

- Modification in technology of production

- Redesign of project to minimize risk by increasing flexibility or adaptability

- Changes in project characteristics designed to reduce real costs arising from damage to the environment.

Modifications Affecting Operations

A checklist of considerations requiring attention in a CPA is presented in appendix D. Although it is not an exhaustive list, it serves to call attention to many factors that could be altered to improve a project.

The checklist will assist the analyst in answering the question, "What kind of change in this specific project might make it better?" In addition to changes, there may be alternatives that are radically different or involve changes that are not physical. For example, alternative solutions may involve:

- Changes in regulatory practices and coordination of all elements that would increase the effective capacity of existing or proposed projects.

- Rationalization of existing price, rate and tariff structures toward more efficient utilization of existing and projected facilities

- Improvements in administrative and operational efficiency of existing facilities or the proposed project

- Alternative locations of industrial activities to take advantage of more abundant labor supplies, excess capacity in power, transport, education, health or other infrastructure.

Modification of Project Characteristics

Some potentially rewarding types of project modifications are discussed below.

ariations in Size and Scale

The size and scale of projects are quite crucial. A project that is oversized in relation to domestic and export market possibilities will generally have a poor rate of return. The basis for determining the best size and scope is the incremental rate of return on the difference flow of two different-sized projects. The method for applying this test is presented below.

In considering the size of a project, one should be alert to the potential advantages of alternatives that involve earlier or more intensive utilization of facilities. In this connection, the scarcity of capital -- as reflected in the marginal opportunity cost of this resource -- is the critical determinant of the extent to which the scale of the project can be set to anticipate future demands.

In manufacturing, multishift operations of facilities can reduce the investment requirement substantially. In a road project, a low-grade road can be used at the start, with improvements made as the volume of traffic reaches specified levels. The economic advantages of all projects depend in part on other developments, but this is particularly so in the areas of transportation, education, and health.

There is little economic return to a road which carries a low volume of traffic, unless it opens up to development a hitherto unproductive area, and the rate of increase in traffic is rapid. Similarly, school and health projects will not yield their full potential economic benefits unless job opportunities are available for the educated and those with improved health.

Variations in Timing of Projects

Some projects that are not feasible at current and near-term future levels of demand may yield favorable returns at a later time. Thus, if prospective demand rules out the implementation of a project of a size that would permit economies of scale, and the demand is growing, the project may be deferred for later consideration.

Development projects, such as roads, communications and other infrastructure, should be timed so as not to "lead" by an appreciable period of time the other inputs in the development. Interdependent projects, in general, require close coordination lest the unutilized investment sunk in the "lead" projects absorb resources that could have been more productively invested elsewhere.

Similarly, it is important to consider ways of getting output as early as possible. Particularly for large, complex projects, special attention to planning and implementation can make the rates of return more favorable by minimizing delays in completion of construction and run-in time. For example, projects are very sensitive to governmental delays involving licenses, custom clearances, and other government procedures. By calling attention to these factors at an early date, it may be possible to reduce delays quite substantially; necessary legislation or administrative rulings may be obtained in advance. Some design alternatives may permit more favorable phasing (as measured by difference flows). The use of modern scheduling techniques, e.g., PERT, and project controls are effective means of achieving better phasing of inputs and outputs and, thereby, more beneficial projects.

Technology

The choice of technology should be made in light of the relative factor costs in the country in question, availability of technical and managerial skills, and conditions under which the project will be operating. For example, a country that has abundant supplies of labor but is short of capital will find labor-intensive methods of production offer some (but not unlimited) advantages. Each technological alternative will have an associated cash flow; by means of comparisons of the discounted values of the differences in these flows, the preferred technological alternative can be identified. Each technological alternative will also have other requirements, such as raw materials of specified quality. A frequent mistake in projects is the use of technology which is too advanced, i.e., it places unreasonable demands on available technical and managerial talents. This is a matter that should be addressed explicitly in the project analysis.

Location

Consideration of alternative locations of the project should take into account the effects of respective locations on transport and on access to raw materials and markets as these are reflected in money flows. The effects of the project on increased employment and income in a region in need of development, and the attraction and retention of persons with required skills, also require consideration in the search for higher rates of return. Where the generation of income in a region is preferred for social and political reasons, it is important that the money flows of the best alternative be compared with those likely to be realized in the proposed location of the project.

Standards of Design

In designing a project, the engineer is constantly faced with options that require more capital but give greater durability, lower maintenance cost, less cost of expansion at a later date, or better service. These decisions sometimes come in the form of standards or specifications in the scope of work. Imbedded in the decision is the tradeoff of more capital investment now versus savings or benefits at a later date. Such decisions are best made with regard for the rate of growth of demand, the cost of capital expressed as an annual rate, and the relative costs of the alternative standards.

Flexibility

In the face of uncertainty, it is particularly important to give consideration to alternative project designs that have hedging characteristics, i.e., designs that can economically accommodate varying circumstances. For example, in designing a manufacturing plant or other facility, one can, at some small increase in investment cost, often make subsequent expansion less costly. In making plans for educational projects, additional modest investments may permit more economical future changes in use of the facility. The building of low-grade roads on good alignments facilitates later upgrading if traffic growth warrants higher standards.

Environmental Considerations

The examination of alternatives cannot be viewed as being complete without explicit consideration of the effects of the project(s) on the environment. For each of the various alternative forms of the project, the environmental effects should be noted, and the economic and financial costs of preventing -- or reducing to tolerable levels -- the undesirable environmental effects should be considered. These costs, in turn, should be compared with estimates of the real economic costs of implementing the project without effective measures to prevent deterioration of the environment.

Many projects may yield attractive rates of return only by excluding real costs in the form of noise, air, or water pollution, soil erosion or loss of aesthetic values. In the CPA, consideration should be given to the shaping of projects in such a way as to minimize the real costs; if the real costs of environmental damage are greater than the real cost of preventive or remedial measures, the NNRR will be increased by modification of the project to incorporate the measures.

However, as the benefits of environmental protection are not likely to yield revenue to the enterprise bearing the costs of the preventive or remedial measures, the BERR is almost certain to be adversely affected. Some form of governmental regulation or subsidy may be necessary to induce enterprises to incur the necessary costs.

Irrigation, manufacturing and power projects are among the more common environmental offenders. Although not necessarily involving capital projects, programs providing chemical fertilizers and insecticides are capable of bringing about profound changes in the ecology of large areas. Power plants may contribute not only to pollution of the atmosphere, but by thermal pollution of streams, they may also profoundly alter stream ecology.

It is not reasonable to expect that a CPA can anticipate all of the environmental implications of projects, much less place a value on the "costs" of pollution or the "benefits" of prevention or restoration. However, the analyst should at least identify major environmental hazards associated with alternatives, and suggest the nature and extent of additional study required.

Testing for the Preferred Project

The discounting procedure, together with the criteria for project evaluation discussed in chapter III and illustrated in appendix A, provides measures in terms of which the best of a number of alternative formulations of a project can be identified and the degree of its superiority assessed.

An application of the criteria is illustrated in table 1, utilizing the surplus flows from the hypothetical Project A and Project B introduced in chapter III (pp. 24-27).

Project B is accepted as the preferred project in terms of the internal rate of return criterion; the same ranking is arrived at by application of the "discounted value of net benefits" criterion, i.e., the algebraic total of column 6, table 1, is larger than that of column 5. The discounted net difference in surplus flows, shown in column 7, indicates that Project B is superior -- on economic grounds -- to roject A. The comparison of discounted value of net benefits or of the discounted value of the difference in net benefits is the most convenient technique for assessing the relative merits of alternative projects.

The different time patterns in the distribution of the $500,000 surpluses in Projects A and B reflect differences in the assumed circumstances and technologies underlying the two projects. These merit further comment, as they may suggest factors to be considered in the formulation or modification of projects, and in the alternatives that may be examined.

Table 1. Comparative Surplus Flows, Project A and Project B

Year	Undiscounted surplus			Discount rate 12 pct.	Discounted surplus (at 12 pct.)		
	Project A (1)	Project B (2)	Difference: Project B-Project A (3)	(4)	Project A (5)	Project B (6)	Difference: Project B-Project A (7)
1.........	-300	-200	100	.8929	-268	-179	89
2.........	-400	-330	70	.7972	-319	-263	56
3.........	75	75	0	.7118	53	53	0
4.........	80	125	45	.6355	51	79	28
5.........	125	130	5	.5674	71	74	3
6.........	140	130	-10	.5066	71	66	- 5
7.........	160	130	-30	.4523	73	59	-14
8.........	190	130	-60	.4039	77	53	-24
9.........	190	130	-60	.3606	69	47	-22
10.........	240	180	-60	.3220	77	58	-19
Total......	500	500	0		-45	47	92

Source: Chapter III, pp. 31 and 33.

1. Project A is more capital-intensive than Project B in the sense that total investment in the former is $700,000, as compared with only $530,000 in the latter. In Project B, it is assumed that less machinery, or less expensive machinery, is employed than in Project A. In circumstances of abundant labor and high capital costs, this type of factor input adjustment can be made, for example, by using manpower rather than machinery for movement of materials, work in process and finished products with no effect on the quality of product. Other opportunities for substitution also exist, but the range of variation in factor proportions is limited.

2. The size of Project B, that is, the maximum capacity, is more closely related to the size of the immediate market. Hence Project B, with a smaller capacity, will reach capacity sooner (in the third year of its operation) than Project A (in the sixth year of its operation). Thus during the early years of operation the excesses of revenues over current expenditures are greater for Project B than for Project A.

The practical implication of this feature is that projects which may not yield a satisfactory rate of return at an early stage of development may do so at a later stage when the demand for their output has increased because of economic and population growth. Also, projects that are "overbuilt" relative to the size of the market will be less beneficial than those implemented on a more modest scale unless economies of scale are large.

3. It will be noted that the current inputs in years 3 through 10 are higher per unit of output for Project B than for Project A. It is assumed that this reflects the higher variable unit costs arising from the smaller capital investment in Project B. This feature has several important implications for project formulation. First, if demand is unstable, Project B may have an additional advantage because of the greater flexibility in the flow of inputs in years of curtailed demand. Conversely, if demand grows faster than projected, the advantage lies with Project A, as unit costs of inputs fall significantly up to an output approximating its designed capacity.

The "sensitivity analysis," explained in a subsequent section, can be applied in determining the impact of uncertainties with respect to future prices of inputs. Project B, for example, will be very vulnerable to increases in prices of inputs in future years because of the greater importance of current (future) inputs, relative to initial, fixed inputs.

4. Note that there is no positive rate of discount or marginal opportunity cost of capital at which the hypothetical Project A would have a higher present net value than Project B. This is because the undiscounted flows of surpluses have been arbitrarily equated to highlight the importance of timing in project evaluation. However, the priorities accorded to projects may be quite different at different rates of discount (different marginal opportunity costs of capital). In general, the lower the marginal opportunity cost of capital, the higher the more capital-intensive projects or those with longer gestation periods will rank, and vice versa. This is because the lower the rate of discount, the lesser will be the real costs of deferring the benefits from large investments in the gestation period.

Evaluation of Mutually Exclusive Alternative Investments

The project analyst may be considering two mutually exclusive alternative installations. One requires a larger investment than the other, but offers lower current costs with greater undiscounted returns over the life of the project (table 2). Is it worth investing $500 more to obtain an additional $850 of output over the life of the project (the undiscounted sum of column 3 of table 2)? Assuming a 10 percent shadow price for capital and applying the discount factors to the difference flow, we find that the present value for both alternatives are positive, indicating that the return on the additional investment is more than 10 percent. It should be noted that both alternatives have a return in excess of 10 percent as indicated by positive present values, but Project B has the higher net present value and is the economic choice. (An equivalent decision would be select that alternative with the higher return on the incremental investment).

The type of computation illustrated in table 2 can be used to test a variety of options open to the project analyst, such as size, phasing, technology, location and starting time.

Table 2. Illustrative Computations for Choosing Investment Options Assuming Shadow Price of Capital of 10 Percent

Year	UNDISCOUNTED Surplus flow, Project A (1)	Surplus flow, Project B (2)	Difference flow (col. 1 - col. 2) (3)	10 Percent Discount Rate (4)
1..................	-1,500	-1,000	-500	0.9091
2..................	+ 150	+ 200	- 50	0.8264
3..................	+ 250	+ 250	0	0.7513
4..................	+ 350	+ 300	+ 50	0.6830
5..................	+ 400	+ 300	+100	0.6209
6..................	+ 450	+ 300	+150	0.5645
7..................	+ 450	+ 300	+150	0.5132
8..................	+ 450	+ 300	+150	0.4665
9..................	+ 450	+ 300	+150	0.4241
10..................	+ 450	+ 300	+150	0.3855
Present value of positive values......	+1,866	+1,450	+416	
Present value of negative values.....	-1,364	- 909	-455	
Net present value....	+ 502	+ 541	- 39	

VI. APPRAISAL OF PROJECTS HAVING OUTPUTS DIFFICULT TO VALUE

Many projects produce outputs the valuation of which presents special problems. Some of these projects, such as flood control and to some extent education and public health, yield benefits that are indivisible; other projects yield indirect benefits for which market valuations are not practical. In still other cases, governments may decide as a matter of policy that certain services shall be distributed on a "free" basis, or for only a nominal charge. In all of these cases, the analyst will find it necessary to carry on the appraisal without the benefit of a direct market assessment of the value of output.

Valuation in Terms of Cost of Alternatives

The estimated value of a flood control project, for example, may be based, in part, on the average annual losses incurred from flooding over a representative period of time. To these values might be added such other quantifiable benefits (e.g., prevention of erosion) as might arise from the flood control project.

Some types of governmentally provided "free" services may enable individuals to avoid payments made to private suppliers of the same or a similar service. The savings in private expenditure could thus be considered as one component of the value of the government service. The estimated value of the "output" of projects to provide (more adequate) police or fire protection may include the savings in insurance costs, and reductions in private expenditures for fire protection, guards, night watchmen, and protective systems.

Estimated Value of Effects on Complementary Activities

Wherever a nonpriced service has important effects on a complementary activity the output of which can be valued, it may be feasible to measure indirectly what it is not possible to value directly. For example, the "output" of a bridge that permits a substantial reduction in time and distance of travel between points generating and receiving a heavy volume of traffic may be valued in terms of savings in vehicle operating costs made possible by the use of the bridge rather than the longer alternate route. The valuation of most projects for governmental provision of transport facilities will involve estimates based on some measurable benefits to users, usually of private cost-reduction type.

Valuation of output of educational and public health projects will include the value of additional production attributable to better trained, physically more alert workers and to reduced absenteeism. Additional suggestions for the valuation of outputs of projects of this type are offered in the individual sector guidelines.

If, as will usually be the case, the valuation of outputs of this type of project reflects important subjective judgments, it is well to use a range of values rather than a single value. If, under the regular procedures for computation of an internal rate of return, the project yields a rate equal to or in excess of the accounting rate of interest using the lower limit of the range of value, the project probably merits further consideration.

Minimum Cost and Alternative Levels of Service

Ingenuity will enable the analyst to place a value on many types of outputs not sold for a price. Still, there will be other projects and components of the output of still other projects in which this will not prove to be possible. In these cases, project appraisal takes a more limited form: the search for the least-cost project that will provide specified levels of service.

The technique involved is illustrated in Table 3, with hypothetical inputs being used for alternative projects to supply school facilities. The more durable building has a higher initial cost, while the less durable building has higher future maintenance costs. Which alternative offers the least costly way of providing the required physical components? As shown in Table 3, the choice requires the application of the discounting procedure.

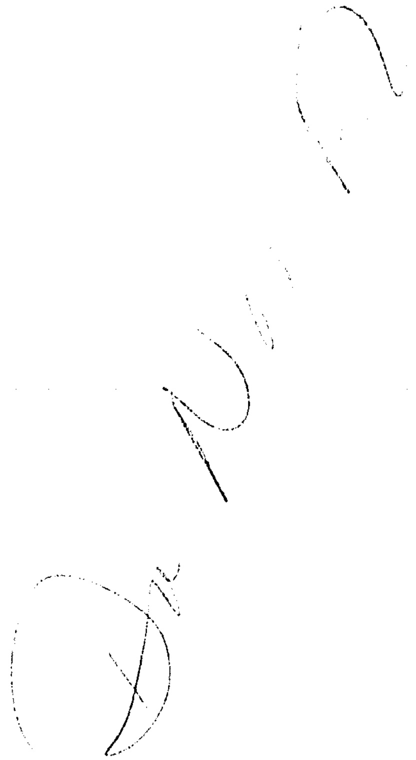
At a discount rate of 10 percent, the more durable building is the least-cost alternative. However, at higher discount rates -- consistent with less abundant supplies of capital -- the less durable building would provide the least cost alternative.

Valuation of Output and
Pricing Policy

There should be no confusion between the task of output valuation, and the question of selling the output for a price. The former should be carried as far as practicable to facilitate an assessment of the project's contribution to the national economy, i.e., to permit computation -- if possible -- of an NNRR. Computation of a BERR for such projects is usually not meaningful. In any case, the process of estimating the value of output is not usually directed to a price determination. However, such estimates may be relevant -- along with other data — in fixing user charges for facilities provided at governmental expense.

Table 3. Investment and Maintenance Costs for Alternative School Buildings

Year	Undiscounted			10 Percent Discount f ctor
	Costs of durable building (1)	Costs of less durable building (2)	Cost difference flow (col. 1 - col. 2) (3)	(4)
L				
1....	-5,500	-3,700	-1,800	0.9091
2....	- 500	- 700	+ 200	0.8264
3....	- 500	- 700	+ 200	0.7513
4....	- 500	- 700	+ 200	0.6830
5....	- 600	-1,000	+ 400	0.6209
6....	- 500	- 700	+ 200	0.5645
7....	- 500	- 700	+ 200	0.5132
8....	- 500	- 700	+ 200	0.4665
9....	- 500	- 700	+ 200	0.4241
10....	- 500	-1,000	+ 400	0.3855
11....	- 500	- 700	+ 200	0.3505
12....	- 500	- 700	+ 200	0.3186
13....	- 500	- 700	+ 200	0.2897
14....	- 500	- 700	+ 200	0.2633
15....	- 600	-1,000	+ 400	0.2394
16....	- 500	- 700	+ 200	0.2176
17....	- 500	- 700	+ 200	0.1978
:				
Present value of costs at 10 pct...	-8,644	-8,715	+ 71	



VII. SENSITIVITY ANALYSIS

The NNRR, as described previously, reflects the best estimate of future outputs, prices and other factors that will affect the benefits expected from the project. But uncertainty attaches to these estimates. Therefore, it is necessary that CPA's include an evaluation of the effects of divergence of values from the best estimates of values of inputs and outputs on which rate of return calculations have been based. The purpose is to determine the "sensitivity" of the best estimates of the CPA to prices, levels of demand, etc.

Sensitivity analysis need be undertaken only for major inputs and outputs. The objectives are to:

1. Identify ways in which the project can be modified to minimize risks arising from divergence of realized prices, etc., from best estimates;

2. Identify those areas in which more information is required in order to narrow the range of uncertainty; and to which special attention should be directed in more detailed analyses of the project;

3. Incorporate the risk factor in the CPA. For example, between two projects with the same NNRR based on best estimates, the project for which the risk element is smaller should receive priority.

The computed NNRR (or the BERR) on a project is properly regarded as the best estimate -- the mean -- of a range of possible values. In turn, each of the values for inputs and outputs is likewise a best estimate from a range of values; each value in the range has its "probability" of being realized.

Sources and Types of Risks

Controllable Risks

Careful project planning and supervision of implementation can reduce or eliminate some risks. For example, early provision for import licenses, construction permits, customs clearance, etc. will be of assistance in avoiding delays in completion of projects; this will lower the probability that construction costs will be at the higher end of the range. A review of projects that have encountered delays and bottlenecks in the past will suggest other causes of unsatisfactory performance or of delay in the completion of construction that can be avoided by planning and/or modification of the project.

Risks may be reduced by providing built-in flexibility in projects: for example, designs to facilitate shifts in output or to permit utilization of substitute fuels and materials. If the availability of managerial and technical skills poses a risk, the project may be redesigned to minimize the requirements for such skills, or to include as project inputs the provision of the required skills from an outside source. From the standpoint of the project -- but not necessarily of the economy -- risks may be shifted by long-term contracts.

A CPA does not require the development of the full range of measures to control risks, but estimates of the administrative and other costs attributable to reduction of risks and uncertainties should be included in inputs for an alternative form of the project; if these additional costs reduce risks sufficiently to raise the expected NNRR, the "preferred project" is that form which includes the risk-reducing outlays.

Uncertainty Resulting From Uncontrollable Factors

The physical resource flow and the money flows of a project will include factors and parameters affecting rates of return of the project that are not subject to control by project design or management. By computing the rates of return under alternative values of these parameters and their respective probabilities, one can determine the probable range of rates of return of the project, and the "best estimate" rate as shown in table 5. The same general procedure can be applied to the values of inputs and outputs.

For example, annual growth rates of demand for electric power and the respective probabilities of their occurrence are estimated as follows:1/

Table 4. Computation of "Best Estimate" Rate of Growth in Demand for Electricity

Annual growth (Pct.)		Estimated probability	Growth rates times probability
Range	Mid-point		
5 to 7	6	.20	1.20
7 to 9	8	.40	3.20
9 to 11	10	.30	3.00
11 to 13	12	.10	1.20
Total		1.00	8.60a/

a/ "Best estimate" growth rate.

1/ The growth rates in demand for ~~electric~~ power and the respective probabilities would normally be derived from projected rates of growth and changes in structure of GDP.

For an electric generating project, the rate of growth of demand would be sufficiently important to trace the effects of differential rates of growth on the rates of return from specified alternative facilities. In this assessment, the scale of the project should be varied over a range. The (hypothetical) rates of return shown in table 6 are illustrative of the pattern of rates that might emerge from this testing of alternative scales for projects to provide electric power.

As shown in the hypothetical case above, the best estimate of the rate of growth in demand for electric power is 8.6 percent per annum. If the rate of growth in demand is only 6 percent, the preferred project for generation of electric power is the small project; if the rate of growth is 8 percent, the preferred project is the medium-sized one; and if the rate of growth in demand is 10 percent or over, the large-scale project offers the highest prospective rate of return.

The matrix of annual rates of return shown in table 6 would be worked out for each alternative (size) project, at each of the growth rates in demand.

Table 5. Annual Rates of Return for Various Scales of Project at Assumed Demand Growth Rates

	Event (percent demand growth per year)			
	6 pct.	8 pct.	10 pct.	12 pct.
Probability....	.20	.40	.30	.10
	(Annual internal rates of return on project: percent per annum)			
Scale of project:				
Small........	14	12	10	8
Medium.......	10	15	13	10
Large........	6	8	14	18

In terms of this hypothetical illustration, the probability of the annual rate of growth in demand being at least 7 percent, but less than 11 percent, is 70 percent; thus, the selection of the medium-scale project is indicated.1/

The MNRR on many projects will depend on the overall rate of growth in the economy. Hence, a sensitivity (to GNP growth rate) analysis, similar to the illustration for an electric generating facility, is appropriate for such projects.

Risks Arising From Inadequate Information

Uncertainties exist because of inadequate information concerning a critical input, or output, value. In such cases it is generally possible to establish a probability distribution of the possible values that may occur.

For example, a probability distribution might be developed in estimating the cost of excavation of a potential site for a dam. The engineer might have visited the site and talked to a geologist who was familiar with the area. On the basis of this limited information his estimates of the possibilities and their respective probabilities might be as follows:

Event	Estimated probability	Estimated cost
Sand	.10	$140,000
Clay	.60	150,000
Rock	.30	300,000

If the cost of excavation connected with the occurrence of rock, together with its probability, is significant, it becomes important to note this and either to undertake

1/ The 70 percent is the sum of the probabilities of 40 percent for a growth rate of 7 percent to 9 percent, and 30 percent for a growth rate of 9 percent to 11 percent per annum.

borings in connection with the CPA analysis, or to warn that such borings need to be undertaken before the decision is made to proceed with the project.

Key Factors to Which Projects Are Sensitive

The key items of sensitivity will vary from project to project. The principal classes that merit the analyst's attention in a CPA are noted in the following paragraphs.

Uncertainty in Demand for Product or Service

The projection of demand for a product or service is, at best, a highly uncertain process. Using whatever historical data are readily available, one makes a projection of demand over time -- a best estimate of the demand.

A useful way of approximating the effects of demands differing from the best estimate is to aggregate those costs that are fixed with respect to volume and those costs that are proportional to the physical volume of output. If x is the percent deviation in volume then:

- Change in value of output for x-percent deviation in volume (constant prices) is given by $\frac{x}{100}$ X (best estimate of total value)
- Change in cost for x-percent deviation in volume is given by $\frac{x}{100}$ X (best estimate of total variable cost)
- Change in surplus flow for x-percent deviation in volume is given by $\frac{x}{100}$ X (total value of output - total variable cost of best estimates).
- After-tax change in surplus for x-percent deviation in volume is given by (1-T) X $\frac{x}{100}$ X (total value - total variable cost) where T is the tax rate.

If the above is computed for the yearly flows, the rate of return corresponding to the percent deviation in volume can be derived readily. Ideally, an upper and lower probable limit of demand calculation should be made.

Uncertainty in Selling Price

Where a product or service is sold, the rate of return (BERR) will be sensitive to the selling price. It is necessary to determine the effects of selling prices that are different from the best estimate.

If the selling price is changed by y percent, then the change in the after-tax surplus for the year is given by $(1-T) \times \left(\frac{y}{100}\right) \times$ (best estimate of total sales revenue).1/

However, where an accounting or shadow price is employed in valuation of output, changes in market prices will not necessarily affect the NNRR.

Uncertainty Concerning Cost of Raw Material

Where there is considerable uncertainty about an important variable-cost item such as fuel or raw material, one can readily compute the change in the annual surplus by the relation $(1-T) \times \left(\frac{z}{100}\right) \times$ (best estimate of total variable cost).2/

Scope of Sensitivity Analysis

Because there are a large number of factors that can affect the rate of return, the analyst should be selective

1/ Assuming that there is no change in the volume of units sold and that taxes are proportional to revenues. Allowance should be made for price elasticity of demand.
2/ Assuming that the change in price of materials does not influence the volume purchased.

with respect to factors to be tested for sensitivity. The basis for selection should be the degree of uncertainty attaching to major factors and the relative importance of the factor in the determination of the rate of return.

The techniques described above can be applied to the BERR as well as to the NNRR analysis. They can also be applied when other criteria, such as the discounted present value of net benefits, are employed in project evaluation.

VIII. SUGGESTED FORMS FOR COMPILATION OF DATA AND COMPUTATION OF INTERNAL RATES OF RETURN

The principal concepts, estimating procedures and techniques involved in CPA's have been discussed and illustrated in preceding chapters of these guidelines. Suggested forms to facilitate compilation of data and computation of rates of return are presented in this chapter. Hypothetical inputs and outputs are employed to illustrate use of the forms.

Schedule of Domestic Investment

The (hypothetical) numerical values in columns 1 and 2 of table 6 are coefficients to be applied in the pricing of the several inputs; the negative signs preceding these coefficients indicate that they refer to inputs. In a CPA, the numerical values in column 1 would be the ratio of the shadow prices to market prices of the various inputs and outputs.

The column headings "NNRR" and "BERR" refer to the valuation for purposes of computations of the net national rate of return and business enterprise rate of return, respectively. The values entered on the right-hand side of the form represent actual market price valuations (price times quantities) of inputs in each year. In the illustration, all investment is assumed to occur in years 1 through 4, with outputs beginning in the fourth year.

Inputs requiring special treatment in the computation of the rate of return to the national economy include:

Land. In the illustrative case shown in table 7, the correction coefficient for land is unity; i.e., in the illustration, land is priced at its market value in the computation of the NNRR as well as the BERR. The NNRR computation should include --as an annual input -- the annual rental value of the land, or an estimate of the annual net product attributable to the land in its alternative use.

Taxes. In general, both internal taxes and customs duties are to be excluded from inputs in computation of the NNRR, but both are included in computing the BERR. The rationale for this exclusion in the former computation is that taxes represent the share of government in the net income generated by the project, and that the total net income (and associated rate of return) are not affected by the way in which the net income is shared by the claimants. However, some payments by enterprises to governments are, in effect, payments for services rendered. Special assessments against real property are sometimes made to reimburse government for the cost of providing water and sewerage service, road access or other infrastructure for the use of the taxpayer. If, in the absence of the governmentally provided service the cost would be an internal charge to the project, it is appropriate to treat the "special assessment" type of levy as a real cost in computing the NNRR.

Similarly, special taxes imposed to finance measures to improve or restore the environment may be charged as a real cost to the project, provided the source of the pollution is clearly identified with the project.

Subsidies. Subsidies are a receipt (or a reduction in cost) in the computation of the BERR; they are assigned a coefficient of zero in computation of the NNRR.

Transfer payment. Transfer payments are, in general, excluded from the NNRR calculation. Taxes, subsidies and debt repayment are cases of transfer payments, as distinguished from payments to the owners of factors of production to compensate them for the contribution of the factors to current output.

At the bottom of table 6, the domestic investment for an illustrative chemical plant are summed by years -- as they will be entered in the computations for the business enterprise and the net national rates of return. The totals for the former are obtained by the simple addition of the amounts shown in each of the annual columns of the value of inputs. No adjustments are necessary since the IERR price-correction coefficients (column 2) are unity (1) for all inputs. This means that market prices are used.

In the case of valuation for purposes of computing the NNRR, market prices are adjusted to conform to shadow or accounting prices. Four adjustments are made in the hypothetical case:

1. The accounting wage rate for unskilled labor is set at 80 percent of the market wage rate It should be noted that this is an arbitrary figure used only for illustrative purposes in this particular case. The principles governing the selection of an appropriate shadow rate for any particular situation are discussed in Appendix B.

2. Customs duties paid on imports are not real costs from the viewpoint of the national economy, and hence have a correction coefficient of zero; i.e., they are omitted from the cost of imported components of investment. They would also be omitted from NNRR calculations of imported values of materials, supplies and services used in production.

3. Accounts receivable (less accounts payable) are exactly offset elsewhere in the economy by an excess of accounts payable. Hence, this item does not give rise to any net working capital requirement in the economy as a whole. For similar reasons, cash reserves do not constitute a real cost. Zero correction coefficients are used for both categories.

4. The value of foreign exchange is estimated to be undervalued by 20 percent; therefore, for calculation of the NNRR, c.i.f. prices are increased by 20 percent.

Table 6. Schedule of Domestic Investments for a Proposed Chemical Plant

Investment	NNRR (1)	BERR (2)	Year 1 (3)	Year 2 (4)	Year 3 (5)	Year 4 (6)
<u>Fixed</u>						
Land..................	-1.00[a/]	-1.00	100			
Labor, skilled, bldg..	-1.00	-1.00	100	500	200	
Labor, unskilled, bldg.................	- .80	-1.00	100	400	300	
Other building........	-1.00	-1.00	300	2,100	1,000	
Domestic freight......	-1.00	-1.00	65	134	140	
Duty on imports.......	0	-1.00	309	138	665	
Domestic insurance....	-1.00	-1.00	32	15	70	
Organization expense..	-1.00	-1.00	75	25		
<u>Working capital</u>						
Domestic material inventory.............	-1.00	-1.00			195	194
Foreign materials duty................	0	-1.00			39	
Finished goods inventory................	-1.05[b/]	-1.00				400
Accounts receivable minus accounts payable................	0	-1.00			237	
Cash reserve..........	0	-1.00			2,000	51
<u>Annual investment from viewpoint of</u>						
Business enterprise (BERR)...............			-1,081	-3,312	-4,846	-645
National economy (NNRR)...............			- 752	-3,094	-1,845	-614

a/ See the discussion of alternative treatment of cost of land in NNRR computation.
b/ Coefficient of 1.05 to reflect import content of one-fourth of finished goods inventory [1/4(1.20)+3/4(1.00) = 1.05].

The NNRR domestic investment input for year [illegible] is calculated as follows:

	Actual value (BERR)	Correction coefficient	Real value of input (NNRR)
Land....................	100	1.00	100
Skilled labor (construction)..................	100	1.00	100
Unskilled labor (construction)..................	100	.80	80
Other construction costs.	300	1.00	300
Domestic freight.........	65	1.00	65
Import duties............	309	0	0
Domestic insurance.......	32	1.00	32
Organization expense.....	75	1.00	75
Working capital (total)..	0	0	0
Total...................	1,081		752

Computations for other years are made in the same manner. The domestic investment in the finished goods inventory in the fourth year is 5 percent above the market valuation to reflect the overvaluation of 20 percent in the import content (25 percent) of the finished goods inventory.

Schedule of Foreign Exchange Costs

The compilation of data in table 7 follows the same format as that in table 6. In the case used for illustrative purposes, the accounting rate of foreign exchange is 20% above the official rate; i.e., the correction coefficient to convert actual to real costs of foreign inputs is 1.20.

As in the case of domestic capital inputs, the correction factors are applied only in the summation of inputs for purposes of NNRR computations. For this purpose, foreign exchange costs of capital inputs in the first year are valued at 3,783.6 (3,153 X 1.2); for the second year, 1,336 X 1.2 = 1,603.2 etc.

The adjustment in the c.i.f. prices of directly imported goods and services for overvaluation of the domestic currency is comparatively straightforward, given the estimate of an approximately accurate shadow price for foreign exchange. In principle, the value of domestic inputs (capital or operating) should be adjusted also to include a shadow price of the import content of inputs purchased or domestically produced. This has been done in the case of the finished goods inventory, shown in table 6. It would also be appropriate to make a similar adjustment in domestic freight expenses to reflect the undervaluation of the import content of the investment in railways, highways and road transport, as well as the import content of current inputs of fuel and supplies. Calculations of the foreign exchange component included in such local procurement are quite often complex and difficult. For convenience, the analyst might initially limit such calculations to those inputs in which the apparent import content is a significant component of the cost of the domestic input, and the particular inputs are, in turn, significant components of the total project inputs.

Table 7. Schedule of Foreign Exchange Costs of a Proposed Chemical Plant

Investment	NNRR	BERR	Year 1	Year 2	Year 3
<u>Fixed</u>					
Equipment........	-1.20	-1.00	3,088	1,307	6,665
Foreign freight..	-1.20	-1.00	65	29	140
Engineering......	-1.20	-1.00			1,145
<u>Working capital</u>					
Foreign materials for inventory...	-1.20	-1.00			182
<u>Foreign exchange component of investment</u>					
Business enterprise (BERR)....			-3,153	1,336	-8,132
National economy (NNRR)..........			-3,783.6	-1,603.2	-9,758.4

Alternatively, a general adjustment might be made for broad categories of projects, based on sector studies of the average import content of inputs in the sectors in which the projects are found.

The separation of investment inputs into two categories, domestic and foreign (tables 6 and 7, respectively), is advisable. Separate projections will facilitate consideration of foreign exchange requirements and possible external financing, as well as the domestic resource inputs appropriate to the project.

Projected Operating Statement

The illustrative operating statement shown in Table 8 corresponds -- in a general way -- to the conventional profit and loss statement. It will be noted that the statement shown in table 8 begins with year 4; this assumes 3 years will be required for construction during which there will be no output.

The NNRR and BERR symbols and the correction coefficients have the same meanings as in table 6 and 7. Several of the individual items in table 8 merit explanatory comment.

Depreciation. While conventional profit and loss statements recognize depreciation as a cost and profit as a residual, neither item is recognized explicitly in the computation of either the BERR or NNRR. The total cost of assets is entered as an input in the year in which acquired; to record depreciation as an additional cost (input) would involve double counting.

Wage and salary payments to foreign personnel. It is assumed that one-half of the salary is paid in foreign, and one-half in domestic, currency. Thus, the correction coefficient applied in the calculation of the NNRR is $\frac{1.20+1.00}{2} = 1.10$. For calculation of the BERR, such payments are entered at market rates.

Unskilled labor. The correction coefficient is 0.80, for the same reasons explained in connection with table 7.

Imported raw materials. The correction coefficient is 1.20, the same as in table 8, to reflect overvaluation of domestic currency.

Derivation of Net Operating Surplus

The annual net operating surpluses will differ, depending on whether the concept refers to the business enterprise, or the national economy.

Business enterprise annual surpluses. The BE surplus is the revenue from sales, less total costs, exclusive of depreciation. For year 4, the computed surplus is 8,833 - (4,446-1,330) = 5,717; for year 5, it is 10,292 - (5,300-1,330) = 6,322, and so on for subsequent years.

NNRR annual surpluses. Computation of the annual surpluses, viewed from the standpoint of the national economy, requires the application of other correction coefficients. For year 4, the actual costs, correction coefficients, and national economic costs are as follows:

	Actual costs (BERR)	Correction coefficients	National economic (real) costs (NNRR)
Foreign personnel..........	58	1.10	64
Skilled workers............	414	1.00	414
Unskilled workers..........	100	.80	80
Taxes, payroll.............	89	0	0
Domestic materials and supplies..................	1,396	1.00	1,396
Foreign materials and supplies.....................	185	1.20	222
Import duties..............	16	0	0
Electricity................	256	1.00	256
Insurance..................	60	1.00	60
Miscellaneous, domestic.....	542	1.00	542
Total costs................	3,116		3,034

Table 8. Projected Operating Statement, Proposed Chemical Plant

Investment	Corr. Coefficients NNRR	Corr. Coefficients BERR	Year 4	5	6	7	8	9	10	11	12	13	14	15
			(Monetary Units)											
Foreign personnel[a/]	1.10	-1.00	58	72	36	18	0	0	0	0	0	0	0	0
Personnel, skilled	-1.00	-1.00	414	532	532	532	532	532	532	532	532	532	532	532
Personnel, unskilled	- .80	-1.00	100	100	100	100	100	100	100	100	100	100	100	100
Payroll taxes	0	-1.00	89	110	110	110	110	110	110	110	110	110	110	110
Dom. raw materials & supplies	-1.00	-1.00	1,396	1,854	2,040	2,040	2,040	2,040	2,040	2,040	2,040	2,040	2,040	2,040
For. raw materials & supplies	-1.20	-1.00	185	220	246	246	246	246	246	246	246	246	246	246
Duty	0	-1.00	16	22	25	25	25	25	25	25	25	25	25	25
Electricity	-1.00	-1.00	256	372	408	408	408	408	408	408	408	408	408	408
Insurance	-1.00	-1.00	60	60	60	60	60	60	60	60	60	60	60	60
Depreciation	0	0	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330
Misc. domestic supp. & services	-1.00	-1.00	542	628	662	662	662	662	662	662	662	662	662	662
Subtotal of cost			4,446	5,300	5,549	5,531	5,513	5,513	5,513	5,513	5,513	5,513	5,513	5,513
Sales	+1.00	+1.00	8,833	10,292	12,805	12,805	12,805	12,805	12,805	12,805	12,805	12,805	12,805	12,805
Profit before taxes	0	0	4,387	4,992	7,256	7,274	7,292	7,292	7,292	7,292	7,292	7,292	7,292	7,292
Operating surpluses, viewpoint of:														
Business enterprise (BERR)			5,717	6,322	8,586	8,604	8,622	8,622	8,622	8,622	8,622	8,622	8,622	8,622
National economy (NNRR)			5,799	6,423	8,688	8,708	8,728	6,726	8,728	8,728	8,728	8,728	8,728	8,728

a/ Half assumed to be paid in foreign currency.

Initially, the market value of output is assumed to reflect the real value to the economy. In year 4, this value is 8,833; thus, from the viewpoint of the national economy, the surplus flow for year 4 is 8,833 - 3,034 = 5,799.

For subsequent years, the BERR and NNRR surpluses have been computed in the same manner shown in table 8.

Summation and Computation of NNRR

The values of inputs and outputs derived in tables 6 and 8 are brought together, and the computation of the internal rate of return to the national economy is demonstrated, in table 9. The various sources of table 9 are explained below, column by column.

Column 1. From table 6.

Column 2. Column 2, from table 6.

Column 3. From table 8.

Column 4. Columns 1 plus 2 plus 3.

Column 5. This column shows new information: the amount by which the market prices used in valuation of output overstate the valuation in terms of c.i.f. plus handling, which is taken as the real value of output. The amounts are subtracted from column 4 to yield a more refined valuation of the flow of surpluses accruing to the national economy by shadow pricing output.

Column 6. Column 4 minus column 5.

Column 7. From the table of discount factors in appendix E.

Column 8. Column 6 multiplied by column 7, by years.

Column 9. From the table of continuous flow discount factors in appendix E.

Column 10. Column 8 multiplied by column 9, by years.

Computation of the NNRR by interpolation is shown at the bottom of table 9.

Table 9. Summation and Computation of NNRR

Year	Domestic invest-ment (1)	Foreign exchange invest-ment (2)	Oper-ating surplus (3)	Total un-adjusted surplus flow (4)	Adjustments for price and other factors (5)	Adjusted surplus flow (6)	Discount factor at 20% (7)	Discounted surplus flow at 20% (8)	Discount factor at 25% (9)	Discounted surplus flow at 25% (10)
1	-652	-3,784	0	-4,436		-4,436	0.8333	-3,697	0.8000	-3,549
2	-3,094	-1,603	0	-4,697		-4,697	0.6944	-3,262	0.6400	-3,006
3	-1,845	-9,758	0	-11,603		-11,603	0.5787	-6,715	0.5120	-5,941
4	-594		5,799	5,205	-810	4,395	0.4823	2,120	0.4096	1,800
5			6,423	6,423	-1,039	5,484	0.4019	2,204	0.3277	1,797
6			8,688	8,688	-1,253	7,435	0.3349	2,490	0.2621	1,945
7			8,708	8,708	-1,253	7,455	0.2791	2,081	0.2097	1,563
8			8,728	8,728	-1,253	7,475	0.2326	1,739	0.1678	1,254
9			8,728	8,728	-1,253	7,475	0.1938	1,449	0.1342	1,003
10			8,728	8,728	-1,253	7,475	0.1615	1,207	0.1074	803
11			8,728	8,728	-1,253	7,475	0.1346	1,006	0.0859	642
12			8,728	8,728	-1,253	7,475	0.1122	839	0.0687	514
13			8,728	8,728	-1,253	7,475	0.0935	699	0.0550	411
14			8,728	8,728	-1,253	7,475	0.0779	582	0.0440	329
15			8,728	8,728	-1,253	7,475	0.0649	485	0.0352	263
16			689	689	-105	584	0.0541	32	0.0281	16
Present value of discounted surplus flows:								+3,259		-156

Internal rate of return to National Economy by interpolation:

$$NNRR = 20\% + \frac{(3,259)}{(3,573+156)} \times 5\%$$

$$= 20\% + (.994) \times 5\%$$

$$= 20\% + 4.8\% = 24.8\%.$$

Net Rate of Return to the
Business Enterprise

Computation of the net (internal) rate of return to the business enterprise is made in the same manner as for the national economy, except for adjustments shown in column 5 of table 7 which are not applicable in the case of the BERR.

The BERR, as computed from the illustrative case, is approximately 27.6 percent. It is higher than the internal rate of return for the national economy as a whole because: (1) a shadow price is used for inputs requiring foreign exchange; i.e., a higher value has been placed on imported inputs in the NNRR than in the BERR calculation; and (2) a shadow price (c.i.f. plus handling cost) is used for valuation of output in computing the NNRR but not the BERR. As the estimated domestic price of output is higher than the c.i.f. price, this adjustment contributes to the lower rate for the NNRR.

APPENDIX A: MEASURES FOR PROJECT CHOICE

Estimated values of annual inputs (costs) and outputs (benefits) of projects must be aggregated in a manner that will permit comparisons among projects. Those projects which offer a greater excess of discounted outputs (benefits) over inputs (costs) (other things being equal) can be assigned a higher priority than those from which lesser net returns are expected. Since projects vary in absolute size and in the timing of inputs and outputs, a measure must be applied that will enable the analyst and/or decision-makers to rank projects in terms of a common denominator. It's assumed that the time horizon for projects being compared are equal.

Three measures are widely used to make the comparisons noted above:

1. Discounted benefit-cost ratios
2. Internal rates of return
3. Discounted present values of net benefits.

Each of these measures has certain advantages -- and limitations. These are briefly described below.

The Discounted Benefit-Cost Ratio

The discounted benefit-cost criterion has been widely used in project appraisals but it yields results which can be misleading. For this reason, caution should be exercised in the application of this method of ranking projects. In general, the discounted B/C ratio is a less reliable criterion than the internal rate of return and discounted present value of net benefits criteria.

One of the limitations arises from the degree of "grossness" -- or netting out of costs and benefits -- employed in the appraisal. The effects of netting out of current operating costs from both the inputs and outputs are shown in table A-1.

Although the hypothetical case presented in table A-1 covers only a short span of years, the discounted B/C ratio is raised by computing it on the net rather than the gross basis. If the B/C ratio is greater than unity on the gross basis, it will always be raised by the netting out process illustrated in table A-1; conversely, if the ratio is less than unity on a gross basis, the netting out will always reduce the ratio.

Thus, the size of the discounted B/C ratio for projects will depend, in part, on the degree to which netting out of items is applied. In practice, some analysts may net out more (or less) than others, depending in part on their data problem. What is perhaps of greater importance, different industries (and even different projects in the same industry) may have widely varying ratios of current operating costs to total inputs. For the latter reason, discounted B/C ratios do not provide a sound basis for selection of projects that will make the maximum contribution to economic growth, i.e., projects selected on the basis of this criterion will not necessarily yield the largest increases in discounted present values.1/

1/ For an elaboration of the inherent limitations of this criterion see Roland N. McKean, Efficiency in Government Through Systems Analysis, Wiley: New York, 1958, pp. 107-113.

Table A-1. Effects of Netting Out of Current Operating Expenses on Benefit-Cost Ratios

I. In Gross Terms

Year	Total inputs	Current cost inputs	Total outputs	Discounted 10 pct.		
				Total inputs	Total outputs	Surplus flow
1.....	200	(0)	0	182	0	-182
2.....	300	(25)	100	248	83	-165
3.....	50	(40)	200	38	150	112
4.....	100	(60)	300	68	205	137
5.....	200	(100)	450	124	279	155
Total.	850		1,050	660	717	57

Ratio of Gross Benefits to Gross Costs, both discounted at 10 percent $= \frac{717}{660} = 1.086$

II. In Net Terms (benefits and costs reduced by current operating costs)

Year	Net inputs	Net outputs	Discounted 10 pct.		
			Net inputs	Net outputs	Surplus flow
1...........	200	0	182	0	-182
2...........	275	75	227	62	-165
3...........	10	160	8	120	112
4...........	40	240	27	164	137
5...........	100	350	62	217	155
Totals......	625	825	506	563	57

Ratio of Net Benefits to Net Costs, both discounted at 10 percent $= \frac{563}{506} = 1.11$

Internal Rate of Return

The internal rate of return criterion recommended in these guidelines is not subject to these limitations. As shown in the last column of parts I and II of table A-1, the "surplus flow" (one basis for computation of the internal rate of return) is independent of the degree of netting out, i.e., it is the same whether inputs and outputs are on a gross or net basis. As the internal rate of return is equal to the rate of discount that will reduce the algebraic total of the discounted annual surpluses (deficits) to zero -- or equate the discounted annual inputs and outputs -- it will be the same (for any given project) whether gross or net values are used.

It is also unnecessary to estimate, or select, in advance a discount rate in using the internal rate of return criterion; the rate of return on the project is derived from the undiscounted values of inputs and outputs, or the stream of surpluses and deficits. When internal rates of return have been computed for a number of projects, the projects can be ranked on the basis of the computed rates. However, at this stage, the computed rates should be compared with the best estimate of the marginal opportunity cost of capital. On purely economic grounds, only those projects with internal rates of return equal to or above the estimated marginal opportunity cost of capital would be selected for more detailed feasibility studies and/or implementation.

The internal rate of return criterion is also subject to limitations. In the first place, it embodies the implicit assumption that the stream of surpluses yielded by the project are reinvested in another project and earn the computed internal rate of return on the project being analyzed. To the extent that this assumption is unrealistic, the actual rate will diverge from the computed rate, even if all estimated costs and benefits of the specific project appraisal are realized.

A second limitation of this criterion is that it may yield indeterminate results; i.e., there may be no discount rate, or two discount rates that will equate costs and benefits. Two rates will result when the stream of differences between costs and benefits changes from negative to positive values, and subsequently becomes negative.

Although it is not a serious limitation in practice, the internal rate of return calculation yields only a single, unvarying rate of return over the life of the project -- if the computation yields a determinate rate.

<u>Discounted Present Value of Net Benefits</u>

Conceptually, this criterion is subject to fewer limitations as a guide to project evaluation than either of the two criteria discussed above. It does require, however the use of a predetermined discount rate reflecting the marginal opportunity cost of capital. The discount rate also be varied over the life of the project, a procedure which may be desirable in certain circumstances.

Given estimates of the value of inputs and outputs over the life of the project, the discounted present value of net benefits is derived by applying the appropriate discount factor to the difference between the value of output and input for each year, and adding (algebraically) the discounted values. The sum is the "discounted present value of net benefits." If this value is positive the project merits further consideration. As the computed discounted present value of net benefits approaches zero, the internal rate of return on the project approaches the rate used in discounting.

The discounting of net benefits, i.e., the value of annual outputs minus the value of annual inputs, is especially useful in evaluating alternative and mutually exclusive projects. In this application, the stream of surpluses (deficits) for each of the alternatives is first computed; then a third stream of annual surpluses (deficits) is found as the <u>difference</u> between the annual surpluses (deficits) of the alternative projects. The stream of annual differences is then discounted; if the sum of the discounted annual differences is positive, the preferred alternative is the project with the larger (positive) stream of discounted surpluses.

Comparison of Computations

A comparison of steps in computation of the three criteria is presented below, with reference to hypothetical data shown in tables A-2 and A-3.

The assumed values of inputs and outputs are shown in columns 1 and 2, respectively, of table A-2; the stream of annual net benefits (undiscounted) is shown in column 3 and is obtained by subtracting column 1 from column 2. Discount rates at 8 percent per annum and 15 percent per annum (from table D-1, appendix D) are shown in columns 4 and 5. The discount rates are equal to $\frac{1}{(1+r)^n}$, where r is the rate assumed, the marginal opportunity cost of capital and n is the number of years.

The annual values of inputs and outputs shown in columns 1 and 2 are multiplied by the discount factors in column 4 to obtain discounted present values of inputs and outputs (at 8 percent), shown in columns 6 and 7. (Column 8 is not required for the discounted benefit-cost ratio computation.)

The discounted benefit-cost ratio is obtained by dividing the algebraic sum of column 7 by the algebraic sum of column 6. In the example, a ratio of 1.08 is obtained, with a discount rate of 8 percent.

The annual values of inputs and outputs (and the resulting surpluses and deficits) discounted at an annual rate of 15 percent are shown in columns 9, 10 and 11, respectively. At a 15-percent rate, the discounted benefit-cost ratio is .98, i.e., less than unity.

Table A-2. Computation of Discounted Benefit-Cost Ratios and Present Values of Net Benefits

Year	Value of			Discount factors		Discounted values: 8%			Discounted values: 15		
	Inputs (1)	Outputs (2)	Surplus[a/] (3)	8 pct. per year (4)	15 pct. per year (5)	Inputs (6)	Outputs (7)	Surplus[a/] (8)	Inputs (9)	Outputs (10)	Surplus (11)
1....	10,000	0	-10,000	.9259	.8696	9,259	0	-9,259	8,696	0	-8,696
2....	5,000	3,000	- 2,000	.8573	.7561	4,287	2,572	-1,715	3,781	2,268	-1,512
3....	5,000	7,000	2,000	.7938	.6575	3,969	5,557	1,588	3,288	4,603	1,315
4....	5,000	8,000	3,000	.7350	.5718	3,675	5,880	2,205	2,859	4,574	1,715
5....	5,000	8,000	3,000	.6806	.4972	3,403	5,445	2,042	2,486	3,978	1,492
6....	5,000	8,000	3,000	.6302	.4323	3,151	5,042	1,891	2,162	3,458	1,297
7....	5,000	8,000	3,000	.5835	.3759	2,918	4,668	1,751	1,880	3,007	1,128
8....	5,000	8,000	3,000	.5043	.3269	2,522	4,034	1,513	1,635	2,615	981
9....	5,000	8,000	3,000	.5002	.2843	2,501	4,002	1,501	1,422	2,274	853
10....	5,000	8,000	3,000	.4632	.2472	2,316	3,706	1,390	1,236	1,978	742
Total.	55,000	66,000	11,000			38,001	40,906	2,907	29,445	28,755	-685

Discounted benefit-cost ratio (8%) = $\frac{40,906}{38,001}$ = 1.08

Discounted benefit-cost ratio (15%) = $\frac{28,755}{29,445}$ = .98

a/ Minus (-) figure indicates deficit.

Table A-3. Interpolating for Internal Rate of Return

Year	Undiscounted net benefits[a/]	Discounted at 13 pct. per year	Discounted at 14 pct. per year
1..........	-10,000	-8,850	-8,770
2..........	- 2,000	-1,556	-1,538
3..........	2,000	1,386	1,350
4..........	3,000	1,839	1,776
5..........	3,000	1,629	1,557
6..........	3,000	1,440	1,368
7..........	3,000	1,275	1,200
8..........	3,000	1,128	1,053
9..........	3,000	999	924
10..........	3,000	885	810
Discounted present value.......		65	-270

Internal Rate of Return, by interpolation:

$$IRR = .13 + .01\left(\frac{65}{(65+270)}\right)$$

$$= .13 + .0019$$

$$= 13.2\%$$

a/ From table A-2.

Similar computations for a number of projects would provide a basis for ranking; no project on which the discounted benefit-cost ratio is substantially less than 1.0 would normally be considered acceptable for more detailed project studies, or for implementation on the basis of purely economic considerations. A ratio value of less than unity indicates an internal rate of return below the marginal opportunity cost of capital.

The computation of the discounted present value of net benefits is also illustrated in table A-2. As shown in column 8, the present value of the algebraic sum of the annual benefits (deficits), discounted at 8 percent per annum, is 2,907 -- indicating this to be an acceptable project if the marginal opportunity cost of capital is 8 percent per annum or less. However, at a 15-percent discount rate, the project does not yield a rate of return equal to that available from other projects, i.e., equal to the marginal opportunity cost of capital. The observed results may be generalized; if the discounted present value of net benefits is positive (assuming the rate of discount is equal to the marginal opportunity cost of capital), the project is worthy of further feasibility study or of whatever step toward implementation is appropriate. Projects may be ranked or assigned priorities in terms of the absolute value of the discounted present values of their respective net benefits.

The direct computation of internal rates of return on projects is cumbersome; a satisfactory approximation can be obtained by interpolation from discount rates. The procedure is illustrated in table A-3, with the basic input and output data drawn from table A-2.

The internal rate of return may be defined as a discounted rate that will equate the stream of values of inputs and outputs, or -- alternatively -- the rate of discount required to reduce the present value of the stream of net benefits to zero.

It can be seen that the internal rate of return is substantially above 8 percent per annum (as shown in column 8, table A-2, at 8 percent the discounted present value of the stream of net benefits is 2,907). It can also be seen that the internal rate of return is below 15 percent per annum (as shown in column 1, table A-2). At a 15 percent rate of discount the discounted present value of the stream of surpluses is negative, -685. Hence the rate that will equate the present value of inputs and outputs (given a zero discounted present value of net benefits) is greater than 8 percent but less than 15 percent.

The internal rate of return can now be approximated by a (usually short) process of selecting a rate on either side of the anticipated solution and interpolating. This procedure is illustrated in table A-3.

The approximate internal rate of return can be interpolated as follows:

$$IRR = .13 + .01 \left(\frac{65}{(65 + 270)} \right) = .13 + .0019$$

$$= 13.2 \text{ percent per annum.}$$

APPENDIX B. PRICING IN PROJECT APPRAISALS

The "pricing" of physical units of inputs and outputs is a crucial step in project appraisal. The use of inappropriate, or inaccurate, prices in the valuation of inputs and outputs will give rise to misleading measures of the economic benefits of proposed projects.

In appraising projects from the standpoint of their contribution to national economic growth (NNRR), the "appropriate" set of prices is that which reflects real costs (of inputs) and real benefits (of outputs) to the economy. These real costs and benefits may or may not be accurately measured by market prices. This appendix offers suggestions for identification of those instances in which market prices are likely to be unacceptable measures of real costs or benefits, and for the estimation of accounting or shadow prices to use in place of market prices.

In the evaluation of projects from the standpoint of the enterprise, whether privately or publicly owned, the appropriate prices are market prices. Pricing problems would then be related to:

- Current versus projected future prices
- Inflationary price trends
- The averaging of prices to minimize distortions
- What price to use when the output of the project exerts a strong influence on market price.

Price Projections

If relevant and acceptable price projections (those expected to prevail during the life of the project) are available from the central planning authority, the central bank or other reliable sources, these should be used in a CPA. The development of price projections is likely to be a critical task in the CPA. As an alternative when this task proves too dificult in the CPA is to price both inputs and outputs at constant average prices for recent years, with perhaps some adjustments where such prices are clearly atypical. If this is done, the sensitivity analysis discussed in chapter VII should include an appraisal of probable prices changes and their effects on the respective rates of return on the several projects.

In the case of large projects that can be expected to produce significant effects on either the prices of inputs or outputs, an effort should be made to anticipate such price changes in estimating future costs and benefits. For example: a large-scale grazing scheme that will, say, triple the domestic supply of meat and dairy products will probably exert a downward pressure on prices that should be taken into account in estimating the value of future output. If the same project will create a demand for, say, twice the presently available domestic supplies of oil cake, the probable effects on input costs should also be taken into account.

Accounting or Shadow Prices

In computing the net national rate of return (NNRR), consideration must be given to the use of accounting or shadow prices in lieu of market prices in the valuation of inputs and outputs. The estimation of an appropriate accounting or shadow price is by no means a simple task. Shadow pricing should be undertaken only when market prices of significant inputs or outputs are clearly inaccurate measures of real economic costs of inputs, or of the "real" value (benefits) of output. The real economic cost of a factor of production is the marginal opportunity cost, i.e., the loss in output in the present marginal use of an input that would result if the marginal unit of the factor of production were transferred to the project.

There is no completely operationally satisfactory method for estimating the real, that is, the shadow, or accounting prices. Given technological conditions of production and patterns of behavior of producers and consumers, there exists a unique "optimal" pattern of resource allocation, and a related unique structure equilibrium prices associated therewith. Such prices are opportunity costs, and are the appropriate ones to employ as shadow prices in project appraisals designed to attain optimum resource utilization under the given conditions.

As a practical matter, however, the derivation of an equilibrium set of interdependent shadow or accounting prices based on economic models is not likely to be feasible. Therefore, where accounting or shadow pricing is deemed to be necessary, a process of estimating shadow or accounting price from partial information is generally employed.

Despite the shortcomings of shadow prices derived by partial, *ad hoc* procedures such shadow pricing is preferable to exclusive reliance on market prices where the latter are clearly inaccurate measures of real costs and benefits, and where projects are being evaluated in terms of their potential constribution to national economic growth.

The market prices most frequently found to be unsuitable for use in estimation of the NMRR (as distinguished from the profitability of the project from the enterprise point of view) are

1. Various interest rates, as a proxy for the opportunity cost of capital;
2. The wage rate of unskilled labor, particularly in LDC's with high rates of unemployment and extensive underemployment;
3. The official rate of foreign exchange.

It's preferable if the project analyst is provided reliable shadow prices for major inputs (unskilled labor, capital, foreign exchange) by the central planning authority, central bank, etc. The use of such accounting or shadow prices will conserve the time of the project analyst. If available, such accounting prices should be specified in the terms of references for consultants' work programs. If identical shadow prices are used in all project appraisals, a higher degree of comparability will be achieved than would be the case if each analyst attempted to establish his own set of shadow prices.

Opportunity Cost of Capital

The marginal opportunity cost of capital proves the minimum acceptable internal rate of return and the discount rate applicable to the net present value calculation in determining the economic justification of the proposed project. The measure of that concept for our limited purposes is the probable or projected return on the alternative inestments superceded or substituted by the contemplated investment.

There is no need in these guidelines to outline the controversy among economists as to the appropriate techniques for measuring the marginal opportunity cost of capital or take a position favoring a particular approach. The literature is replete with substantial disagreement as to the proper choice of the statistical manipulation that may approximate such a measure.[1] Suggestions have included rates of return on equity capital, the ratio of profits before taxes plus interest payments to the depreciated value of physical assets in constant prices, long-term yields on government bonds, etc.

Unless there is conclusive evidence to the contrary, we do suggest that the minimum acceptable internal rate of return necessary for economic justification should be at least 10 percent. This might be modified downward if the indirect benefit of the project appear to be substantial but quantification is not feasible. In those instances, the analyst should clearly outline what efforts have been to derive approximations of such indirect benefits and the rationale for inclusion.

The Accounting Wage Rate for Unskilled Labor [2]

In principle, this accounting price should be based on the net cost, to the national economy, of the input of unskilled labor into the project under review. Assuming the project is being evaluated in terms of its prospective rate of return to capital, the net cost will be composed of essentially two elements:

1. The output of the worker in his present employment, from which it is assumed he would transfer to the project

2. The additional consumption and other demands on output attributable to employment in the particular project.

1/ "On Estimating the Economic Cost of Capital", prepared by J. K. Schmedtje, IBRD-IDA, Report No. EC-138, Oct. 21, 1965; "On the Social Rate of Discount" by W. J. Baumol, American Economic Review, Vol. LVIII, Sept. 1968, N. 4, pp. 788-802.

2/ The basic concept underlying this section is fully discussed in Chapter XIII (The Estimation of the Shadow Wage Rate) of "Manual of Industrial Project Analyses in Developing Countries" Vol. II, Social Cost Benefit Analysis, by J. M. D. Little and J. A. Mirrlees, Development Centre, OECD, Paris, 1969.

For the first of these components, totally unemployed workers would have a marginal opportunity cost of zero. For underemployed, unskilled workers, the marginal opportunity cost will be something more than zero, but probably less than the going market wage rate for the type of labor. For the underemployed worker, the best estimate of the first component noted above can be made from the answer to the question, "By how much would the total value of output be reduced if the worker were withdrawn from his present (under) employment?"

The second component of the marginal opportunity cost of unskilled labor is almost certain to be greater than zero, but less than the total expenditures for consumption by the worker newly employed in the project. The underemployed -- and even the totally unemployed -- consume something. From a broader welfare appraisal the additional consumption accompanying the employment would, of course, be a benefit that would appear as an output as well as an input, i.e., as a component of the marginal opportunity cost of the labor.

Where data exist, a rough estimate of the second component of the marginal opportunity cost of unskilled labor may be made by comparing consumption levels of unemployed and underemployed unskilled workers with consumption of fully employed unskilled workers, and treating the difference as the <u>additional</u> cost of utilization of unskilled labor in the project and is a component of the marginal opportunity cost of the labor input.

The <u>incremental</u>, real economic cost of employment versus unemployment or substantial underemployment mav include such elements as the resources required to provide training; additional requirements for food, clothing and medical care; the costs of social infrastructure that may be necessary as the rural unemployed and underemployed shift to urban jobs; and transportation to and from the place of employment. It is only to the extent that the output of the worker exceeds these increments in the costs of his maintenance (plus any loss in real output in his present employment) that employment of the worker will yield any positive return on the capital employed in the project.

In LDC's large numbers of unemployed and underemployed members of the labor force usually reflect the constraints of capital shortages and the lack of foreign exchange -- as well as structural rigidities and imperfections in the labor market(s). Not uncommonly, money wage rates are established in the urban industrial sectors (or in modern plantation agricultural schemes) of what are essentially dual economies. The money wage rates so established tend to become the "norms" which employers in the modern sector are expected to pay as requirements for additional workers are met, either from the urban unemployed or the rural underemployed. These norms are often supported by unionized workers, and/or by government regulations or less formal policies. In fact, the productivity of workers may well exceed their wages given the constraints noted above on the expansion of employment; but from the standpoint of project evaluation in terms of the net returns to the economy, the relevant real cost of labor is the marginal opportunity cost of its employment on the project in question not the money wage which is necessary to put the worker in productive employment.

Accounting or Shadow Rate of Foreign Exchange

In many LDC's, the domestic monetary unit tends to be substantially overvalued. Thus, imported inputs tend to be too cheap relative to domestic inputs; and the values of exported outputs, expressed in the domestic monetary unit, are also understated. These distortions can give rise to serious bias in project appraisal. The choice of technology (the capital-labor factor relationship) is especially sensitive to the foreign exchange rate. Under these circumstances, the evaluation of projects involving substantial imported inputs and/or exports of output, the use of an accounting exchange rate will improve the basis of the appraisal.

One approach to the estimation of an accounting rate of exchange is through comparisons between the wholesale prices of imported and domestically produced goods considered to be perfect substitutes, disregarding import duties and internal excise taxes. Thus, if the price of domestically produced portland cement, for example, is 25 percent above world market prices (c.i.f. plus local handling costs), the presumption is that the ratio of the accounting exchange rate to the official rate is 1.25/1.00, insofar as this one good is concerned. If similar comparisons can be made for a large number of goods, or in terms of a broadly based, representative wholesale price index, the resulting ratio can be used as a correction factor to estimate an accounting exchange rate.

Alternatively, where there is a substantial volume of foreign trade, "effective rates" of exchange for imports and exports may be of use in estimating the accounting or shadow rate of exchange. However, if import licenses are denied for significant quantities of important commodities, the effective rate will be below the appropriate level for the accounting or shadow rate of exchange.

An effective rate of exchange on imports may be computed by dividing the sum of domestic c.i.f. cost of imports plus all duties, port charges, customs clearance and import license fees, and penalty interest on deposits required to obtain import licenses, by the c.i.f. value of imports expressed in foreign currency. A similar computation may be made to arrive at an effective rate of exchange for exports. To the official exchange receipts from exports all subsidies -- direct and indirect -- would be added, and the total divided by the f.o.b. value of the export expressed in foreign currency. In this computation, it is important to include all indirect forms of subsidy, including loans at preferential interest rates, the profits from sales of privileged imports available only to exporters, lower transport and electric rates for exporters, etc., as well as direct subsidies.

In many countries, central monetary authorities compute more or less continuously what is generally called the "effective rate of exchange." The method of computation generally follows that suggested in the second alternative above. Where available, these are probably satisfactory bases for the estimation of the accounting exchange rate, subject to the qualifications noted above.

For some developing countries, independent market rates of foreign exchange may be available from published (or easily obtainable) quotations in free markets outside the country. However, such market quotations should be used with extreme caution, as they often reflect illicit transactions or very limited volumes of exchange. Similarly, black-market rates within a country are not generally an appropriate base for an accounting exchange rate. These rates are generally set in very thin markets in which both buyers and sellers are frequently engaged in illicit transactions involving high risks.

Taxes and Pricing in the Net National Rate of Return

In general, taxes imposed in the production process should be excluded as costs (inputs) in project appraisal, from the standpoint of the prospective returns to the economy. This applies to import and export duties, as well as to internal taxes on commodities and raw materials. The rationale for the exclusion is that taxes do not represent a social cost, as distinguished from a private or enterprise cost of obtaining the output. In this context tax receipts are viewed as a share of the benefits of the project allocated to government, rather than an economic cost.

Pricing of Outputs

Prevailing market prices, and price projections based thereon, provide satisfactory "weights" for estimation of the value of output if a project is being evaluated from the standpoint of the enterprise rate of return. But in most LDC's, such prices are not likely to provide an accurate measure of the real value of output viewed from the standpoint of the economic returns (NNRR) on a project.

In LDC's, markets for many products are highly imperfect, with prices set by few buyers and sellers, price determination by administrative action, the compartmentalization of markets because of inadequate transport and communication, etc. Prices in such markets are an imperfect guide, at best, to the estimation of the national economic value of output from prospective projects.

Where output will consist of marketable products (i.e., divisible goods which can be sold for a price) and such goods are traded in world markets, the c.i.f. price (exclusive of duties) provides a satisfactory base for valuation of domestic output -- if a "correct" exchange rate is employed in converting the foreign to the domestic currency value. If both nonlabor inputs and outputs consist largely of goods traded in world markets, it may be useful to use world prices for the computation of an NNRR, with domestic labor inputs converted to world prices by use of the accounting rate of foreign exchange.

APPENDIX C. SUGGESTED FORMAT FOR SUMMARY EVALUATION

The following is suggested as one possible format for an evaluation summary. The summary should be designed to provide decision-makers with an easily understood statement of alternatives and recommendations.

I. Technical Analysis

A. Description of best alternative project in terms of location, size, construction and production processes (technology) and designed capacity

B. Explanation of unresolved technical issues; recommendations for further engineering investigations

C. Compatibility of technical characteristics and

1. Managerial capabilities
2. Labor force
3. Climatic conditions
4. Environmental standards
5. Availability of machinery and equipment operating supplies, power and transport

II. Economic Analysis

A. Demand and/or output projections

B. Estimated inputs

1. Capital
   a. Foreign
   b. Domestic

2. Operating
   a. Foreign
   b. Domestic

Although there is no completely satisfactory method of determining "correct prices" in the absence of reasonably free, competitive markets, the analyst should be alert to the price distortions arising from such factors as those cited above, from clearly temporary shortages, and from disruptions in supply and inflation. By using accounting prices, rather than actual prevailing prices, estimates can be improved in these circumstances.

External Costs and Benefits

In chapter II, attention was directed to certain inputs, the costs of which are not actually paid by an enterprise. The inclusion of such costs is appropriate if the project is being appraised from the NNRR standpoint because they are borne somewhere in the economy. For example, air and water pollution may impose real costs on the population in the form of illnesses and medical expenses. Access roads and streets, water and sewerage services and other infrastructure, to the extent required for the project, whether or not the expense of providing them is actually borne by the project.

An analogous situation exists with respect to outputs (benefits) on which an enterprise is not able to impose a price and, therefore, collect revenues. The extreme cases of such benefits are found in the government sector: national security, fire and police protection, education, public health, etc.

In some types of projects, e.g., development roads, the external benefits may be so important that the proposed road can be properly evaluated only by consolidation with the land development schemes or other developments that it will serve.

C. Pricing assumptions

1. Output
   a. Market prices
   b. Shadow prices, if used

2. Inputs
   a. Market prices
   b. Shadow prices, how estimated
      (1) Unskilled labor
      (2) Marginal opportunity cost of capital
      (3) Foreign exchange rate
      (4) Other, if used

D. The net national rate of return (NNRR)

1. The preferred alternative form of the project

2. Alternatives used in comparison, and characteristics

E. Sensitivity Analysis

1. Range of probable NNRR

2. Proposed measures to reduce risks and raise NNRR

3. Recommendations for further study, if necessary

III. Financial Analysis

A. The business enterprise rate of return (BERR)

1. The preferred alternative form of the project

2. Alternatives, for comparison

B. Proposed measures to effect reconciliation of BERR and NNRR, if required

IV. Other Considerations in Project Selection

A. Consistency with development strategy and policy objectives:

1. Distributive effects
2. Regional pattern of development
3. Import substitution versus export promotion
4. Employment effects
5. Effects on interindustry linkages, i.e., industrial integration

B. Environmental effects

V. Recommendations

A. Rejection of project

B. Postponement of project

C. Modification and further study

D. Full feasibility study

1. Identification of those aspects, concerning which available data do not provide basis for firm finding
2. Suggested scope of work for feasibility study

E. Design and finance

1. Qualifications
2. Recommended measures to enhance project
   a. Government policies, practices and administration
   b. Training
   c. Supporting projects

APPENDIX D. CHECKLIST FOR THE PRELIMINARY PROJECT APPRAISAL

Purpose

The purpose of this checklist is to:

1. Suggest sources and types of information useful for the CPA;

2. Identify the elements requiring examination and assessment as background for the CPA;

3. Note the principal factors to be considered in the formulation of the project and the testing of alternatives;

4. Signal where further investigation, study and action are required to help assure a successful outcome of the project and to avoid likely pitfalls. Quite often, early knowledge about potential difficulties will permit arrangements that can eliminate or minimize the difficulty.

Common Sources of Information

. Basic economic data: Central planning boards, Ministry of Finance, Ministry of Public Works, foreign trade statistics, central banks

. Sectoral economic data: From concerned ministries and agencies such as Agriculture, Housing, Labor, Commerce and Industry, Communications, Transport, and Power

. Marine Charts - Naval offices, and shipping companies

. Meteorological Data - Hydrologic officer, airlines, local highway and railroad engineers

. Geology - Geological and mineral surveys, mining or extractive processing companies, well drillers, local highway and railroad engineers

. Population and Commerce - Banks, local educational institutions and businesses (utilities, manufacturing enterprises, wholesalers, importers, exporters), censuses and special surveys

. Transportation - Airlines, vehicle registrars, railroads, shipping companies, petroleum companies, brokers and agents.

Most of the sources listed above will be found in the majority of LDC's. However, it will usually be advisable to assemble as much information as possible from secondary sources such as UN publications and country reports of the World Bank and AID.

Review of Existing Conditions and Experience Relevant to the Project

Which activities in the country resemble most closely the proposed project?

Has the experience with such activities been reviewed with reference to important matters such as:

1. The causes of cost overruns and delays in construction

2. Labor difficulties or labor practices that affect operations (termination allowances, shift differentials, holidays, overtime, etc.)

3. Government regulations

4. Restrictions on importation or disposal of construction equipment

5. Performance of local contractors and subcontractors

6. Rates of utilization of capacity. If significant underutilization has been experienced, what are the reasons?

7. Availability of skilled personnel for management, construction and operation

8. Problems encountered in obtaining materials, imported or domestic

9. Reliability and availability of power output

10. Effects of climate on types of project similar to those being appraised

11. Reliability and availability of transportation and communication

12. Escalation of construction costs

13. Availability of operating funds, supplies, spare parts, foreign exchange, etc.

14. Attitude towards foreign participation.

Can difficulties encountered in previous projects of a similar nature be expected in the proposed project? Does the project as planned assume that there will be similar difficulties? If not, what specific steps are being planned to avoid or minimize such difficulties?

Engineering and Technical Data Requirements

Capital projects involve combinations, enlargement, improvements and modernization of physical assets. Hence, it is necessary at the outset of an appraisal to ascertain that it is physically possible to implement a proposed project, and to establish the physical characteristics of the proposed project in sufficient detail to permit order-of-magnitude estimates of construction and operating costs. The required detail will be significantly less for a preliminary project appraisal than for full-scale feasibility studies and the preparation of prebid estimates.

There is no way to define accurately the precise amount of engineering and technical study that will be required for all CPA's. There are, however, guidelines which will assist the analyst, if used in the broad sense. When the project, or alternatives, have been identified, the following technical data will be required.

1. Has the planned location of the facility been justified in terms of the following requirements:

a. Topography - is the terrain suitable?

b. Geology - is the area buildable, e.g., are faults present?

c. Ecology - is the facility likely to [illegible] surrounding community by air, water, noise pollution; safety factors; adverse effect on use of adjacent lands?

d. Availability - is sufficient area available on a timely basis?

e. Best use - is this the best site - is it too good for the planned use?

2. Is adequate local skilled and unskilled available? Are training facilities available?

3. Is basic building material (sand, gravel, cement, fertilizers, steel) available locally? Is the grade adequate?

4. Is sufficient water of required quality readily available?

5. Is sufficient power or power source readily available?

6. Are the local building standards adequate and reasonable?

7. Are local manufactured products available? Is quality adequate; are probable delivery times reasonable?

8. Is local construction equipment of adequate size and performance available?

9. Are competent subcontractors available?

10. Is adequate fuel (equipment) available?

11. Are maintenance and machine shop facilities available?

12. What are the electric power characteristics: voltage, cycle, etc.?

If sufficient time or data do not permit a reliable answer to the above questions, the analyst should qualify his answers by assigning a percent confidence level or probability of error factor to each significant point. For example, if the available building material (cement, gravel, sand) has not been tested for standard strength and grade, the investigator would be required to estimate its quality by personal inspection and by inspection of structures constructed with the material. He would then assign a percent factor reflecting his degree of certainty as to its quality.

Shaping the Project

What major alternatives to perform the same or similar function have been considered and rejected on the basis of:

- Restraining circumstances (specify)
- Economic, engineering, institutional, and attitudinal considerations (specify)?

Are there some alternatives that should be considered in later stages of study of the project?

List the major sources of uncertainty about the project and how the project has been changed to cope with the uncertainty.

Estimation of Costs

Describe:

- Basis of costing of the project, i.e., proposed size and technical characteristics of project as these affect cost
- Estimated level of cost in relation to other countries; in relation to similar projects in the country
- Use of scaling
- Major units of costing; costing by modules, and adjustment of module prices to local conditions
- Allowance for cost escalation during construction
- Allowance for training costs
- Allowance for startup costs
- Allowance for substandard service facilities
- Allowance for other cost considerations.

What is the basis for deciding when to use imported materials, particularly when indigenous materials are available?

Describe the outer limits of estimated investment required by the project and the factors that are most likely to raise costs.

Enumerate the standards that have been adopted for the construction and the operation of the project. What are the other standards that were considered? Give the basis for their rejection.

Does the estimate of investment cost include investments needed to obtain services such as:

- Maintenance or improvement of public highways, water courses or communications to service project
- Procurement or financing the procurement of railroad rolling stock or improvements to track
- Purchase and supply of materials and equipment for expansion or maintenance of water, sewer, gas, electric or other utility systems connected to the project
- Expansion costs of public institutions, including medical services, to serve the project's population
- Relocation of persons displaced by the project.

Estimation of Demand and Valuations of Output

The physical characteristics of the project will be determined, in part, by the planned or projected output. In this connection, the CPA is directed to:

1. Examination of the economic , demographic and institutional factors that are expected to determine the quantities demanded -- if the output is to be distributed through the market.

2. Assessment of the need for services to be provided through infrastructure projects where market prices are not relied upon to control quantities demanded, e.g., education, public health and (some) transport facilities

3. Estimation of the probabilities of the projected needs or demands being realized

4. Valuation of projected output:

a. At market prices

b. At accounting or shadow prices

5. Special problems of valuation for projects having outputs not sold for a price

a. Indirect (external) benefits, e.g., linkage effects

b. Indivisible benefits, e.g., improved public health and environment

6. Selection of least-cost alternatives where quantification and/or monetary valuation of output is not feasible.

Organization and Management

Identification of Project Sponsorship

1. Policy-makers. Extent to which:

   a. Policy-makers have participated actively in defining the project

   b. Crucial policy options have been identified and are reflected in the definition of the project

   c. Positions of the policy-makers are reflected in the definition of the project

   d. Preliminary appraisal provides the approximate economic returns of different major policy options.

2. Sponsoring entities. Extent to which:

   a. Government agencies (central, regional, provincial, municipal and other local) and quasigovernmental organizations participated in defining the project proposal

b. Private entrepreneurs or private promoters participated in definition of project

c. International lending agencies and other foreign sources, including consultants and equipment suppliers, participated in project definition

d. Other organizations, not designated as sponsoring organizations, participated in definition of project.

Organizational Structure or Form

1. Description of organization proposed to manage and supervise the project operations together with functional, operating and maintenance organization charts, present (if applicable) and projected.

2. Relationship of the proposed organizational form to the managerial requirements of the project.

3. Does proposed organizational structure reflect the work and kinds of operating and maintenance activities required to accomplish the project objectives?

4. Extent to which project involves unusual organizational complexity, and to which organizational structure reflects the technology of the project.

5. Does project require unusual organizational coordinative arrangements with other agencies and depend on effective interface relationships with other organizations in support of project objectives?

6. Extent to which organization charts reflect (a) the intended legal or formal overall structure of the organization, and (b) the manner in which the day-to-day operations of the organization are intended to be carried out.

Legal Arrangements

1. Description in general way of arrangements required to legalize the proposed project, including, as applicable, laws to be drafted; governmental directives to be issued or modified; agreements with central and local government authorities to be negotiated; documents to be drawn up between the government, international lending agencies, project investors, and other entities; and estimate of time to complete these arrangements.

2. General description of government authorizations to be issued (e.g., investment incentives, subsidies, tax and import duty exemptions, price and tariff decisions, etc.), and estimate of time to complete these arrangements.

Management Authority and Autonomy:
General Discussion

1. Will the autonomy needed for effective project management be limited by the government's need for coordinated development policy, by political factors, or by other reasons?

2. Will project management be able to operate under the preferred budgetary and financial arrangements?

3. Will the project management be able to exercise control over the allocation and utilization of all resources (men, money, facilities, equipment and supplies) approved in the project?

4. Will the project management have necessary autonomy in the selection of key personnel and in conditions of their employment, or will undue interferences be likely?

5. Are limitations likely to be placed on the authority of the management to make enforceable policy and operating decisions required by the project in other areas?

6. Which structural changes will be necessary in an existing parent organization in order to operate and maintain the project properly?

7. Extent to which organizational alternatives have been considered and the justification (advantages and disadvantages) of proposed organizational form.

Availability of and Arrangements for Training Required Managerial and Technical Personnel

1. Description of requirements for managerial and technical personnel for the proposed project as defined by the preliminary organization plan, including position specifications, desired qualities, and salary ranges

2. Indication of availability of suitable general manager of the project and of other key personnel

3. Extent to which other managerial and technical manpower requirements are likely to be met from existing sources, domestic and foreign, public and private

4. Planned or projected arrangements for meeting gaps between requirements and availabilities, e.g., executive development and technical training programs, part-time employment of locally available managers and technicians, hiring of foreign consultants as temporary executives and trainers etc.

Availability of and Arrangements for Training Required Skilled Labor and Meeting Unskilled Labor Requirements

1. Description of requirements for skilled labor, unskilled labor, and casual labor (if any) as defined by the proposed work schedule, including job specifications, wage rates and other provisions. In a general way there should be manning tables which show the types and degrees of skills required both for operating and maintenance functions, and these should be tied in with the organization charts and job descriptions in terms that fit the local situation.

2. Planned or projected arrangements for meeting gaps between requirements and prospective availabilities.

Availability and Development of Organizational Headquarters Physical Facilities

1. General description of space, office, communication and other equipment, and other facilities required by the project organization

2. Extent to which proposed project organization will depend on facilities provided by cooperating or subordinate organizations

3. Extent to which new facilities will be required

4. Projected arrangements for meeting requirements for organizational physical facilities.

Other Considerations

1. Degree to which the quality and traditions of administration of the project's environment are likely to influence the successful organization and management of the project

2. Degree to which existing or pending legislation and governmental regulations are likely to affect organization and management of the project, including pending economic and social legislation, administrative reforms, and (as applicable) such legal considerations as concessions, conventions, franchises, rights-of-way, permits, licenses, etc.

3. Extent to which social implications of the project are likely to affect organization and management of the project

4. Extent to which overall environmental factors (international as well as national) are likely to affect the organization and management of the project.

APPENDIX E. PRESENT VALUE DISCOUNT FACTORS FOR SINGLE PAYMENT AND CONTINUOUS PAYMENT FOR GROWTH RATES OF 3 PERCENT TO 50 PERCENT

Table E-1. Single Payment Present Worth Factors for Growth Rates From 3 Percent to 50 Percent

Year	Growth Rate																	
	3%	4%	5%	6%	7%	8%	10%	12%	13%	14%	15%	20%	25%	30%	35%	40%	45%	50%
1	.9709	.9615	.9524	.9434	.9346	.9259	.9091	.8929	.8850	.8772	.8696	.8333	.8000	.7692	.7407	.7143	.6897	.6667
2	.9426	.9246	.9070	.8900	.8734	.8573	.8264	.7972	.7831	.7695	.7561	.6944	.6400	.5917	.5487	.5102	.4756	.4444
3	.9151	.8890	.8638	.8396	.8163	.7938	.7513	.7118	.6930	.6750	.6575	.5787	.5120	.4552	.4064	.3644	.3280	.2963
4	.8885	.8548	.8227	.7921	.7629	.7350	.6830	.6355	.6133	.5921	.5718	.4823	.4096	.3501	.3011	.2603	.2262	.1975
5	.8626	.8219	.7835	.7473	.7130	.6806	.6209	.5674	.5428	.5194	.4972	.4019	.3277	.2693	.2230	.1859	.1560	.1317
6	.8375	.7903	.7462	.7050	.6663	.6302	.5645	.5066	.4803	.4556	.4323	.3349	.2621	.2072	.1652	.1328	.1076	.0878
7	.8131	.7599	.7107	.6651	.6227	.5835	.5132	.4523	.4251	.3996	.3759	.2791	.2097	.1594	.1224	.0949	.0742	.0585
8	.7894	.7307	.6768	.6274	.5820	.5403	.4665	.4039	.3762	.3506	.3269	.2326	.1678	.1226	.0906	.0678	.0512	.0390
9	.7664	.7026	.6446	.5919	.5439	.5002	.4241	.3606	.3329	.3075	.2843	.1938	.1342	.0943	.0671	.0484	.0353	.0260
10	.7441	.6756	.6139	.5584	.5083	.4632	.3855	.3220	.2946	.2697	.2472	.1615	.1074	.0725	.0497	.0346	.0243	.0173
11	.7224	.6496	.5847	.5268	.4751	.4289	.3505	.2875	.2607	.2366	.2149	.1346	.0859	.0558	.0368	.0247	.0168	.0116
12	.7014	.6246	.5568	.4970	.4440	.3971	.3186	.2567	.2307	.2076	.1869	.1122	.0687	.0429	.0273	.0176	.0116	.0077
13	.6810	.6006	.5303	.4688	.4150	.3677	.2897	.2292	.2042	.1821	.1625	.0935	.0550	.0330	.0202	.0126	.0080	.0051
14	.6611	.5775	.5051	.4423	.3878	.3405	.2633	.2046	.1807	.1597	.1413	.0779	.0440	.0254	.0150	.0090	.0055	.0034
15	.6419	.5553	.4810	.4173	.3624	.3152	.2394	.1827	.1599	.1401	.1229	.0649	.0352	.0195	.0111	.0064	.0038	.0023
16	.6232	.5339	.4581	.3936	.3387	.2919	.2176	.1631	.1415	.1229	.1069	.0541	.0281	.0150	.0032	.0046	.0026	.0015
17	.6050	.5134	.4363	.3714	.3166	.2703	.1978	.1456	.1252	.1078	.0929	.0451	.0225	.0116	.0061	.0033	.0018	.0010
18	.5874	.4936	.4155	.3503	.2959	.2502	.1799	.1300	.1108	.0946	.0808	.0376	.0180	.0089	.0045	.0023	.0012	.0007
19	.5703	.4746	.3957	.3305	.2765	.2317	.1635	.1161	.0981	.0829	.0703	.0313	.0144	.0068	.0033	.0017	.0009	.0005
20	.5537	.4564	.3769	.3118	.2584	.2145	.1486	.1037	.0868	.0728	.0611	.0261	.0115	.0053	.0025	.0012	.0006	.0003
21	.5375	.4388	.3589	.2942	.2415	.1987	.1351	.0926	.0768	.0638	.0531	.0217	.0092	.0040	.0018	.0009	.0004	.0002
22	.5219	.4220	.3418	.2775	.2257	.1839	.1228	.0826	.0680	.0560	.0462	.0181	.0074	.0031	.0014	.0006	.0003	.0001
23	.5067	.4057	.3256	.2618	.2109	.1703	.1117	.0738	.0601	.0491	.0402	.0151	.0059	.0024	.0010	.0004	.0002	.0001
24	.4919	.3901	.3101	.2470	.1971	.1577	.1015	.0659	.0532	.0431	.0349	.0126	.0047	.0018	.0007	.0003	.0001	.0001
25	.4776	.3751	.2953	.2330	.1842	.1460	.0923	.0588	.0471	.0378	.0304	.0105	.0038	.0014	.0006	.0002	.0001	.....
26	.4637	.3607	.2812	.2198	.1722	.1352	.0839	.0525	.0417	.0331	.0264	.0087	.0030	.0011	.0004	.0002	.0001	.....
27	.4502	.3468	.2678	.2074	.1609	.1252	.0763	.0469	.0369	.0291	.0230	.0073	.0024	.0008	.0003	.0001	.....	.....
28	.4371	.3335	.2551	.1956	.1504	.1159	.0693	.0419	.0326	.0255	.0200	.0061	.0019	.0006	.0002	.0001	.....	.....
29	.4243	.3207	.2429	.1846	.1406	.1073	.0630	.0374	.0289	.0224	.0174	.0051	.0015	.0005	.0002	.0001	.....	.....
30	.4120	.3083	.2314	.1741	.1314	.0994	.0573	.0334	.0256	.0196	.0151	.0042	.0012	.0004	.0001	.....	.....	.....
31	.4000	.2965	.2204	.1643	.1228	.0920	.0521	.0298	.0226	.0172	.0131	.0035	.0010	.0003	.0001	.....	.....	.....
32	.3883	.2851	.2099	.1550	.1147	.0852	.0474	.0266	.0200	.0151	.0114	.0029	.0008	.0002	.0001	.....	.....	.....
33	.3770	.2741	.1999	.1462	.1072	.0789	.0431	.0238	.0177	.0132	.0099	.0024	.0006	.0002	.0001	.....	.....	.....
34	.3660	.2636	.1904	.1379	.1002	.0730	.0391	.0212	.0157	.0116	.0086	.0020	.0005	.0001	.....	.....	.....	.....
35	.3554	.2534	.1813	.1301	.0937	.0676	.0356	.0189	.0139	.0102	.0075	.0017	.0004	.0001	.....	.....	.....	.....

Table E-2. Present Worth Factors for Growth Rates From 3 Percent to 50 Percent, Continuous Flow Compounded at Annual Rate

Period	Growth Rate 3%	4%	5%	6%	7%	8%	10%	12%	15%	20%	25%	30%	35%	40%	45%	50%
0 to 1	.9854	.9806	.9760	.9714	.9669	.9825	.9538	.9454	.9333	.9141	.8963	.8796	.8639	.8491	.8352	.8221
1 to 2	.9567	.9429	.9295	.9164	.9037	.8912	.8671	.8441	.8115	.7618	.7170	.6766	.6399	.6065	.5760	.5481
2 to 3	.9288	.9067	.8853	.8646	.8445	.8252	.7833	.7537	.7057	.6348	.5736	.5205	.4740	.4332	.3973	.3654
3 to 4	.9017	.8718	.8431	.8156	.7893	.7641	.7166	.6729	.6136	.5290	.4589	.4004	.3511	.3095	.2740	.2436
4 to 5	.8755	.8383	.8030	.7695	.7377	.7075	.6515	.6008	.5336	.4406	.3671	.3080	.2601	.2210	.1969	.1624
5 to 6	.8500	.8050	.7647	.7259	.6894	.6555	.5922	.5365	.4640	.3674	.2937	.2369	.1927	.1579	.1303	.1083
6 to 7	.8252	.7750	.7283	.6848	.6443	.6065	.5384	.4790	.4035	.306[illegible]	.2350	.1822	.1427	.1128	.0899	.0722
7 to 8	.8012	.7452	.6936	.6461	.6021	.5616	.4895	.4277	.3509	.2551	.1880	.1402	.1057	.0806	.0620	.0481
8 to 9	.7779	.7165	.6606	.6095	.5628	.5200	.4450	.3818	.3051	.2126	.1504	.1078	.0783	.0575	.0427	.0321
9 to 10	.7552	.6890	.6291	.5750	.5259	.4815	.4045	.3409	.2653	.1772	.1203	.0829	.0580	.0411	.0295	.0214
10 to 11	.7332	.6625	.5992	.5424	.4915	.4458	.3677	.3044	.2307	.1476	[illegible]	.0638	.0430	.0294	.0203	.0143
11 to 12	.7118	.6370	.5706	.5117	.4594	.4128	.3343	.2718	.2006	.1230	.0770	.0491	.0318	.0210	.0140	.0095
12 to 13	.6911	.6125	.5435	.4828	.4293	.3822	.3039	.2427	.1744	.1025	.0616	.0378	.0236	.0150	.0097	.0063
13 to 14	.6710	.5889	.5176	.4554	.4012	.3539	.2763	.2167	.1517	.0854	.0493	.0295	.0175	.0107	.0067	.0042
14 to 15	.6514	.5663	.4929	.4297	.3750	.3277	.2512	.1935	.1319	.0712	.0394	.0223	.0129	.0076	.0046	.0028
15 to 16	.6325	.5445	.4695	.4053	.3505	.3034	.2283	.1727	.1147	.0593	.0315	.0172	.0096	.0055	.0032	.0019
16 to 17	.6140	.5236	.4471	.3824	.3275	.2809	.2076	.1542	.0997	.0490	.0252	.0132	.0071	.0039	.0022	.0013
17 to 18	.5962	.5034	.4258	.3608	.3061	.2601	.1887	.1377	.0867	.0412	.0202	.0102	.0053	.0028	.0015	.0008
18 to 19	.5788	.4841	.4055	.3403	.2861	.2409	.1716	.1229	.0754	.0343	.0161	.0078	.0039	.0020	.0010	.0006
19 to 20	.5619	.4655	.3862	.3211	.2674	.2230	.1560	.1098	.0656	.0286	.0129	.0060	.0029	.0014	.0007	.0004
20 to 21	.5456	.4476	.3678	.3029	.2499	.2065	.1418	.0980	.0570	.0238	.0103	.0046	.0021	.0010	.0005	.0002
21 to 22	.5297	.4303	.3503	.2857	.2335	.1912	.1289	.0875	.0496	.0199	.0083	.0036	.0016	.0007	.0003	.0002
22 to 23	.5143	.4138	.3336	.2696	.2182	.1770	.1172	.0781	.0431	.0166	.0065	.0027	.0012	.0005	.0002	.0001
23 to 24	.4993	.3979	.3178	.2543	.2040	.1639	.1065	.0698	.0375	.0138	.0053	.0021	.0009	.0004	.0002	.0001
24 to 25	.4847	.3826	.3026	.2399	.1906	.1518	.0968	.0623	.0328	.0115	.0042	.0016	.0006	.0003	.0001	.....
25 to 26	.4706	.3679	.2882	.2263	.1782	.1405	.0860	.0556	.0284	.0096	.0034	.0012	.0005	.0002	.0001	.....
26 to 27	.4569	.3537	.2745	.2135	.1665	.1301	.0800	.0497	.0247	.0080	.0027	.0010	.0004	.0001	.0001	.....
27 to 28	.4436	.3401	.2614	.2014	.1556	.1205	.0728	.0443	.0214	.0067	.0022	.0007	.0003	.0001	.....	....
28 to 29	.4307	.3270	.2490	.1900	.1454	.1118	.0661	.0396	.0186	.0055	.0017	.0006	.0002	.0001	.....	.....
29 to 30	.4181	.3144	.2371	.1793	.1359	.1033	.0601	.0353	.0162	.0046	.0014	.0004	.0001	.....	.....	....
30 to 31	.4060	.3024	.2258	.1691	.1270	.0956	.0547	.0316	.0141	.0039	.0011	.0003	.0001	.....	.....	.....
31 to 32	.3941	.2907	.2151	.1596	.1187	.0886	.0497	.0282	.0123	.0032	.0009	.0003	.0001	.....	.....	.....
32 to 33	.3827	.2795	.2048	.1505	.1109	.0820	.0452	.0252	.0107	.0027	.0007	.0002	.0001	.....	.....	....
33 to 34	.3715	.2688	.1951	.1420	.1037	.0759	.0411	.0225	.0093	.0022	.0006	.0002	.....	.....	.....	....
34 to 35	.3607	.2585	.1858	.1340	.0969	.0703	.0373	.0201	.0081	.0019	.0005	.0001	.....	.....	.....	.....

DRAFT CIRCULATED FOR COMMENT

APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II (A)

TRANSPORTATION

TELECOMMUNICATIONS

ELECTRIC POWER PROJECTS

Agency for International Development

September 1971

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APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II - TRANSPORTATION

Agency for International Development

September 1971

CONTENTS

CONTENTS (Continued)

FOREWORD

The project analyst using these guidelines should first read Part I, General Guidelines. It provides insights into key considerations for capital project appraisals (CPA's) in all sectors.

The transportation project guidelines deal expressly with those matters relevant to transportation projects. They tell the analyst how to think about a project in transport; what to look for; and how to assure consideration of all elements essential to a CPA. They assist in identification of institutional, cultural, political, and other factors which can weigh heavily on a project. They encourage concentration on big issues in broad orders of magnitude, leaving details and matters of lesser importance to be explored possibly in a subsequent study.

The CPA is most efficiently undertaken by multidisciplinary teams, e.g., social scientists (economists, financial analysts, political scientists, etc.) and technical specialists (engineers, agriculturists, etc.). The structure of the individual multi-disciplinary team can only be detailed within a specific analytical and project context. The term project analyst or analyst, used herein,refers to a member of a team engaged in a CPA.

I. GUIDELINES APPLYING TO ALL TRANSPORT MODES

Introduction

Transport service is a necessary -- but not sufficient -- precondition for most economic development. Investments in transport facilities can absorb a sizable, and often too large, proportion of the capital available in less developed countries. Care in selection of transport investments can save large amounts of capital.

In concept, the appraisal of transport projects does not differ from that for other investments, but it presents special difficulties of fact-finding and analysis due to the characteristics of transport, its interdependence with other economic sectors, the wide dispersion of its benefits, the multiplicity of public and private agencies involved in providing transport facilities and services, the variety of transport modes, and the need for intermodal integration of the transport system and coordination between transport and other sectors.

Steps in the Appraisal of Transport Projects

Appraisals of transport projects include the following steps:

1. Identification -- in the light of macro and sectoral economic conditions -- of the need and the particular objective or objectives to be met. This step includes estimation of the transport demand to be satisfied; it may also, in certain circumstances, require the quantification of the transport project's role in a broader development proposal.

2. Quantification of the physical inputs and outputs of the specified project

3. Valuation of inputs and outputs, i.e., pricing of the project

4. Computation of measures of economic return

5. Examination of alternatives to verify the selection of the project.

6. Sensitivity analysis

7. Evaluation summary.

While the above steps are discussed as discrete tasks that can be taken in the stated order, it should be recognized that in the course of carrying out these steps there will be considerable interaction. For example, in carrying out step 5, the analyst may find that other alternatives suggest themselves, so that he may find it necessary to return to step 2.

Definition of Project Purpose and Consideration of Alternative Solutions

Transport activity is useful only in its service to other economic, social, or governmental activities. Therefore, CPA's for transport require considerable attention to the general condition and development trends of the country's economy. This is facilitated by an economic development plan, and even more by a transport sector study and regional development plan. If no such ready references are available, it is necessary to collect from other sources sufficient information to understand the relationship of the proposed project to other activities in transport and to economic development policies and strategy, potentials and constraints elsewhere in the economy.

The transportation project usually is based on the seemingly obvious solution to a problem. To judge whether such a solution is the right one, the CPA must start with a definition of the project's basic purpose. That purpose, for example, is not "to provide a highway from A to B" but "to facilitate the production and marketing of specific crops" or to support whatever other activity appears to need transport service. Once the basic purpose is clearly defined, the project analyst can examine alternative means of meeting the need and decide whether the proposed project is the best solution under existing conditions.

Relationship of the Project to Macroeconomic Variables and Sectoral Conditions

The demand for and the supply of transport services are closely linked to macroeconomic matters.

- Lack of transport can constitute a bottleneck to economic growth. Growth in the demand for transport, on the other hand, is a function of the rate of growth and changes in composition of GNP.

- Planned changes in the structure of the economy, e.g., emphasis on manufacturing for export and the pattern of geographic distribution of production envisaged in the plan have important implications for transport project appraisals.

- The availability of government funds will limit transport investments.

- The government's monetary, pricing, and wage policies will heavily influence the costs of transport construction.

- The availability of foreign exchange and the realism of the exchange rate will affect the importation and cost of rail cars, trucks, fuel and other items required for transport.

- Government policies toward recovering the costs of services will determine road user charges -- tolls, fuel taxes, licenses, fees -- affecting the choice of modes by users of transport services.

The impact of general economic conditions, plans and policies goes far beyond the few items mentioned. The project analyst must view the project in relation to those macroeconomic factors likely to impinge directly on the project.

Fortunately, sector studies in transport are becoming more common. They will identify key macroeconomic factors bearing on the sector, as well as political, cultural, and institutional matters of importance. They will help the analyst to find the best solution by allowing him to see the project as part of the entire transport system of the country or a region thereof, or as part of a system encompassing several countries. A national transport sector survey will provide such data as:

. An inventory of existing facilities, including their state of maintenance and their actual and potential capacity

. The volume of traffic, its trend in the recent past (say, 5 to 10 years), its indicated future growth, and its relationship to capacity

. Organization and operating practices, regulatory and taxation policies, and any other factors affecting transport activities

. Costs of construction and maintenance for the several transport modes

. Plans for regional transport development within the country and with neighboring countries

. Indications of constraints -- financial, physical, managerial, institutional -- which limit transport development.

Exploring Alternatives

With a correct definition of the basic need to be met by the project and an understanding of the economy and its transport system, the analyst can explore alternative ways of meeting the need. Alternatives that should be examined include the following:

. Rationalization of rate and tariff structures, tax schedules or administrative regulations to foster more efficient utilization of existing facilities

- Improvements in maintenance, operation, or administration to increase the effective capacity of existing facilities

- Use of storage facilities to reduce peak transport needs

- Use of a different mode of transport and/or a different routing of traffic which would serve the purpose at lower cost (see chapter II)

- Changing the location (or even the nature) of planned facilities generating the transport need

- Changing the location of the proposed transport facility

- Modifying the scale or design standard of the proposed facility and providing its ultimate capacity by stage construction over a longer period of years

- A combination of two or more of the alternatives indicated above.

Each of these alternatives implies inputs (costs) and benefits, the latter in the form of an added receipt or an avoided cost. An effort must be made to place a value on each.

Identification and Measurement of Costs

The economic test for transport projects is their contribution to national income or economic development. The preferred measure used for the CPA is the net national rate of return, i.e., the internal rate of return on the project with inputs and outputs valued in "real" terms (General Guidelines, chapter II).

As explained in the General Guidelines, the costs relevant to these economic tests are the resource inputs required for the project. These inputs must be supported by a reasonable engineering estimate of the material, labor, and equipment inputs required for each element of the project during its lifetime. Wider margins of error are permitted in estimates for the CPA than for the feasibility study. However, sensitivity analysis should be employed in order to make explicit the effects of uncertainties on the rate of return, to identify the elements requiring more detailed investigation and to suggest appropriate measures to reduce risks (General Guidelines, chapter VII).

In order for the costs of the physical inputs of labor and material to be added up, they must be expressed in monetary terms and estimated separately for each year of the project's life to permit due allowance for the time value of money. (See the section on discounting in chapter III of the General Guidelines.) In calculating the business enterprise rate of return (BERR), inputs are valued at current market prices.

As explained in the General Guidelines, the calculation of the rate of return to the national economy (NNRR) requires that inputs and outputs be valued in real terms. Where market prices are not available or are not accurate measures of real costs and benefits, shadow or accounting prices must be employed. The economic cost of the capital to be invested in a project is the opportunity cost of capital -- that is, the rate of return to be obtained by marginal capital investments in the country, rather than the particular market rate of interest which the government or other borrower may have to pay under the special circumstances of the project. Unless the internal rate exceeds the opportunity cost of capital, the project is not a profitable one from a national economic viewpoint.

Use of opportunity costs rather than market prices may also be indicated for labor inputs in countries where unemployment or underemployment is extensive, especially if there are legal minimum wage rates.

Expenditures or outlays which do not reflect the cost of economic resources to the national economy (but which are merely transfers of funds within that economy) must be excluded from the computation of real costs to the economy. The most important examples are selected taxes and similar levies, not only those separately stated but also those reflected in market prices; for instance, import duties included in the domestic price of equipment and supplies, or fuel taxes, license fees, etc., included in the expense of motor vehicle operators and therefore in the private cost -- but not in the national economic cost -- of vehicle operation.

Finally, special care is needed to ascertain that all costs inherent in the project are considered. In some instances, execution or operation of a project involves external costs that are not paid by the project, but that are necessary to achieve the project's purpose; for example, construction and maintenance costs of an access road to a port, airport or railway station, or costs of additional equipment needed for road maintenance or for maintenance of increased railway rolling stock. Such costs are included in the NNRR computation, but not usually in the BERR calculation.

Where major elements of cost cannot be estimated with certainty, sensitivity analysis (see General Guidelines, chapter VII) should be applied. If the priority to be assigned to the project is highly sensitive to the uncertain elements of cost, these sources of uncertainty should be identified and considered as candidates for further study.

Identification and Measurement of Benefits

In principle, the valid measure of economic benefits from a transport project is the net value added to the economy's output by the service the transport project supplies. Transport projects may yield substantial indirect benefits through the stimulus provided to economic development. The principal difficulties in measurements of benefits arise from the fact that the benefits of many transport projects are widely dispersed among and within other sectors of the economy that it is only feasible to identify and measure them in an approximate and indirect fashion. The analyst should go as far as he can in trying to quantify specific benefits, but selective judgments are also called for.

Benefits can more easily be calculated for projects whose benefits are not widely dispersed. Benefits can be traced for a transport project designed exclusively or mainly to support a geographically and economically separate economic activity; for example, the development of agriculture in an entirely undeveloped area or of market production in an area limited to subsistence farming, or the development of a mine or an industry in a remote location. In such situations, however, the benefits and costs of the transport project should -- in most instances -- be consolidated with the other inputs required for and benefits arising from the development project.

The majority of transport projects are designed to provide, and most often to improve, transport service for a variety of economic activities. It is impracticable to trace all the consequent net additions to economic output that may be expected to accrue during the life of the transport facility. In these circumstances, benefits resulting directly from the improved transport service must then be used. Most important and most readily measurable are savings in operating expenses and travel time of freight and passengers which accrue to users of the facility (or of alternate existing facilities relieved of congestion). Reduced expenses for facility maintenance may also constitute an important source of benefits. Reduction of accidents and of damage to goods, and improvements in service reliability, convenience, and comfort also may represent real benefits, although they are rarely capable of precise valuation.

All these benefits are directly associated with the traffic served by the proposed new or improved facility. It is assumed that they correspond to benefits arising for the national economy because reduced transport costs presumably will be reflected in lower prices of goods to consumers or higher revenues to producers. Indirect benefits are properly considered, however, insofar as they exceed the mere reflection of direct benefits; that is, when the improvement of transport conditions stimulates additional productive activity.

<u>With-and-Without Basis for Estimation of Benefits</u>

In order to assess each of the benefits directly associated with an improvement in transport service, two estimates must be made: an estimate of benefit per unit of transport service, and an estimate of the volume of traffic to which the benefits apply during each year of the project's assumed life. These annual estimates are needed for comparison with costs because the time pattern of costs and benefits is not the same, and the difference in timing affects the present net value (or net cost) of the project. Derivation of unit benefits and of traffic estimates differs among the several modes of transport and is discussed separately for each mode in following sections.

Benefits for each mode must be measured by the difference between the conditions that would prevail during each year of the project's life with and without execution of the project. That this is not the same as the difference between conditions before and after execution of the project is best illustrated by the example of benefits arising from savings in operating and maintenance costs associated with the improvement of a transport facility (a road, railway, port or airport) which is now serving a volume of traffic approaching its capacity. If this facility is not improved or expanded, growing traffic will result in increasing congestion and rising operating and maintenance costs. If the improvement project keeps these costs down or reduces them, the cost savings during each year of the project's life are measured by the difference between costs on the improved facility and those which would arise in the same future year in the absence of the improvement, not merely by the difference between present and future costs.1/

The with-and-without test applies not merely to the estimates of benefits per unit of transport service but also to those of traffic volume. If traffic increases are expected because of general economic expansion in the project's service area, estimates of future traffic must be derived from gaugings of (1) the current traffic and (2) its prospective rate of increase with and without execution of the project.

Even without execution of the project, increased economic activity will result in larger traffic volumes. The new or expanded transport facility may attract additional traffic from alternate routes or modes and may contribute to the stimulation of new economic activity. Traffic estimates, thus, must be a composite of (1) the traffic currently served and its prospective expansion (sometimes called the "normal" traffic), (2) any traffic diverted from or to the facility, and (3) any traffic newly generated by the availability of improved transport service.

1/ For a more extensive discussion of this important point see Hans A. Adler, "Sector and Project Planning in Transportation," World Bank Staff Occasional Paper Number Four, pp. 45ff.

Where information on traffic volume is available for a sizable number of past years, estimates of future normal traffic sometimes are made simply from the assumption that traffic will continue to increase at the average past rate. This is a hazardous assumption unless it can be shown that the rate of increase in traffic has historically exhibited a stable relationship to the growth in economic activity, and that the historical rate of growth in economic activity can be expected to continue over the period of the projection. Where these relationships cannot be shown and where information on past traffic is not sufficient for this kind of projection, other bases for projection are required. These are discussed in the modal sections.

Estimates of traffic diversion must take account of the fact that the choice of transport mode and route is made mainly by shippers and passengers on the basis of rates, fares, quality and availability of service, and the particular requirements of the consumers of transport services, although transport operators have some limited freedom to modify routing.

Newly generated traffic may add substantially to the benefits of a transport project, but it need not necessarily do so. Although the project may stimulate new economic development which would not occur without it, the benefits from such a development are not entirely attributable to the transport service improvement because many other inputs are also required.

Traffic projections for particular modes, and for components of any single mode, should be made in the light of the anticipated growth in overall traffic demands, in conjunction with an analysis of the transport network as an integrated supplier of transport services. The construction of a new road link or a bridge, for example, can have an important effect on traffic growth on not only connecting roads, but also on the traffic demands on rail and port facilities.

If information on origins and destinations is available -- or can readily be collected -- it can be useful in developing a basis for the "assignment" of traffic, present and projected, to routes and modes that will facilitate the achievement of the most economical intermodal arrangements. This type of analysis can be most useful in appraising the relative merits of transport projects in terms of how well they conform to the expected spatial pattern of demand for transport services.

Economic Criteria

When benefits have been identified and measured to the greatest extent possible and values have been placed on the estimates, the annual value of these benefits should be entered in tabular form, such as that suggested in chapter VIII of the General Guidelines. Together with estimated values of inputs, by years, these data form the basis for the quantitative CPA, in terms of internal rates of return to the enterprise and to the national economy as a whole.

The identification and measurement of benefits from transport projects involve numerous and difficult judgments. Presentation and statistical manipulation of a wealth of data -- or of statistically expressed assumptions in lieu of unavailable data -- are no substitutes for incisive economic analysis. As in other types of projects -- although to a greater degree because of the widespread diffusion of benefits -- CPA's in transport involve more than mechanical computations. At the same time, such computations, based on carefully made quantifications of costs and benefits, provide an essential element in the process of project appraisal.

Divisibility and Timing of Transport Investments

Proposed transport projects often have several separable components. Each of these components should be appraised separately. One component (e.g., one new wharf) may show a high net benefit, or rate of return, and the second component (a second wharf) a much lower or even negative one. Even though the net benefit of the entire project (consisting of two new wharves) may seem satisfactory, only those components that show a satisfactory net benefit by themselves should be executed. Computation of discounted present net values for increments of investment can provide guidance in choosing the most beneficial combination of components in the project (General Guidelines, chapter V).

Stage Construction

Very often, a component which does not show a satisfactory benefit at the time of the CPA may do so at a later stage in the economic development of the country. Proper timing of transport investments may require stage construction; for example, one wharf constructed now, with the second being constructed in 5 or 10 years; or one stretch of highway or railway line constructed at the outset and another after 5 or 10 years; or a lower grade road built first which will be upgraded later. Resulting increases in total construction cost may be far more than offset by the net returns to the capital employed in an alternative project during the period of deferment. Computations of the discounted (at the opportunity cost of capital) net present values for immediate execution of the entire project and for stage construction will provide guidance for selection of the most economical phasing.

Even if the opportunity cost of capital is as low as 10 percent per year (and in most of the less developed countries it is between 12 and 15 percent), a million dollars invested today must return $331,000 within the first 3 years. That amount is wasted if the investment is made 3 years before it is needed. Stage construction can often minimize such waste of capital, either by construction of part of the facility initially and expansion of it later, or by provision of a low-grade facility first and improvement of it when a larger transport demand is to be satisfied.

II. INTERMODAL COMPARISONS

Comparisons of the costs and benefits of meeting identified transport requirements -- present and projected -- by alternative modes are an essential component of the project appraisal. For example, shipments of oil products from a refinery can be accomplished by one or more of the following modes: roads, barges, railroad, or pipeline. Ore may be shipped by road, by rail or by both modes or in slurry pipelines. Selection of the optimum transportation mode or a combination of modes is dependent on several variables. These variables are

- Kinds of products to be shipped
- Expected economic life of the alternative transport facilities
- Other uses for which the transportation facilities can be utilized, e.g., transportation of persons
- Distances for movement
- Quantities of the products to be moved in a given time
- Value of the product
- Impact of the alternate modes on general economic development and national integration.

If the volume of shipments is large and destination points fixed and comparatively few in number, the movement of refinery products from location A to location B may warrant construction of a pipeline. On the other hand, a railroad provides flexibility for movement of other products and passengers, thus providing a viable economic instrument to facilitate the development of a region. Short distances of movement with a diversity of destination points may warrant consideration of movement by road transport on highways, involving new construction or improvement of existing highway networks. Railroads and highways may be used to move other products and provide passenger transportation links.

A simplified form of analysis that can be made for single product movements is shown in figure 1. The unit cost of shipping a product in dollars per unit is measured on the vertical axis, and distance on the horizontal axis. Each of the cost curves represents a different mode, for instance, road transport (A), rail (B), and pipeline (C). A series of equal unit cost points can be identified. Between these points a given transport mode is preferable from a cost standpoint.

Comprehensive analysis must be made, of course, of inter-modal transportation requirements in addition to distance, e.g., size of shipments, total annual volume of traffic, perishability of commodities, and speed. Discussion of these complex relationships is beyond the scope of these guidelines; however, it must be noted that careful analysis must be made and included in support of the mode selected in the project proposal.

In LDC's those transport modes that facilitate overall economic development should be given careful consideration. Thus, a road may be preferable to a railroad link and, in turn, a railroad may be preferable to a pipeline because of the development impacts of these modes. Cost-effectiveness can be utilized in arriving at an assessment of the most economical means of providing the required transport service, including newly generated traffic.

In the search for the least-cost mode for effecting given commodity movements, attention should also be directed to the possibilities of economies (and diseconomies) of using more than one mode for the movement; e.g., a combination of highway and rail transport may provide a lower total cost for the movement than exclusive reliance on either railway or road transport. The economies of road transport in handling small lots over short distances and the cost advantages of carload railway shipments over longer distances must be weighed against the additional costs of transshipments from one mode to another and the (probable) losses from breakage and theft with multimodal shipments.

The choice of one mode over another or a combination of modes should also take into account the costs of distribution associated with the alternatives, e.g., warehousing, storage costs, the costs of capital tied up for longer periods of time in the use of slower modes, etc.

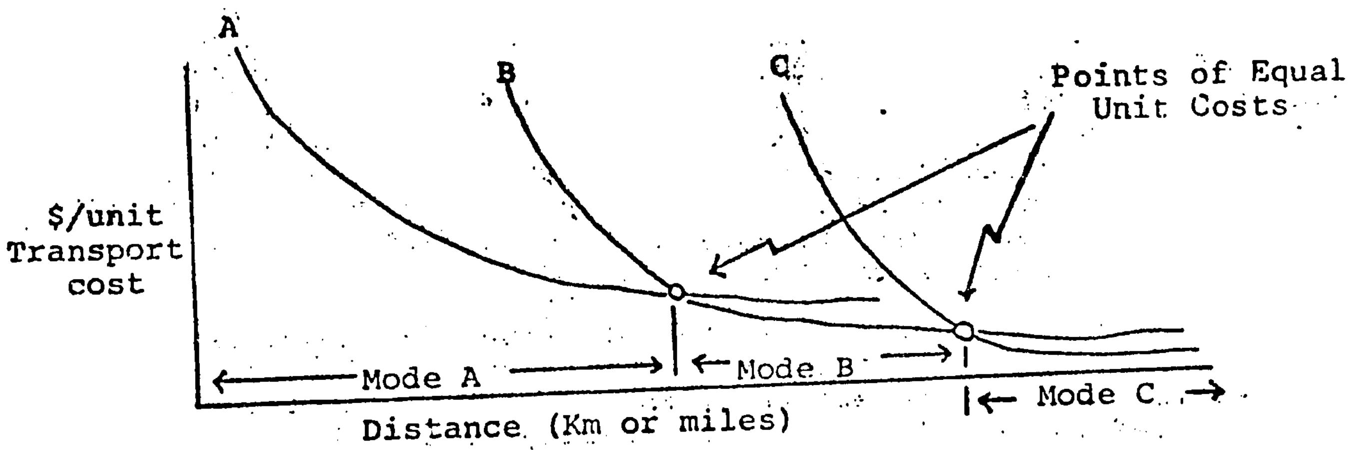

Figure 1. Simplified Form of Analysis for Single Product Movements

III. HIGHWAY PROJECTS

Introduction

Many of the special problems encountered in highway project appraisals arise from the fact that highway facilities are provided and maintained by some governmental entity but are used for highway transport by relatively large numbers of private and governmental operators for a great variety of economic and noneconomic purposes. Economic appraisal needs to take account of both facility investment and operations. Because of the separation of responsibility for these two aspects, substantial research is usually required to collect the necessary data.

The economic justification of highway projects depends crucially on the relationship of the highway capacity to be provided (which determines the investment needed) and the volume and character of the traffic to be served (from which the benefits will be derived). The relationship of capacity to traffic appropriate for LDC's differs from that applicable in advanced economies because of: (1) the higher opportunity cost of capital, (2) the lower labor cost, and (3) the greater uncertainty about traffic development in the LDC.

The CPA for highways -- like other project appraisals -- should include an evaluation of (1) the technical feasibility of the project, (2) the economic costs and benefits of the project, and (3) the financial feasibility of the project. Each of these aspects is discussed in the following sections. In addition, the social criteria concepts outlined in Chapter IV of the General Guidelines should be reviewed in the CPA. The social consequences in regard to the probable distribution of benefits is of particular significance for highway projects, both the traditional user cost savings and the development or penetration road project categories.

Technical Feasibility

While it is physically possible to build a road under most natural conditions, it may be prohibitively costly where conditions are unfavorable. In any case, the costs of construction, maintenance, and repair are heavily influenced by topographic, ground and subsurface conditions. Therefore, the procedures and data employed in site evaluation and the conclusions reached should be examined in the CPA from the standpoint of their influence on the costs of the project.

Site evaluation should include a review of the following factors: (1) topography; i.e., the extent of flat ground and slopes; (2) ground conditions, especially bearing strength and ease of excavation and stabilization; (3) drainage of the surface and subsurface and elevation of the water table; (4) weather conditions, including amount and distribution of precipitation; (5) clearing needs concerning both vegetation and structures; (6) availability of surface and ground water for consumption and construction use; (7) availability of natural and processed construction materials; and (8) interfaces with existing or planned roads and highways.

Topographic maps of a 1:500,000 scale are sufficient for a CPA (although not for design and construction planning) but they should show contours at less than 20-foot intervals, and preferably at 5-foot intervals, to provide adequate information on such features as ravines, low escarpments, rock knobs, and sinkholes. Geologic maps, especially if made on a topologic base, provide general information on the nature of the landscape the character and drainage of subgrades, and the nature of the foundation (distinguishing rock, soils derived from rock and transported soils). This information can be refined by the use of soil maps.

Where the area is not accessible to ground survey parties and map information is inadequate, it may be supplemented or even replaced by clear stereoscopic aerial photographs. The features they show can be interpreted to provide much information useful in arriving at order of magnitude estimates of construction costs.

A more detailed discussion of soil types, the availability of water, and construction materials commonly associated with various types of terrain is presented in appendix A.

Traffic Projections

Traffic estimates are a key element in any highway project proposal. They provide the basis for: (1) determining the highway capacity required, (2) quantification of the benefits to be expected from its utilization, and (3) evaluation of the adequacy of the proposed project. To measure benefits, estimates of prospective traffic demand must be made both with and without execution of the project, as is described in the section for all transport modes. These estimates need to be built up from separate components representing normal, diverted, and generated traffic.

All these estimates must be developed by a combination of experienced judgment with careful analysis of a sizable amount of traffic and economic information. If all of the necessary traffic information has been collected completely and reliably for a few years -- origin and destination data, detailed traffic counts by type of vehicle, purpose of trip, and hourly, daily, and seasonal variations -- the analyst can proceed to relate each of the various traffic components to its economic or social determinant -- such as business or pleasure travel, delivery of specified products, etc. -- and can estimate the prospective volume of each type of traffic on the basis of economic data indicating the probable rate of growth in the relevant economic activity. Traffic not directly related to a specific activity usually can be expected to grow with the income of the relevant group of travelers or consumers, although not necessarily in direct proportion.

But information in the required depth and detail is seldom available in LDC's. The analyst must rely on a generally less satisfactory data base in developing projections of future traffic. Correspondingly greater responsibility, therefore, is imposed on the judgment of analysts preparing and appraising traffic estimates.

There is no substitute for at least a minimum of traffic information which can be provided by classified hourly counts and O/D surveys for a week or two at a few stations. The design of such a minimal survey should be based on a discussion with informed people (local police, highway and other officials, service station attendants, regularly traveling bus and truck drivers, etc.) on the general characteristics and composition of the traffic. After the survey, further interviews with similar sources, and especially with managers of relevant enterprises, should be undertaken to determine how representative the survey period traffic can be assumed to have been. Techniques for traffic estimation suitable for use in LDC's are presented in appendix B.

Preparation and appraisal of traffic estimates cannot be limited to a series of routine statistical procedures. Traffic analysis requires an understanding of each significant traffic stream, its variations and composition, and the economic factors that generate it and those that will affect it in the future. Such an understanding often will reveal alternative ways of meeting the prospective traffic demand in more economical ways.

Design Standards and Highway Capacity[1/]

Economic justification of any highway project depends crucially on the proper relation of the proposed design standards to the prospective traffic demand. Therefore, for the CPA, it is necessary to assess the proposed design standards to ascertain that the proposed facility is neither overdesigned nor underdesigned in relation to the projected traffic demand.

Design standards have many components. Most important are the width and surface characteristics of the traffic lanes and shoulders, horizontal curves and vertical grades, and sight distances. These characteristics determine how fast a given vehicle can safely and conveniently travel over the highway under various traffic conditions and, therefore, also the number of vehicles the highway can accommodate in a given period of time -- i.e., the highway's capacity.

The most extensive and thorough engineering research on the relation of design characteristics to highway capacity has been conducted in the United States. Many of its results are readily applicable to conditions elsewhere, since they are concerned with physical rather than economic relationships.

1/ For detailed tables showing relation of capacity to geometric design characteristics for rural roads and urban streets in LDC's, see appendix C.

It does not follow, however, that the design standards recommended to meet a given traffic demand in the United States are appropriate also for LDC's. Costs of capital are substantially higher in these countries; productivity, on the other hand, is lower, so that both time saving and convenience in highway travel have a lower value. For any given traffic demand, therefore, design standards used in LDC's generally should be lower than those used in the United States.

In relating traffic demand to highway capacity, both composition and timing of traffic need to be considered. The larger the proportion of slower-moving heavy vehicles, the lower will be the practical capacity of a highway of given design; also, the larger the proportion of heavy vehicles, the higher will the design standard have to be to permit the same average travel speed for a given volume of traffic.

Selection of design standards should be made with a view to the possibilities for stage construction. Those basic elements of the road that can be upgraded only at a disproportionate cost, if at all, should be designed for the capacity eventually needed. They include the alignment, especially the horizontal and vertical curvature; the right-of-way; and the earthwork to provide the eventually required roadway-formation width. Elements that should be deferred until the larger capacity is actually needed include part of the pavement width, the shoulder stabilization, and some miscellaneous features such as guardrails, headwalls, fencing, lighting and slope protection. The outlay involved in providing them later will be somewhat higher, but the cost difference will be more -- often far more -- than offset by the saving in capital cost resulting from the deferral.

The significance of savings available from stage construction is illustrated in table 1. The opportunity cost of capital was assumed to be 10 percent, a net saving was found to result from building roads initially

Table 1. Savings Obtainable From Stage Construction

Type of construction	Cost in US$/mile		Net saving c/	
	Amount a/	Present value b/	$/mile	percent
Minor road (up to 400 ADT)				
Initially to full standard	68,300	68,300	-	-
One standard lower for 5 yrs.	73,300	61,100	7,200	10.5
Two standards lower for 5 yrs.	75,600	60,900	7,400	10.8
One standard lower for 10 yrs.	73,300	53,600	14,700	21.5
Two standards lower for 10 yrs.	75,600	51,900	16,400	24.0
Two-lane highway (up to 800 DHV)				
Initially to full standard	107,300	107,300	-	-
One standard lower for 5 yrs.	115,900	98,400	8,900	8.3
Two standards lower for 5 yrs.	120,700	97,200	10,100	9.4
One standard lower for 10 yrs.	115,900	87,600	19,700	18.4
Two standards lower for 10 yrs.	120,700	82,700	24,600	22.9
Four-lane highway (over 800 DHV)				
Initially to full standard	183,000	183,000	-	-
One standard lower for 5 yrs.	219,700	173,500	9,500	5.2
Two standards lower for 5 yrs.	228,200	168,200	14,800	8.1
One standard lower for 10 yrs.	219,700	144,900	38,100	20.8
Two standards lower for 10 yrs.	228,200	131,800	51,200	28.0

a/ The costs first shown above include, alternatively, (1) the amount required for initially constructing the road to the full standard indicated and expected to be eventually required, or (2) the amount required for initially constructing the basic elements to the same standard, but the deferrable elements only to the extent needed for operating the road at one or two standards lower plus the amount required for upgrading to full standard after 5 or 10 years.

b/ The present values shown represent the sum of the initial expenditures plus the present value of subsequent upgrading costs, with the latter discounted to the present at 10 percent per year.

c/ The net savings compare the present value of the indicated type of construction with that of initial construction to full standard.

only one standard lower than those needed, and upgrading them only 5 years later. The saving will be larger where the cost of capital is higher.

Apart from checking for the internal consistency of proposed design characteristics, the CPA should apply two tests: First, the traffic volume for which the road is designed should be compared with the traffic forecast, in terms of average daily traffic volume (ADT) for less heavily traveled roads, and in terms of design hour volume (DHV) for more heavily used highways. This comparison will show whether the traffic volume for which the road is to be provided will be reached within a reasonable number of years. Second, it should focus on the operating speed that is anticipated. Too low a design speed results in inefficient traffic operation; too high a design standard involves a wasteful capital investment.

Construction and Maintenance Costs

Cost estimates for CPA purposes are best provided and checked on the basis of modules. The appropriate module for both construction and maintenance of roads is the cost per mile. Cost estimates per mile, however, are meaningful only if it is clear that they cover all cost elements, are properly related to the characteristics of the project, and are based on reliable information adjusted to reflect local unit prices of materials, labor, fuels and other components in the cost modules.

In order to be complete, estimates must include the costs of (1) planning and design, (2) purchase of the right-of-way, (3) initial construction, (4) subsequent upgrading, and (5) adequate maintenance. The best sources of information on all cost elements are records of recent and comparable experience in the same country. When estimates must be based on other sources, these should be clearly identified and the manner in which original data have been adjusted should be explained. For the purpose of calculation of the IMRR in a CPA, cost data also must be adjusted to exclude taxes and to allow for the application of shadow prices as appropriate. (See General Guidelines, chapter II and appendix B.)

Construction Costs

The cost of construction varies widely, depending on the type of road and on local conditions. The amount of grading required, the width and thickness of the surfacing, the wages paid, the productivity of labor, and the availability of materials all have an influence on construction cost. It is, however, possible to give a general average of the cost for each type of road as constructed all over the world to serve as a general index of cost relationships among road types. Such data are presented in table 2.

Table 2. Average Costs of Constructing Roads in Flat Terrain (Based on or Adjusted to Costs in 1968)[a/]

(per mile)

Type of surface[b/]	Average construction cost per mile of road (24 feet wide)
Sand-clay, untreated	$31,400
Sand-clay, treated	36,800
Gravel, untreated	45,000
Gravel, treated	67,400
Macadam, untreated	67,400
Macadam, treated (secondary roads)[c/]	89,800
Low-cost bituminous mixtures	54,000
Bituminous macadam	110,500
Bituminous concrete (primary roads-medium type)	131,000
Cement concrete	157,000

a/ Developed from Ralph M. Parson Company cost data.
b/ The volume of traffic that can be accommodated by these surfaces will vary according to the geometry of the road. No quantitative value for road capacity can be given when only the surface type is known.
c/ More data on these types of roads are provided in table D-1.

An illustrative set of estimates for several type of roads in varied terrain is shown in appendix D, table D-1.

A number of useful tables indicating order-of-magnitude cost modules in some detail are presented in appendix D. The values shown in these tables are averages which must be checked against local unit prices.

The average prices shown in appendix D, tables D-1 through D-5, have arbitrarily been assigned a location factor of 1.00. Factors for a number of geographic locations in LDC's are indicated in table D-6. These location factors were developed from actual bid experiences and reflect all of the intangibles that account for price differentials between geographic locations. If any of the unit prices shown in the preceding tables are used, they should be multiplied by the applicable geographic cost factor shown in table D-6. In addition to adjustments to reflect country-to-country variation, correction factors for changes in prices should be applied also.

Although the average cost information, percentage composition of costs, and cost differentials associated with location are useful in the CPA, they have severe limitations. It must be clearly understood that the use of such broadly based averages in lieu of reasonably well prepared information on the cost factors prevailing in or near the project area requires a detailed explanation and justification.

Maintenance Costs

Locally based information is even more essential for the appraisal of maintenance costs than of construction costs. Maintenance has a much larger component of labor cost and is almost always carried out by indigenous (usually governmental) organizations with local labor. Records on maintenance expenditures require careful review before their end results can be used because they often fail to include all the costs of road maintenance. Appropriate allowances for depreciation of machinery and equipment used in maintenance, and an allocation of administrative costs, are frequently omitted.

Approximate surface-maintenance costs per mile for various types of surfacings are shown in table 3. These costs are based on values compiled from reports of several highway organizations in the U.S. and in other countries. In addition to the expense of surface maintenance, the total cost includes such items as the cost of maintaining the base and the roadside, the cost of betterments to the road, overhead charges, and the cost of work on drainage structures and snow removal. Such general items will cost from $865 to $1,730 per mile per year.

Table 3. Approximate Surface-Maintenance Costs on Roads

Type of surfacing	Annual surface-maintenance[a/] cost per mile of road (24 feet wide)
Sand-clay, untreated...............	$1,340 to $2,670
Gravel, untreated..................	2,010 to 3,120
Waterbound macadam, untreated.....	2,130 to 3,340
Surface-treated types.............	1,120 to 2,010
Bituminous road mixes.............	888 to 1,520
Bituminous macadam................	667 to 1,360
Bituminous concrete...............	446 to 890
Cement concrete...................	335 to 667

a/ For estimated total maintenance cost, add $865 to $1,730 to these numbers.

In interpreting maintenance costs, it is essential to consider the amount of traffic to which the various surfacings are subjected. For example, the maintenance cost of a hard-surface pavement on heavily traveled highways could be about the same as those for sand-clay roads with very light traffic. However, the maintenance cost per vehicle is much less for hard pavement than for sand-clay.

The Benefit Estimates

Most of the basic issues encountered in the appraisal of benefits from road construction and improvements are similar to those raised by other transport projects.

Benefits (and costs) of transport projects proposed mainly to support a geographically isolated economic development cannot be segregated from the benefits (and costs) of the entire development. The benefits attribute, for example, to an agricultural penetration (or development) road cannot be meaningfully allocated or assigned to the road costs required for the project. The penetration road can only be treated as one interrelated element of the total development project. The emphasis in the agricultural penetration road analysis is the net increase in the value of agricultural output over and above the incremental costs needed to generate that level of output.1/

In the following discussion attention is focused on the quantification and valuation of benefits from road projects designed to provide or improve transport service for a variety of activities already conducted or presently developing in the road service area. The ultimate economic effects of such transport service are widely dispersed, and accrue to those who do not, as well as to those who do, make direct use of the road. In estimating the benefits from the facility, the CPA must be based on the benefits directly associated with the service, notably the savings of expense and of time accruing to direct users of the road.2/ Their expenses are determined by the type of vehicles they use, the load factor, the condition of the road, the terrain, the composition and density of traffic, and the distances they travel. The unit of transport service most convenient for consideration of all of these variables is the cost of operation per vehicle mile.

Since vehicle type is one of the variables affecting road transport cost, operating costs per mile must be considered separately for various vehicle types. At a minimum, a distinction must be made between light vehicles (passenger cars, small buses, and light delivery trucks and similar vehicles usually built with passenger car engines and chassis) and heavy vehicles (large buses, trucks and tractor-trailer

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1/ An excellent summary of the methodology applicable to development or penetration road projects is presented in Chapter IV (Estimating Benefits from Transport Investments) of "Preparation and Appraisal of Transport Projects", U.S. Department of Transportation, June 1968, Wash., D.C. 20590

2/ The direct benefits accruing, in the first instance, to the users of the highway -- particularly for goods transport -- may be disseminated to a much broader segment in the form of reduced costs of goods purchased and/or higher prices for goods produced, made possible by reduced costs of transport.

combinations). There are, of course, differences among light vehicles, but they are not usually enough to be significant. Thus, all light vehicles may be represented by a single one typical of the traffic or, better by a weighted average of two or three types widely used in the service area. Differences among heavy vehicles are substantial, however, and it is desirable to use separate unit values for two or three of these types, provided that traffic information is correspondingly detailed. Otherwise, an average, however, should be based not only on vehicle types actually used in the service area; an effort should also be made to approximate the proportion in which they are present in the area traffic and to apply corresponding weights in computing average unit costs. Special attention must be paid to the proportion of diesel-powered units; it often is significant among heavy vehicles and in some countries also among lighter ones. 1/

The effect of road conditions on operating cost also has several dimensions. Most important is the difference among road surfaces. According to a World Bank Staff Paper, 2/ improvement of an earth road to a gravel road can be expected to save light vehicles 22 percent and heavy vehicles from 30 to 43 percent of their operating expenses; corresponding savings from changing a gravel road to a paved one are 22 percent and from 26 to 37 percent; changing an earth road to a paved one may save 39 percent and from 48 to 64 percent. Less dramatic but still significant cost differences arise from the geometric characteristics of roads. Rise and fall and curvature have some modest direct effect on vehicle operating expense. In addition, these characteristics, together with road width, sight distance and surface condition, affect the speed at which traffic can move and thus the cost of operation.

Operating costs also are influenced by traffic conditions. The most important factor in the majority of LDC's is the composition of traffic: the proportion of heavy vehicles which tend to delay all traffic movement, especially on narrow roads and substantial grades, and the presence of nonmotorized traffic (including pedestrians) which may impede traffic movement even more. In LDC's, traffic volume on most roads (except those in the vicinity of the larger cities) is so low in relation to the capacity of otherwise satisfactory roads that it rarely causes any significant delay.

1/ Widespread use of light diesel vehicles is almost always an indication of preferential taxation on diesel fuel.

2/ Jan de Weille, "Quantification of Road User Savings," World Bank Staff Occasional Paper Number Two. p. 31.

The effects of road and traffic conditions on the running speed and, hence, operating expenses of various types of vehicles has been studied in many countries, most extensively and thoroughly in the United States. Although the published results must be adjusted insofar as they reflect U.S. economic conditions, the underlying physical relationships are generally applicable. The effect of road and traffic conditions on travel speed and consumption of fuel and oil, tire wear, vehicle life and maintenance, and on time consumed in travel are virtually the same in all environments but the most unusual ones (e.g., deserts or arctic wastes). However, the values to be placed on time saved will vary greatly between countries. Prices of vehicles, fuels, tires and lubricants will also differ among countries, and the pricing of the savings in wear and tear and fuel consumption must take local prices for the valuation.

Some studies assign equal values to the time of all drivers and passengers, based on the assumption that leisure time is as valuable as working hours. This view is not universally accepted. Some regard it as unjustified to assign so high, if any, a social value to leisure time in countries with large numbers of unemployed and underemployed persons. The value to be assigned to driver and passenger time saved should be decided in view of local economic conditions and the purposes of passenger trips. It is recommended that the analyst exercise restraint in the valuation of passenger time saved.

Vehicle operating cost data that may be found useful in the absence of specific local information are presented in appendix E.

In addition to the procedures thus far discussed, benefit analysis often is also concerned with travel distance. This may be shortened either by improving the alignment of the road that would in any event be used by the traffic, or by providing a shorter connection for traffic which previously was compelled to use a circuitous route. Especially in the latter case, distance savings may substantially contribute to the cost saving benefits of a project. The full cost of the trip over each route must be computed and the difference multiplied by the number of trips. Comparison of total trip costs is also necessary for computing benefits accruing to traffic diverted from another mode.

Apart from the tangible savings to road users, improved road service provides a variety of other benefits to them and to others, including comfort and convenience. Like the amount allowed for passenger time savings, these are benefits whose social value in developing countries may be questioned.1/ Less questionable is the benefit from reduction of accidents and damage to goods; it is, however, a difficult benefit to measure.

In the assessment of benefits, perhaps the best procedure is that which confines the value estimates of benefits used for the basic justification of the project to those that can reliably be established; other anticipated benefits might be noted and the best estimates of their value provided for use in the sensitivity analysis.

Economic Appraisal

The results of the economic appraisal should be summarized in the form of the computed NNRR; this measure, based on real social costs and benefits, will facilitate comparisons with similar rates for projects in other sectors, and with other transport projects. Other measures may also be computed, if desired, using the same basic data from the tables described in chapter VIII of the General Guidelines.

Financial Feasibility

A review of the road tax situation in the country is also needed in the check of the financial feasibility of the project. Although added traffic generated by improved road conditions will increase the government's revenue from road user taxes, these transfers of funds from road users to government are not a gain for the national economy and play no direct role in the economic justification of the project. They do, however, make it easier for the government to carry the financial burden resulting from the road investment, or at least that part which arises from domestic expenditures. Moreover, the way in which these transfers are effected will influence the use of the facility and therefore the net social gains

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1/ The inclusion of time savings for passengers in private motor vehicles is especially difficult to justify as a real benefit attributable to a highway project in an LDC. Passengers in buses less so, but is also subject to questioning. The technique of calculating time savings, adding up the minutes saved to derive the number of hours and than multiplying the estimated hours by monetary value per hour saved, is conceptually incorrect. Unless there are special reasons to do so, passenger time savings in private motor vehicles should be excluded from the CPA for a highway or road project in an LDC.

realized from the project. The financial analysis also should examine other budgetary resources for covering both domestic and foreign exchange costs and should relate the foreign exchange requirement to the country's prospective balance of payments.

Evaluation Summary

The results of the CBA including noneconomic aspects, as well as the rate-of-return calculations should be summarized for presentation to decision-making authorities. Suggested forms are shown in Appendix C of the General Guidelines.

IV. RAILWAY PROJECTS

Introduction

The basic considerations relevant to all transport projects are applicable, in general, to the preliminary appraisal of railway projects, with due attention to the particular characteristics of railroads. This section is designed to point out the more important of these characteristics as they affect railway projects and the tasks of making appraisals.

Characteristics of Railways and Railway Projects

Railway project appraisal is facilitated by the fact that almost everywhere a single organization is responsible for the provision of both railway facilities and railway operations. In important ways this makes a CPA for railway projects somewhat simpler than for highway projects.

Almost invariably a sizable amount of basic data on railway traffic, operations, and costs is recorded in the course of the railway's daily business. There is also a well-established tradition of periodic reporting and analysis of railway operating results. These reports can be helpful even though their dependability and timeliness vary widely and the traditional forms of reports and methods of analysis do not always lend themselves readily to economic assessment.

Entirely new railway projects are not frequently proposed. More often, railway capital projects involve extension, improvement, or rehabilitation of facilities and acquisition of rolling stock.

The CPA for an improvement or rehabilitation project inevitably will have to consider the physical, operating, and economic condition of the entire system, although the project proposal may be couched in much narrower terms. Most railways in LDC's were built at a time when railway construction and operating technology, as well as economic conditions, were quite different from those prevailing today. Management practices adopted in the railroad's early days in many cases have changed too slowly, if at all, and improvement of the railway's service to the economy may depend on modernization of management and operations as well as on investment of capital in physical facilities. In the examination of alternatives, this possibility merits special attention.

In LDC's many railroads were built before efficient road transport was available. These railroads now find it difficult to maintain their position in competition with road transport, even though that competition in many cases has been impeded by restrictive regulations favoring railroads. Some of these railroads no longer perform a substantial and useful service; new capital invested in their rehabilitation or improvement is justified only if it can be demonstrated that existing and prospective traffic demands can be served more economically by rail than by alternate modes -- usually road transport. It does not follow, however, that railroads generally are outmoded They still are able to provide many transport services at lower cost than trucks, especially in moving heavy bulk goods over substantial distances and with reasonable regularity.

Railroads in LDC's are generally well placed to provide bulk service from production centers for primary products to export points and to consumption centers which have developed in or near port areas. They also can supply local transport service to the areas they traverse if these areas have not been penetrated by the road network. However, as noted earlier, railways constructed to meet the needs arising in an earlier stage of development may not be ideally located to serve the needs of a more highly developed internal economic structure. Nevertheless, while the economic sectors to which railroads can offer the lowest cost transport service may be limited in number, these sectors may continue to be of strategic economic importance.

In most LDC's, projects to upgrade rail facilities, such as installation of heavier rails, signalling and communication equipment, locomotives and freight and passenger cars, will have a very high foreign exchange content. The CPA should take special cognizance of the country's ability to meet the foreign exchange costs, from its foreign exchange reserves, expected current foreign exchange earnings, or from loans. Because of the importance of foreign inputs relative to total investment costs of such projects, the use of a realistic foreign exchange rate in the pricing of the imported inputs is critical. A shadow or accounting rate of the exchange may be required (see General Guidelines, appendix B). Producers of railway locomotives, rolling stock and equipment frequently offer credit terms on the sale of their products. In the financial appraisal, if such terms have been proposed they should be carefully examined in light of: (1) the projected flow of funds available for debt service, and (2) the costs, including interest, of alternative sources of equipment. Favorable credit terms -- extended grace periods, long maturities and low nominal rates of interest -- may be more than offset by excessively high prices charged for the equipment; "free" technical assistance offered in connection with equipment should also be scrutinized for the same reasons.

Technical Feasibility

The physical conditions -- terrain, soil types, drainage, etc. -- affecting the feasibility of the provision of a railway line at reasonable cost are in many ways similar to those applying to highway construction. In an appraisal of the technical feasibility of a railroad project, attention also needs to be given to the technical requirements of operation after construction is completed. These include not only the need for additional rolling stock (which usually must be imported) but also the system's readiness to supply the necessary technical and managerial manpower and to maintain track and rolling stock efficiently.

Design Standards and Capacity

For the purpose of investment analysis, the capacity of a railroad is measured by the volume of traffic that it can handle within a given period and at lower cost than any other transport mode that is available (or could be made available) to serve the same traffic. Cost in this context includes not only the expense of railroad movement itself but also any other cost that will be incurred to supply the transport service concerned (e.g., delivery to and from stations) and, whenever it is significant, the cost of differences in time elapsing between dispatch and delivery.

Numerous physical and operational factors within the railroad system itself affect capacity, and the many interactions among these factors provide opportunities for tradeoffs among them. The CPA analyst may find that construction features which involve a sizable capital investment may be replaced by less expensive modification of other design elements or by changes in the prevailing or anticipated operating practices (e.g. improved couplings to permit longer train units, or better signalling and communications).

Many railways in LDC's are limited to a single track over most of their system. Obviously, capacity would be very sharply increased by double-tracking of an entire line. However, it may be sufficient to double-track a short section which carries especially heavy traffic or to provide more double-tracked passing sections. Where the train control system is outmoded, signal improvement to permit train movements at shorter intervals may be the most effective and least expensive means of providing the required increase in capacity.

The combination of track and signals determines the number of trains that can move over the line in any given time. The same number of trains can move larger volumes of freight, however, if train capacity is raised, which can be done in a variety of ways. Train length in some instances is limited merely by tradition or institutional factors, even though engines with greater motive power already are available or are to be provided as part of the proposed project. Train length may also be limited, however, by the length of existing passing sections, suggesting their extension as a relatively low-cost means of improving capacity. In other situations, steep grades or sharp curves may preclude the use of longer trains or higher speeds; unless such grades or curves are too numerous, an improvement of the alignment may be worth considering.1/

Longer trains may require stronger engines, but very often engine capacity is not fully used. The removal of other

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1/ In constructing a new line, bridges or tunnels can provide an alignment which avoids steep grades and sharp curves. The increase in construction cost that is entailed must be balanced against the increase in capacity and reduction in operating expense.

constraints which preclude longer trains may make the use of such trains feasible without new engines or with the new engines to be introduced as part of the project under consideration. In any event, removal of over-age engines and replacement of steam engines by diesel units are indicated as cost-reducing measures on many railroads and will incidentally increase train movement capacity. Length and capacity of trains are, however, not only functions of engine capacity, but are also affected by other equipment of the trains. Outmoded couplers on freight cars may preclude lengthening of trains, and their replacement by automatic couplers may need consideration. Goods movement capacity, moreover, is determined not only by train length, but also by the size and loading of freight cars.

Thus many physical characteristics of rail line and rolling stock affect capacity. In addition, however, operating methods are an important factor. If freight cars are delayed by slow switching operations or are used by shippers and consignees for unduly long periods for storage purposes, the railway's capacity is impaired. The same is true if engines or cars are idle for extended periods because of inefficient maintenance and repair operations. Inadequate ancillary facilities -- such as switching yards, maintenance shops, roundhouses, warehouses and storage sheds, loading and unloading equipment -- may limit a railway's capacity, and their improvement often is the least expensive way to provide the required increase in capacity.

The foregoing description of factors affecting a railway's capacity, although not complete, should be sufficient to suggest the wide range of alternatives to be examined in the CPA. If a full-scale feasibility study is indicated as a result of the CPA, the preliminary appraisal can make a valuable contribution by narrowing the choices and specifying the critical areas to be examined in the more definitive study.

In summary, the purpose of a CPA is to find the particular improvements that are most likely to yield the highest return -- those that will at the lowest possible cost enable the railway to perform adequately that transport service which, in its service area, can be most efficiently provided by rail.

Construction Costs

The costs of railroad construction, of course, vary widely with local topographic and economic conditions, and cost estimates of any particular project must take such variations into account. It may nevertheless be useful to the CPA analyst to compare estimates with an illustrative cost schedule such as that presented in appendix F, table F-1. Although the data in the table are based on U.S. conditions and prices, it may help the analyst to check if any significant cost element has been overlooked. Prices of manufactured items are apt to be higher if they must be imported. Prices of land and labor, on the other hand, should be far lower in LDC's. However, it is emphasized that the pricing of construction must reflect local conditions. Where there is relevant local experience, the unit prices derived therefrom should be used; if pricing modules such as those shown in appendix F must be used, they must be modified by being adjusted to local prices.

While railway projects will often involve some construction or reconstruction -- improvement of horizontal and vertical alignments, double-tracking, replacement of bridges, expansion of marshalling yards or improvement of ancillary facilities -- most projects will involve, as their important component, equipment. As noted, locomotives, rolling stock, communication equipment and rails must be imported in the majority of LDC's.

For this reason, the pricing of these items can generally be based on quoted (or negotiated) prices in major producing countries. This simplifies the valuation of major categories of imports. The appropriate prices are c.i.f. plus local handling (import duties are included in the calculation of the BERR but not the NNRR).

Operating Cost Problems

Properly focused and factually reliable cost data should be available to arrive at meaningful answers to a number of questions of the following types:

- What kind of traffic can the railroad serve on what routes at a lower cost than other modes such as water or road transport?

- Will proposed investments for rehabilitation and improvement make the railroad competitive for the economic life of the proposed investment?

- Will a proposed extension of line or increase in rolling stock attract sufficient traffic and serve it at low enough cost to yield a rate of return on the investment comparable to what could be earned in alternative investment opportunities?

The cost data needed to answer these and similar questions are difficult to obtain for several reasons. Traditionally, railway expense accounts are maintained on the basis of administrative distinctions between separate departments responsible for maintenance of way and structures, signals, and locomotives and cars, and for train operations, station services, etc. The costs of a particular transport service consequently are distributed among all or most of these accounts. Moreover, and regardless of the system of expense accounting, railway operation involves substantial joint costs that are difficult to allocate meaningfully to particular services. It is equally difficult to distinguish between fixed and variable costs.

The most effective method of obtaining the desirable cost information is statistical analysis. A classic example of an analysis, initiated by Canadian railways and extended to U. S. experience, appears in a widely known study, The Economics of Competition in the Transportation Industries. 1/ Unfortunately, this kind of analysis requires great technical skill, and much time and money. Therefore, it cannot be normally employed in a CPA in an IDC.

Some of the leading concepts of statistical analysis can be employed, however, in analyses of conventional railway accounts to more nearly approximate meaningful cost figures than is otherwise possible. Such analyses will first break up the existing accounts to allocate the expenses recorded in them to operating elements, using such measures of service as train-miles, gross ton-miles, and locomotive-miles or

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1/ John R. Meyer et. al. (Cambridge: Harvard University Press, 1959).

locomotive-hours. Most of these allocations can be made by the use of usually available operating statistics, although limited field studies may be needed for the segregation of some of the accounts. Aggregating the costs allocated to each operating element from all relevant administrative accounts yields a total annual cost and subsequently an average unit cost for that element. Further analysis of these cost elements can distinguish terminal and line-haul costs and, to some extent, fixed and variable costs. Appropriate combinations of the results of these analyses can yield rough approximations of the cost data required. Although rough, such estimates are far better than average costs based on global data (e.g., a railroad's total cost per ton-mile of freight and passenger service combined).

The recasting of conventional railway cost data into a form suitable for economic analysis (and project evaluation) should ideally enable the analyst to answer the following types of questions:

- What costs will be incurred in supplying specified services (movement of classes of commodities or passengers) between specified points? The answers will provide guidance in the assessment of alternative modal splits, and in traffic assignment analysis for the railway.

- What reductions in operating costs can be expected from proposed capital investments? Such reductions reflect one of the important sources of benefits from railway projects; if significant, such cost reductions can influence the intermodal split of traffic, perhaps yielding benefits from relief of congestion and excessive maintenance costs on highways.

- Do rates and fares bear a proper relation to the costs of providing the service? The findings here will enable the analyst to assess the likelihood that shippers will, in practice, choose the least-cost mode, other things being equal.

If such an analysis has not preceded the project proposal, the CPA analyst will have to be wary of any operating cost figures submitted.

Traffic and Revenue Estimates

The assessment of a railway's traffic and revenue prospects are closely intertwined. Not only will revenue depend on traffic, but both will depend on the rates charged to shippers and passengers. As pointed out in chapter I, shippers and passengers select the mode of transport they use, among other things, on the basis of the charges they have to pay. The railroad's charges, therefore, should be generally in line with its cost, so that it will retain (and perhaps regain) the traffic for which it is the lowest cost carrier and will not pursue the traffic for which it can compete only at rates below its costs.1/ Appraisal of traffic and revenue prospects, therefore, must be based on at least some review of the rate structure.

Some statistical information on the volume and composition of traffic is collected by most railroads. Usually, however, these statistics are not as detailed as necessary for traffic projection. For this purpose, traffic should be broken down by type of passenger (short-haul and long-haul, by class) and type of commodity, and the origins and destinations of each of these types of traffic should be known. These statistics may have to be compiled from original records generated in the course of daily operations, such as bills of lading and ticket records. If full information on the traffic of at least the most recent year cannot be obtained, a simile of it may be constructed from whatever aggregate statistics have been collected plus a sample study of one or more short periods (selected and adjusted for known seasonal and other variations), station records, and such other supplementary sources as may be available.

Some classification of railway traffic is an indispensable basis for any projections.2/ Estimates of future traffic must

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1/ For traffic that the railway can serve by using transport capacity which it will have to provide in any event or which it can provide at little additional cost, the incremental cost is the proposed yardstick for the setting of rates.

2/ The analyst should beware of conclusions based on aggregate traffic data. To illustrate: At the outset of a 1967 study of the Malayan Railway, its management, the government and be prepared by applying to each component of the total a growth factor derived from economic analysis of the probable rate of increase (or decline) in the relevant economic activity, with due consideration for probable diversion of traffic from and to the railroad. The prospects of diversion must be discernd from the rate and cost analysis together with the basic trends in modal distribution of transport demand. If rates are in reasonable relation to costs, railways generally can be expected to retain such bulk movements as those of mineral and agricultural products exported in large volume, and of cement, petroleum products and similar cargoes distributed in their service areas. Where a reasonably good road network exists they are not likely to remain competitive with road transport of package goods, especially over short distances. Under these circumstances, they also are likely to lose most of their passenger traffic. These generalizations notwithstanding, local conditions may indicate a less or more favorable outlook for the traffic of a particular railroad, and these local conditions certainly must be taken into account in the appraisal of any traffic estimate.

Assessment of Benefits

The justification of railroad projects has traditionally been made only on the basis of financial analysis: a comparison of the railway's projected revenues with its prospective expenses, including its anticipated capital charges. It is not sufficient, by itself, however, to justify an investment project.

the interested public were most concerned about its loss of traffic during the preceding several years and attributed it to service deficiencies and truck competition. In fact, as disclosed by a breakdown of total freight traffic by commodities, gradual loss of large iron-ore movements due to exhaustion of mines was responsible for the sharp decline in total tons carried and total ton-miles, whereas all other traffic (in the aggregate) had increased faster than GNP and faster than road traffic.

As explained in the General Guidelines, the principal test to be applied in the CPA is the return to the national economy. It must be based on real costs and real benefits, viewed from the standpoint of the national economy. The real costs of a railway project usually are not very difficult to measure. They are determined by adjusting the monetary outlays of the railway enterprise to eliminate transfer payments and to replace market prices by shadow prices where this is indicated (General Guidelines, appendix B).

Valuation of real benefits poses more difficult problems (except for railroads serving a single productive development project and justified as part of that project). Because of the wide dispersion of benefits from improved transport service, the benefits that can be measured are mainly the differences in social cost of transport with and without the execution of the project. These differences may arise either from lower costs of handling traffic that would be carried by the railway in any event, or from providing rail service for traffic that otherwise would have to be served at higher cost by road transport (or perhaps even air service).

The estimates of the railway's share in the traffic for which it competes with other modes must be based on the charges payable by shippers and passengers, as has already been pointed out. In contrast, the benefits accruing to this traffic must be estimated on the basis of real costs. Where the railway can serve traffic with existing capacity at small additional cost, the incremental cost is the relevant measure. But traffic that can be served only because of the proposed capital investment has to share the cost of that investment. The cost of serving it must be compared with the cost of the alternative mode of transport. The benefit estimate thus requires knowledge of the cost of road or other transport modes.

Where the railroad enterprise itself (or perhaps another government agency) provides some road transport service and maintains adequate cost records, these records may supply suitable cost data for road transport or at least a basis for cost estimates. Otherwise, road transport cost information may have to be collected in the same way as that for highway projects (chapter III). If trucking business in the area is reasonably competitive, however, it may be justifiable to assume that trucking rates charged to shippers are a fairly good reflection of the trucker's private costs. In this case, they need only be adjusted to eliminate components which do not qualify as social costs, such as taxes and estimated profits over and above a rate of return adequate to attract the required investment. The opportunity cost of capital (see General Guidelines, appendix B) may be taken as the required rate of return.

In comparing rail and road transport costs, allowance must also be made for differences in service. Unless the rail service is provided from door to door (e.g., from a siding at the point of production to one at the port of shipment or the storage place in the city, or vice versa), the cost of transport to and from the railway station must be included with the rail cost. If there are any ascertainable differences in packing requirements or in damage risks, these also should be taken into account. The cost of slower service for those goods where speed of delivery is of significant value is also a relevant item in the comparison.

In addition to benefits arising from reductions in service costs, railway rehabilitation and improvement projects often are expected to yield reductions in maintenance expense. The recognition of these as project benefits is appropriate in the computation of national economic benefits, but only to the extent to which social costs rather than private railway expenses can be reduced. The railway's saving in maintenance expense may stem largely from the discharge of unskilled labor. Unless these workers are productively employed elsewhere, there is little gain in real benefits, although from the standpoint of the railway's financial costs there is a saving.

Benefits from accident reduction may be more readily measurable on railways than on roads, since the railway is apt to have records of accidents and their effects so that cost estimates can be made. These benefits can be substantial, especially when improvement for safety's sake of accident-prone lines or operations is a purpose of the project.

The Overall Project Appraisal

When best estimates of costs (inputs) and benefits (outputs) have been derived -- or when the accuracy, completeness, and reliability of such data put forward in the project proposal have been confirmed or modified -- the analyst is in a position to employ the procedures for determination of net rates of return expected from the project. The project should be evaluated from the standpoint of: (1) the railway project as an enterprise, and (2) the railway project's contribution to the national economy. These concepts are distinguished in chapter III, and computations for each are illustrated in chapter VIII, of the General Guidelines.

An accurately computed internal rate of return to the national economy, based on adequate data and adjusted accounting prices where appropriate, is the recommended measure on which to base a judgment of the economic merits of the project. However, other (than economic) considerations may enter in at the level of decision-making, e.g., the military advantages or the vulnerability of the project, the government's commitment to the redress of regional imbalances in economic development, etc.

Where such noneconomic considerations enter, the quantitative appraisal in terms of an NNRR provides a useful means of calling to the attention of the decision-makers the real costs to the economy that are involved in the selection of projects on other than their economic merits.

V. PORT AND WATER TRANSPORT PROJECT APPRAISALS

Introduction

In principle, water transport project appraisals do not differ from those for other transport projects. The CPA should be concerned with the same basic considerations described in the General Guidelines and especially to those applying to all transport modes (chapter I). Still, there are particular factual and conceptual problems which stem from the special characteristics of water transport. These are the subject of this section.

Ocean Shipping

While the development of rail and road transport technologies have sharply narrowed the range of commodities and the areas in which inland and coastal water transport can compete economically, intercontinental cargo traffic is still predominantly waterborne. The only practical alternative -- air transport -- is technically and economically limited to commodities of high value and small bulk for which transport time is critically important, e.g., cut flowers, perishable foods, highly styled apparel, electronic components, etc.

By far the largest part of sea transport is carried out by private and generally competitive enterprises. Even where shipping is conducted by government-owned fleets, such operations are generally conducted by semiautonomous agencies following basically commercial practices.

Yet, whether operated by private or public enterprises, shipping services depend crucially on ports, and these today are almost universally provided by public agencies. They are the object of most CPA's concerned with water transport, and the following discussion is therefore devoted to the appraisal of port projects.

Appraisal of Proposals for Ocean Ports

The growth of sea traffic and the changes in ship technology tend to require improvement of ports almost everywhere. In LDC's, moreover, accelerated economic growth and changes in the structure of the economy often create new and increased transport needs that require improvement of even those ports which were adequate for the traffic of only a few years ago. Finally, many local areas previously served through a more distant port, or through one in a foreign country, desire to have their own port or to attract direct overseas shipping to ports which thus far have been used only for coastal service.

Physical Feasibility

Whatever the reason for the proposal, the first issue to be faced in the CPA is the suitability of the physical characteristics of the location of the port project. Development of a new port or upgrading of a small existing port to a full-scale ocean port will result in wasteful capital investment if the location does not permit satisfactory operation, attract a sufficient volume of ship traffic, and leave room for future expansion. A considerable variety of physical and economic factors require attention. Among these are

- The depth of water in approach channels and at the site of the proposed wharves

- The amount of dredging necessary to establish and maintain the required depths, based on the anticipated types and sizes of vessels that will use the port, and known or estimated rates of siltation

- Hydrographic and meteorological conditions -- currents, rainfall, wind velocities and prevailing directions, and other factors affecting movement of vessels on and off the berths, handling of cargo, protection of cargo, etc.

- Topographic conditions onshore and offshore, as they relate to land transport links, storage facilities, ease of access to the port, and protection of vessels from storms while in port.

Most LDC's can justify only one or a few general cargo ports. It is essential, therefore, that port location be carefully examined so that ports will be located where construction and maintenance costs can be minimized and interconnections with land transport modes can be made efficiently. Alternative locations should be considered, even for proposals put forward to expand or improve existing facilities.

Proposals to upgrade local ports -- used in coastal shipping or as home ports for fishing fleets -- must be examined with a critical eye not only with regard to the natural constraints, but also with regard to the suitability of the location with respect to the land transport network, to major ocean shipping routes and to the traffic generating centers in the country. While the lack of an ocean port may impose a critical constraint on development, provision of a port does not guarantee a more rapid rate of development in its hinterland.

The Role of the Port in the Transport System

The hinterland, or service area of a port, is that region or area which receives its imports and dispatches its exports through the port. The limits of the area are set, in general, by the total private costs of transport between the port and inland origins (for exports) and destinations (for imports), relative to the costs to and from alternative ports.

Projects to improve the operation of a port require evaluation regarding the effect of the proposed improvement on the transport network in which the port is a link. If, for example, the critical constraint on movement through the port is in the road and/or rail links of this network, a capital investment to improve port operations will yield greater benefits if accompanied by improvements in the more critical links of the network, i.e., highways, road and/or rail transport.

Even more crucial than the interaction between port and land transport operations is the influence of port service on the cost of sea transport. Except for fuel consumption, virtually all the costs of ship operation are the same for a day in port as for a day at sea, and the added cost of loading and unloading is a high proportion of the total cost for most general cargo. That total cost, therefore, is sharply raised when the ship must wait until a berth becomes available or is delayed in port by slow loading. Moreover, cost-reducing application of modern ship technology involves high capital investment which can be made to pay off only if the share of voyage time spent in port is limited; hence, the less efficient the ports on a trade route, the less likely is the introduction of modern, cost-saving vessels by the ship operators.

Estimation of Capacity Requirements

The basic steps in estimating the capacity requirements for a port are not essentially different from those used for other transport facilities. There are, however, factors that complicate the translation of estimated tonnages into physical requirements (number, size and types of berths, storage and transit sheds, and handling equipment). These complications arise, in part, because of the uncertain spread of containerization, the rapidity with which ship size is increasing, and the possible use of LASH vessels, as well as the differences in types of general cargo, the balance or lack thereof between imports and export tonnages, the quantities of cargo loaded and/or offloaded per vessel, and other factors.

The following factors should be examined, in roughly the order noted, in the estimation of the required capacity:

- The hinterland of the port should be established, based on the existing or proposed land transport network, relative costs of land transport, and the location of alternative land-sea links.

- Traffic generating economic activity in the hinterland should be projected by major commodities for export, and the demand for imports by type of goods should be estimated. Some historical data on exports and imports will generally be available, although these will require supplementation by other information in the projections, e.g., government policies to restrict imports and/or encourage exports, the projected rate of growth in income and population in conjunction with "propensity to import," and planned structural changes in the economy of the hinterland.

. Total annual projected tonnages should be broken down to reflect irregular movements through the port attributable to seasonal variations in production or demand, irregular calls by vessels, land transport bottlenecks, and predictable weather patterns (such as monsoons) that may disrupt the even flow of goods through the port.

. Given projected annual tonnages and at least a rough estimate of seasonal peaks, the next step is to translate the traffic into physical facilities required. As suggested above, this is a difficult and complex undertaking. No complete list of specific factors to be provided will be applicable in all appraisals, but the following are among the variables to be considered:

-- Type of major commodities. Bulk commodities (e.g., grain, ores, coal, POL, fertilizers, cement) require different and preferably separate port facilities than those suitable for general cargo.

-- Size, frequency of call and loading and unloading equipment on shore and on vessels.

-- Typical tonnage per shipment.

-- Working days per year and shifts per day.

-- Efficiency of port management and longshoremen.

-- Customs procedures for clearance of imports and exports.

-- Availability and utilization of lighters for loading and discharge of cargo to private jetties.

-- Containerized (and pelletized) cargo as percentages of the total.

The influence of these and other variables on the number, size and types of berths, storage space and other onshore facilities must be assessed. In the absence of more specific information, an estimate of 1.0 to 1.2 tons of general per linear foot of wharf per day can be used to arrive at a rough measure of required capacity with no containerization.

There is obvious need for port improvement when berth capacity is no longer sufficient to accommodate ships promptly, and even more need when growing transport demand indicates that more ship calls will be made and port capacity must be increased to forestall costly ship delays. It does not necessarily follow, however, that the increase in capacity must be achieved by providing more berthing space. Frequently, improvements in port operations are a realistic alternative to heavy capital outlays for expanded physical facilities.

Cargo handling can be accelerated in a variety of ways. Mechanical handling equipment may pay off by saving ship time even where the labor cost of manual handling is low. Adequate and uncluttered space for moving cargo and vehicles at shipside, in transit sheds, and throughout the port area also can accelerate cargo operations; the spatial organization of the entire port area therefore deserves as much attention as the berth capacity.1/ In most LDC's, moreover, the least expensive way to increase port capacity is the introduction (where it is not already in use) of a second and, at least during peak periods of traffic, a third shift, even though shift premiums will have to be paid.

To assess what port functions need improvements in operations and facilities, a check on the timing and costing of inward and outward typical cargo movements may reveal the performance of each link. On inward cargo, e.g., a systems analysis should evaluate the relative adequacy of berthing space, cargo-handling equipment, warehousing facilities, and the inland transport network. The ultimate destination of cargo movements should be specified to distinguish transit

1/ Special loading and unloading facilities for both dry and liquid bulk cargo should, if at all possible, be located away from general cargo ports, especially if the industrial plants dispatching or receiving the bulk shipments (e.g., petroleum refineries, cement factories, power plants, flour or sugar mills, etc.) can be erected elsewhere at tidewater.

cargo from other cargo movements. The number of port charges, the customs procedures, the degree of security and the record of labor irregularities also should be looked into. As a first indication of a port problem, the existence of liner surcharges may be ascertained. On the inland transport side, excessive and recurrent demurrage charges may indicate congestion, but may also result from imbalance between rates for use of railroad cars and charges for warehousing.

The CPA for a port project thus has to pay attention to many operational aspects, not merely to proposed construction. All of these aspects need to be considered in the light of the special network role of the port in the transport system, its function as a link between sea and land transport. The trade-offs in terms of discounted values of costs and benefits can be evaluated by means of the techniques described in Chapter V of the General Guidelines.

The Special Case of Container Operation

Provision of port facilities to accommodate container service requires large capital investments and a lead time of several years. Since it may affect the layout of the entire port area (or an important section of a large port), there is a strong tendency to include preparation for container service in almost every port improvement project. Yet there still is great uncertainty as to when, if ever, container service will actually reach many of the ports in LDC's, what form it will take, and how much cargo it will move.

Certainly, some years will pass before the probability of one or another kind of container service to many ports in LDC's can confidently be estimated. The very costly port facilities needed for full-fledged container service may never be used at many of these ports. These facilities include large wharves with special lifting gear and high bearing capacity for the vehicles carrying large and heavy containers to and from shipside, plus sufficient backup area with the same bearing capacity for maneuver, as well as storage sheds where containers can be stuffed and broken up. Less costly facilities are needed for more limited occasional container service, especially if only smaller containers are used.1/ Stage construction also may be employed to provide for all possible future needs while reducing, at least to some degree, immediate capital investment.

1/ Virtually all containers are 8 feet wide and high, but their length ranges from 10 feet to 34 feet and their weight varies correspondingly.

Pricing Port Projects: Inputs

The costs of construction for new ports, or additions and improvements to existing ports, will require engineering evaluations to determine such quantities as:

- The volume (and composition) of dredging, and the nature of any work required to clear approach channels

- Depth and quantity of piling, and the nature of the subsurface strata

- Amount of fill, grading and land preparation required for the port area

- Number and size of transit sheds, storage buildings and other structures

- Estimated quantities of materials for wharves, roads, and other surfaced areas.

The unit prices applied to these physical inputs should be based insofar as possible on local experience. In the absence of such data, prices in other countries can be used, with adjustments to reflect local conditions insofar as data permit. Since most of the equipment and some of the materials used in port construction will be imported, c.i.f. prices will be appropriate for application to a substantial part of total inputs.

Economic Assessments of Port Projects

Port projects have traditionally been justified by a purely financial analysis in which prospective costs were compared with estimated revenues of the port agency. This is not entirely satisfactory for the economic justification, even if port revenues are reasonably related to the benefits accruing to port users. In fact, the complex schedules of charges to ship owners, shippers, consignees, and other incidental users of port facilities almost everywhere are products of history, modified from time to time but poorly related either to the benefits of port users or to the costs of the port agencies.

The principles of economic assessment of port projects require a better measure of benefits to the national economy.

The principal purposes of port improvement are to facilitate maritime service and to reduce its cost by making cargo handling more efficient and by shortening the time ships must spend in port. It is not difficult to measure the time saved by ships when port improvement eliminates a need to wait for a berth or to wait for the proper time to enter a port with limited access. The efficiency of cargo handling and the value of ship's time, however, depend on the design of the ship (the speed, the number and location of hatches, the arrangement of decks, etc.) and many elements of the voyage schedule, such as the distance between terminals, the number of intermediate ports and the circuity involved in reaching them, the volume of cargo available in both directions at each port, the nature of the cargo and the consequent revenue per unit of weight and space.

The most practical measure of port improvement benefits to ship operation is that based on the assumption that there will be no change in ship type or voyage pattern and that the port time saved can actually be used to speed the entire voyage correspondingly and to reduce operating costs by the appropriate multiple of daily ship's cost.

In estimating the saving in ship time, the CPA analyst will have to recall that benefits are to be measured with and without execution of the project. Consequently, the ship time saved will be the difference of port time needed to handle the cargo volume expected in each future year under consideration when the total number of ship calls is apt to be larger because of growing traffic demand and when waiting time per call is apt to be increased if port capacity is not enlarged. Demurrage charges which can be avoided with the project, but which can be expected to increase without it, are a major benefit of projects to reduce congestion. The benefit estimate, of course, will also take account of any effect of the port improvement on the cost of cargo handling and the cost of inland transport, if such effects can be confidently anticipated. In addition, any clearly expectable savings of the port agency in operation and maintenance of port facilities will have to be considered.

This method of estimating benefits presupposes that savings accruing to ship operators will be passed on to the national economy. The validity of this assumption is clouded by several characteristics of the general cargo shipping business.[1] Most general cargo moves in cargo liners, and the operators of these ships on most trade routes are organized in liner conferences. Although the restraint on competition exercised by such conferences is not as strong as may appear at first glance, the adjustment of conference rates to savings in a given port will not be forced by actual competition unless the port is also served by independent operators (on each of its major trade routes if there are several). If this is not the case, pressure from interested shippers and government agencies may achieve the reflection of cost savings in freight reductions, especially if both the available cargo volume and the savings due to port improvement are large enough to suggest the possibility of new service by conference outsiders. Until freight reductions are achieved, however, most of the benefits from port improvement will be captured by the ship owners, who are apt to be mainly foreign interests. The national economy then will benefit only to the extent to which the higher profitability of ship operation increases the ship owners' interest in providing good service at the port.[2]

Rates of Return and Evaluation Summary

Internal rates of return should be computed from both the enterprise (port authority) and national economy points of view. Accounting or shadow pricing should be employed in the circumstances described in the General Guidelines in the computations designed to assess the project's benefits to the national economy. The wide range of measures available to increase effective port capacity -- some of which require heavy investment, while others do not -- will make the particular measure that is recommended sensitive to capital cost and availability.

1/ Although tankers carry approximately half of all maritime freight and other bulk carriers about half of the remainder, they are disregarded here because these guidelines deal only with the appraisal of investments in public transport facilities, and bulk carriers are usually served by private installations, especially in LDC's.

2/ Some possibilities may exist for adjustments in port charges in such a way as to increase the share of benefits from port improvements accruing to the national economy.

Suggested forms for the rate of return analysis and topical outlines are shown in chapter VIIIof the General Guidelines.

Inland and Coastal Water Transport

Inland and coastal water transport now tend to be of limited and declining importance. Nonetheless, inland and coastal water transport continue to play an important role in the transport networks of more, as well as of less, developed countries. Although the vessels engaged in this form of transport are not generally the object of projects involving the public sector, works to improve and maintain facilities for inland water transport (e.g., dams, locks and navigational aids) may be provided at public expense. In some respects, the economic and financial considerations involved are analogous to those arising in highway appraisals, for in both, the government provides facilities that are used by predominantly private carriers. Thus, user charges may be applied to recover -- at least in part -- the costs of providing such facilities.

Water transport on rivers or lakes and along ocean coasts is still the principal means of transportation for people and goods in areas where road construction is extremely expensive because of topographic conditions or is uneconomic because of low population density and productivity. It merits at least an exploratory consideration by the analyst, for it may well be the most efficient means of providing better transport service for an area where an unduly expensive road project is proposed. Motorized craft suited to the particular physical conditions and traffic needs may provide a satisfactory solution and may require far less capital than a road.

Inland and coastal water movement also remains an economic mode of transport for liquid and dry bulk cargoes, even in areas where road or rail service is available and even in highly developed countries. Such bulk movements usually are private or quasigovernmental operations of the enterprises concerned with the goods (petroleum, mining, cement companies, marketing boards for agricultural products, etc.). While the craft engaged are generally privately owned, government expenditures on maintenance of waterway facilities may be involved. In any case this mode should be considered as a possible alternative when

..oad and rail projects are analyzed that might compete for the same traffic. Where water movement can be used from origin to destination, and where speed of movement and perishability are not important considerations, the lower cost usually attracts the traffic.1/

In the evaluation of inland and coastal water transport, it is generally possible to restrict the analysis of benefits to those associated with the movement of a fairly narrow range of (bulk) commodities between a limited number of origin and destination points.

1/ Coastal shipping of general cargo may perhaps also be revived in some areas if container service is divided into long-haul operations between major ports and short-haul service between major and satellite ports. See the section on container operation.

VI. AIR TRANSPORT

Introduction

This section contains brief discussions of major factors to be considered in CPA's for: (1) airports, including ancillary facilities, and (2) aircraft. While air transport accounts for a relatively small fraction of total passenger-miles and ton-miles of cargo traffic, it is the most rapidly growing form of transport, and therefore a relatively large number of projects are proposed in this area.

Airports

The physical requirements for airports are largely determined by the number, size and operating characteristics of the aircraft using the facility; the number of passengers and cargo tonnages; and the range of ground services offered by the airport.

The first step in the appraisal of an airport project is the assessing of the suitability of the proposed site. The principal factors to be considered are:

1. Characteristics of the terrain and size of area available. Airports require comparatively large areas of reasonably flat land, and a larger area free of high obstructions, natural or man-made. Soil requirements for runways, taxiways, and aprons are essentially the same as for heavy-duty highways. The area should be free of serious drainage problems and should provide adequate space for passenger and cargo terminals, service facilities, restaurants, shopping and parking. The total area required must be determined on the basis of traffic forecasts.

2. Location. A compromise is usually required in the choice of location. Although it is desirable that airports be located close to the population centers they are to serve in order to minimize travel time and distance from the airport to origin and destination, other factors must also be considered, including:

a. Heavily populated areas, which must be avoided in approach and climb-out areas

b. The location of other airports and their approaches, which is likely to be of less importance in LDC's than in highly developed countries

c. Pollution, noise and air

d. The cost of land, which is likely to be more expensive in areas close to cities

3. Airspace requirements.

As the size of planes and noise levels increase, airports tend to be located at a greater distance from the centers they serve.

3. Access. Ease of access for motor vehicles must be readily available or must be provided in conjunction with the airport project.

4. Zoning. To prevent encroachment on future space required for expansion, and to prevent the erection of structures that impair approaches, it is important that the areas surrounding the airport be zoned.

5. Length of runways and bearing strength. These must be determined on the basis of the characteristics of the aircraft expected to use the facility, the elevation, the length of the longest nonstop flight of planes taking off from the airport, and climatic and weather conditions. Standard runway requirements under varying conditions are available for most aircraft.

6. Navigation and communication equipment. Requirements for these facilities will again depend on the type of aircraft and the projected number of takeoffs and landings per hour during average peak periods, and under IFR conditions. If the airport is to serve traffic at night, the requirements will be higher than if it operates only during daylight hours. Also, if the airport is to serve major international routes, navigation and communication requirements will have to meet standards for this type of service.

In most LDC's there will be only one or perhaps two international airports. Other airports in these countries may range from the cleared-strip class to fully developed airports capable of accommodating small and medium-sized jet craft.

Projecting Demand

Air transport is the fastest and generally most expensive form of transport. Its use, even though subsidized, is therefore restricted to a relatively small segment of the population for whom time is valuable and for whom the higher cost of air travel is permitted by their relatively high incomes. Cargo transport by air is usually restricted to commodities having high value in small bulk and/or requiring speedy transport because of their perishable nature, e.g., cut flowers, style goods, seafood, electronic components.

These characteristics do not, at first glance, suggest a high level of demand for air service within LDC's or to and from other countries. Nonetheless, air transport is important in many LDC's for both objective and subjective reasons.

The fact that the amount of time saved by air transport increases with distance and with the degree of difficulty encountered by ground transport may justify, on objective grounds, the use of such transport in LDC's. Travel to areas that are remote either because of distance or difficulty of access may, as a practical matter, depend largely on air transport. Subjectively, air service is valued highly as a symbol of progress and of status in the community of nations.

Both physical and socioeconomic (e.g., government colonization plans, if any) factors need to be considered in projecting the demand for air transport. The assessment of these factors is facilitated if it is remembered that the value of time saving must justify the high cost of air service. It follows that, other things being equal, internal air service is more useful in a large territory than in a small one. If the more densely settled regions within a large territory are separated by thinly populated areas, air service may in fact satisfy a transport demand at a lower total cost than would road or rail service, which would require large investments to carry it through long stretches where there would be no local traffic.

The same advantage of air service may be present even in a territory that is not very large if settled or to be settled areas are separated by topographic conditions that make road construction inordinately expensive or unrewarding: Large virgin forests, high mountains, deserts, extensive bodies of water or swamps may create conditions under which the use of air transport is indicated even for relatively short distances. Where no such conditions prevail, short-haul air transport is not likely to be cost-competitive once reasonably good road transport becomes available.

In projecting future demand for air transport, it is useful to develop separate estimates for each of the following components, as each is likely to be influenced by different growth determinants in LDC's:

- Commercial passenger traffic:
  - -- Government officials
  - -- Businessmen
  - -- Individuals, normally in the upper income brackets, traveling for personal reasons
  - -- Tourists, local and international
- Cargo traffic, by major categories of commodities or industries served
- Demands by owners of private aircraft, used for pleasure or business
- Military requirements as they affect joint civilian-military facilities.

The first and second of these components will be relevant for the appraisal of proposed aircraft acquisitions, as well as for airport projects; the third and fourth components of demand are relevant only in the appraisal of airport projects.

Projections of demand by the various types of passengers should be based on:

- Projected increases in personal incomes
- Anticipated growth in the nonagricultural sectors of the economy, by service areas

- Assessment of the country's potential for tourism, both as a destination point and as a stop-over for regional destination points. These factors can influence the demand for domestic as well as international air service

- Government policy with respect to official air travel.

In projecting levels of future demand for domestic air transport it is important to assess -- insofar as possible -- the pent-up demand, that is, the extent to which present use of air transport is limited by the available capacity of planes, or by the lack of airports in potentially lucrative origin and destination points.

Where some data on domestic traffic between existing airports are available, the potential traffic on proposed routes may be estimated by use of the "gravity model" explained in appendix B. Although this technique was developed to estimate interzonal trips by road, it can also be applied for air travel, with appropriate modification of the coefficients.

Given estimates of the number of passengers and cargo tonnage enplaning and deplaning at each airport, the estimates must be converted into plane arrivals and departures. The conversion will require forecasts of seat capacities of planes to be used, load factors and frequency of service. These projections must obviously be made in conjunction with the planned composition of the aircraft fleet.

Pricing of Airport Projects

The pricing of airport projects presents no special problems; the procedures -- modular pricing adjusted for local price differentials, shadow pricing where appropriate, and separation of foreign exchange and local currency costs -- described in the General Guidelines are also applicable to airport projects. Major components for which order-of-magnitude cost estimates are to be prepared include:

- Land acquisition costs or annual rental value and costs of site preparation

- Engineering and design costs, usually involving a heavy foreign exchange component

- Runways, taxiways and aprons

- Access roads, driveways and parking areas

- Hangars, aircraft service buildings, fire and rescue facilities

- Passenger and cargo terminals, including space for restaurants, shops, customs facilities and possibly hotels

- Utilities: water, telephone, electric power, sewerage and drainage

- Fuel storage and service facilities

- Fencing, landscaping, blast protection

- Communication and navigation equipment

Measurement of Benefits

The time saved by passengers, and the shippers and consignee of air freight, constitutes the source of the benefits of air transport. A meaningful valuation of these benefits in a form suitable for use in computation of standard measures of economic feasibility is extremely difficult, particularly in LDC's.

The prospects for the computation of a meaningful measure of financial feasibility are somewhat more promising. Airports, at least major ones, are usually operated by semiautonomous bodies, so that expenditures and receipts attributable to its operations are identifiable. Major sources of revenues include:

- Landing fees, servicing charges, storage charges and other receipts from airlines

- Airport exit "taxes" paid by passengers

- Admission fees to observation decks paid by airport visitors

- Rental receipts from concessionaires occupying terminal facilities

- Income from use of land areas reserved for future expansion

- Government subsidies.

Although the ultimate benefits of the time saved by air travel are difficult to value, the monetary costs of delays to aircraft operators and passengers have been computed for airports in the New York area. These are shown in table 4.

Table 4. Estimated Cost of Delays to Aircraft Owners and Passengers

(dollars per minute)

Delays	Kennedy Airport	LaGuardia Airport	Newark Airport
Commercial carrier arrivals..	$14.13	$11.18	$10.24
Commercial carrier departures	9.38	7.28	6.34
General aviation arrivals....	1.30	1.36	1.38
General aviation departures..	.80	.86	.88

Source: A. Carlin and R.E. Park, _The Efficient Use of Airport Runway Capacity in a Time of Scarcity_ (Santa Monica, California: The Rand Corporation, 1969), Table D14, p.206.

As congestion develops or is anticipated, the appraisal of projects to expand airport capacity can be appraised in terms of savings in time (due to reduced delays) and thus in terms of reduced costs. The techniques useful in the estimation of the value of these savings are essentially the same as for road transport and for the reduction of delays for vessels in ocean ports.

Two elements are involved: the value of the reduction in aircraft operating time, including the cost of the crew, fuel, and lost bookings attributable to delays; and the value of time lost by passengers. As suggested in connection with the measurement of the value of time in road transport, restraint should be exercised in placing a value on passenger time saved by the avoidance of delays.

The establishment of a new airport may also require assessment in terms of its role in the general economic development of a region or service area. Suggestions made elsewhere in these guidelines are relevant in such cases.

Selection of Aircraft

Once the general magnitude of prospective traffic has been estimated, the appropriate type of service must be matched to it. The volume of traffic that can be handled depends on two factors: the size of the aircraft employed and the frequency of trips made. Generally, the larger and faster the aircraft, the lower is its cost per available seat-mile. However, the cost per passenger-mile depends heavily on the proportion of potentially available seat-miles actually utilized; that is, on the ratio of actual to potential aircraft service time and on the ratio of occupied to available seats (the load factor).

As a result, few internal routes in LDC's justify the employment of even the smallest of the modern jet aircraft. These aircraft have the lowest cost per available seat-mile, but they provide far more seat-miles per day than the traffic is likely to utilize. Capability of airports to handle jet aircraft is also a constraint.

Although the more heavily traveled internal routes will require the use of turboprop equipment (available in various sizes), still smaller and slower propeller planes (also available in various sizes) will suffice where prospective traffic volume is light, important as it may be. In assessing the characteristics of different types of aircraft, it is necessary to recognize that the cost of necessary ground facilities rises when larger and faster aircraft are employed. Although smaller planes are slower, their speed advantage over ground transport is still large, especially where the need for air service is due to difficult ground conditions rather than to long distance.

In the design of the operating pattern, the frequency of service and aircraft routing must be paired with the chosen type of equipment. Where a very low volume of traffic is anticipated, service on demand (such as taxi service) may be the best solution. At a somewhat higher traffic volume, a few trips per week rather than several per day may be scheduled, and the equipment may also be employed on several adjoining or neighboring routes. Even if traffic justifies service once a day or still more frequently, it may also be necessary to use the same aircraft on more than one route to obtain satisfactory equipment utilization.

To assure dependable service, more than one available aircraft is necessary. Preferably, a spare should be available for use whenever an aircraft is out of service, although the cost looms large if the active fleet consists of only one or two planes. Service dependability also requires purchase of a spare-parts supply at the outset, as well as its regular maintenance. Postponement of the purchase of spare parts until they are urgently needed may save initial investment cost, but it is apt to prove very expensive in the course of operation.

Provision also must be made for regular maintenance and overhaul. Whether these activities need to be conducted by the carrier itself depends on the availability and costs of alternatives. Facilities for major maintenance require sizable investment. A small carrier will do better to have its equipment maintained by a larger airline, by a facility established jointly by several neighboring carriers, or by the facilities of a manufacturer, if any of these is available within manageable distance and is equipped to handle aircraft of the chosen type. The cost importance of such arrangements makes it necessary to consider them in advance when the aircraft type to be used is selected.

Engineering estimates of the cost involved in any particular equipment and service pattern are not difficult to secure. They should include, of course, the cost of ground facilities that need to be provided for the proposed service. Attention needs to be paid to the fact that much of the cost of any air service in a less developed country must be paid in foreign exchange. Equipment of all kinds must be imported; in most countries fuel must also be imported. In addition, foreign staff is likely to be employed in a variety of capacities, and domestic personnel capable of filling managerial and technical positions, including those of skilled workers, may require training abroad. In any event such personnel are among the country's scarce resources for which a shadow price may be a more appropriate valuation than the wages and salaries they are expected to receive.

Once an estimate of the total cost has been provided for any given equipment and service pattern, the resulting transport cost per unit of expected traffic can be readily computed. The CPA analyst may, however, require more than one such set of estimates if more than minimal traffic is expected. Since there may be some elasticity of demand and since the cost of service depends on the volume offered, demand and supply may be matched at more than one level. Some government subsidy may be required in any event, but it is not necessarily lowest at the most modest level of service.

The CPA can be made more useful to decision-makers if it includes a set of (discounted) costs corresponding to each of several service levels. Such service levels may be described in terms of the number of terminal points to be served, the frequency of service, the speed of service, etc. Alternative combinations of inputs to provide specified levels of service should be examined to determine the least-cost combination (General Guidelines, chapter V).

APPENDIX A. PRINCIPAL CHARACTERISTICS OF TYPES OF TERRAINS AND SOILS

Different surface and subsurface conditions are associated with each general type of terrain: the alluvial plain, the terrace, the bedrock plain, the hill and mountain. Because less developed areas embrace a wide variety of terrain types, a brief analysis of the suitability of the general terrain types for road location should be helpful to the CPA analyst.

Alluvial Valleys and Coastal and Interior Alluvial Plains

Alluvial valleys and coastal and interior alluvial plains contain extensive flat land and require little or no grading. When grading is required, the ground is usually soft and easily excavated. Because of differences in deposition and source of the alluvial material, the more suitable areas having better drainage and coarser soil can be expected at the margins of plains where alluvial fans spread out from the foot of bordering hills and mountains, along streams which are bordered by natural levees, and along the coast on dunes and sandy beach ridges.

Some plains areas are poorly drained and underlain by fine, silty, or clayey soils which are hard to stabilize and may be subject to heaving during freezing weather. Their water table is generally high, and flooding possibilities should always be considered. Obviously, swamps, bogs, and marshes are to be avoided if possible; they involve an expense of time and labor not feasible for most road projects.

Streams and beaches may be sources of sand and gravel for construction if suitable nearby rock has provided source material to the streams or waves. Usually, river gravel is most abundant in stream beds close to hills or mountains of hard rock, but is practically nonexistent in the deltas at the outer edges of wide plains. Beaches on coral islands are composed largely of coral sand, not of common quartz sand which is usually lacking. Water is usually obtainable from nearby streams or lakes, except in arid regions. Ground water is also usually obtainable in alluvial plains without difficulty.

Natural Levees

The natural levees of large streams may provide acceptable road sites, except where flood conditions are prevalent or extensive. Their soils are composed of coarser materials and are normally better drained than those of the lower land on the adjoining flood plain. The sand composing the levees may be too fine and silty to have bearing power, although it is usually better in this respect than the soil of the surrounding area. Alignment of highways is necessarily limited to the direction of elongation of the levees, and fill might be required to widen the levee. Fill is not practicable where streams are actively cutting into their banks, except for temporary installations.

Alluvial and Marine Terraces

The flat areas which in places border alluvial plains, continental coastlines, or islands can sometimes provide excellent sites for road construction. Since their surfaces are above the adjacent stream, lake, or ocean level, they are generally well drained and free from the danger of floods. In alluvial terraces, the water table is normally low and drainage is generally easy to establish where natural drainage is not sufficient. Depth of the bedrock varies with the type of terrace. The main objection to terraces as road sites is the frequent presence of steep-walled valleys and ravines, which occasionally are so closely spaced that they cut the surface into small segments. Gravel and sand deposits suitable for use as construction material underlie many terraces and are usually obtainable from bordering escarpments or ravine walls. Hard rock may also be exposed in cuts or in nearby hills and mountains.

Bedrock Plains and Plateaus

High-level bedrock plains or plateaus, underlain by flat-lying rocks or developed by erosion on folded or massive rocks, may be superior to adjacent lowlands as road sites, especially where the lowlands are poorly drained or offer poor foundations. However, the flat plateau surfaces may be intricately dissected by ravines or may contain minor relief irregularities, such as the scabland type of topography on lava plateaus and the sinkholes and pinnacles on some limestone-capped plateaus. In such cases, grading generally requires rock excavation. The high surfaces are naturally well drained, and if they are not, good drainage can easily be established. Foundations are generally good.

The residual soil cover on bedrock plains may vary considerably in thickness and character, depending on the underlying rocks, the age and geologic history of the plateau, and the climatic conditions. On recent lava flows, the residual soil may be very thin or entirely lacking. In other places, particularly in the tropics, the mantle may be so thick that grading does not reach bedrock and the finished foundation is on the soft, residual material. The bedrock under plateaus and high plains may also be covered by thick deposits of transported materials such as falls of ash or coarser fragments ejected from volcanoes, loess, dune sand, stream-distributed gravel and sand, and glacial drift. Such foundations vary greatly as to suitability. Some consist of well-drained coarse soils, such as the fragmental igneous rock soils and sand dunes and the sandy, residual soils developed on granites. Other foundations have poorly drained, fine soils, such as the clayey soils developed in place on such rocks as limestone and shale, and the plastic, clayey soils found in some areas of glacial drift. Loess and other silty materials, when undrained because of underlying impervious beds, may be subject to frost heave.

Rock suitable for construction is usually abundant on bedrock plains and plateaus; sand and gravel are usually locally available. The distribution and amount of surface and ground water available are highly irregular.

APPENDIX B. SUGGESTED TECHNIQUES FOR ESTIMATING TRAFFIC VOLUME AND DISTRIBUTION

Where information on traffic volumes for a sizable number of past years is unavailable, more generalized projections of future traffic can be developed by the use of partial information.

Bases for Traffic Projections

The following sources may be used as bases for traffic projections:

- Growth of traffic in another region in the same country with a previously completed, similar transport project
- Rates of increase in traffic in one or more (preferably neighboring) countries at similar stages of economic development
- Statistics reflecting the growth of relevant components of the country's gross domestic product (for example, the rate of increase in traffic involving movement of agricultural exports to ports may be projected on the basis of anticipated growth in production of these commodities)
- Census figures showing population growth
- Annual increases in vehicle registration
- Annual increases in national road mileage
- Annual increases in highway fuel consumption.

These sources may be examined for correlation with traffic growth in the service area on the basis of past performance. In forecasting, it will be helpful to establish the range of estimates for high, medium, and low growth rates. For longer term projections, the governmental goals and policies relating to regional land use and development should be considered.

In translating market demand into traffic estimates, the basic parameters are measured in terms of the following volumes:

- Annual traffic (vehicles per year)
- Monthly traffic (vehicles per month)
- Average daily traffic (ADT) (vehicles per day)
- Peak hourly traffic (PHT) (vehicles per hour)

Annual traffic is the total number of vehicles expected to use the highway in 1 year, and is used for determining annual travel, estimating expected highway user revenues, and indicating trends in volume, especially on toll facilities.

Average daily traffic (ADT) is the general unit of measure used in reporting traffic on a highway and is the annual average daily traffic. It represents the total traffic for the year divided by 365. ADT is helpful in determining the demand for service by the highway, evaluating the traffic flow with respect to the overall highway network, developing the overall highway network, and identifying localities where new facilities or improvements to existing facilities are necessary.

Peak hourly traffic (PHT) is used for determining length and magnitude of peak periods, evaluating road deficiencies, and establishing traffic controls and the geometric design of roads and intersections.

Composition of Traffic

Traffic composition can generally be classified into four categories:

- Trucks
- Passenger vehicles
- Motorcycles
- Bicycles

For purposes of general studies, it is customary to consider the traffic mix to consist of trucks and passenger vehicles, with motorcycles being classified as passenger vehicles. Light delivery trucks such as panel or pickup trucks may also be classified as passenger vehicles. All buses, single-unit trucks, truck combinations, vehicles weighing 9,000 pounds or more, or vehicles having dual tires on the rear axle can be considered trucks.

Truck traffic is expressed as the percentage of total traffic during the design hourly volume. Most trucks operate steadily throughout the day, with the result that the truck peak seldom coincides with the passenger-car peak. For general estimates, the customary procedure is to consider truck traffic to be 15 percent of ADT in the absence of specific data indicating a different composition.

Special Components of Traffic

In an evaluation of traffic projections for industrial, commercial, or agricultural developments, production rates can be translated into highway traffic volumes by the estimating of the type and capacity of the transport vehicle. If consideration is given to the seasonal characteristics of the production facility (such as crop harvest), annual, monthly, and daily traffic volumes can be projected. These volumes can be superimposed on a traffic chart along with other estimated traffic volumes to arrive at total traffic for the route segment. This chart usually is presented with the months of the year as the ordinate and the monthly percent of annual traffic as the abscissa. In this way traffic is displayed as a function of time and variations from the average are readily distinguishable.

Distribution of Traffic

The generation, distribution, and assignment of traffic are basic to traffic estimation. From studies previously mentioned (O/D, statistical analyses of GNP data, similarity comparisons within and between countries), an idea of the amount of traffic that might be generated can be developed by due consideration of the specific uses of lands being served by the highway project. Some land-use centers that generate traffic are residential areas, business districts, commercial areas, and agricultural areas.

To distribute the estimated traffic, the simplest mathematical method that may be used is the gravity model.[1/] The gravity model is based on the theory that traffic generating areas attract traffic to them in proportion to their own size (in terms of population or economic factors) and inversely in proportion to the square of the distance between them.

The basic gravity formula is given as follows:

$$T_{1-2} = \frac{KP_1 . P_2}{d^x}$$

Where T_{1-2} = number of trips between areas 1 and 2

P_1 = population of area 1

P_2 = population of area 2

d = distance between areas 1 and 2

x = some power of d, frequently 2

K = A constant used to adjust the different dimensions used in the formula and to weight the attractiveness of the area.

Another method for estimating future traffic distribution between zones is based on the assumption that future distribution will be similar to present distribution and will be influenced mainly by zone size. Future trips generated in each zone are computed by multiplying present trips by a growth factor based on statistical studies, and trips are then distributed among zones in accordance with the attractiveness of each zone.

The step requiring the most judgment in traffic planning is the assigning of the estimated traffic to alternative modes and routes between pairs of zones. No generally accepted method has been developed for assigning trips to alternate modes of transportation. This is highly dependent on local existing

1/ Because the development often entails a break with the past, mathematical relationships based on past data should be used with caution. This is particularly true where transport facilities open up new areas.

transport facilities and access to them. In the assigning of trips to specific alternative highway routes between origins and destinations, both travel times and travel distances can be used as criteria in selecting the preferred route.

APPENDIX C. DESIGN CHARACTERISTICS AND CAPACITY: INTERURBAN ROADS AND URBAN STREETS IN LDC's

The number of vehicles that a road or street can accommodate at specified running speeds will depend on the terrain, the physical characteristics of the road (running surface, shoulders, horizontal and vertical alignments and sight distances) and the composition of the traffic, especially the proportion of the traffic accounted for by heavy vehicles.

The relation of these variables is shown in tables C-1 and C-2 for interurban roads and urban streets, respectively. These tables must be considered as illustrative, not as guideposts. The standards for each country should be designed in the light of its own conditions -- its cost of capital and labor, its rate of economic growth, and its topographic characteristics. Whatever standards are set in a country should generally be maintained to permit efficient road construction, maintenance, and administration, as well as efficiency in the traffic use of the country's highways. Individual road characteristics may have to be modified to meet particular local conditions, but such deviations from national standards should be exceptional and the reasons for them should be made explicit. The CPA analyst should receive the information needed to refer to national standards and to appraise any deviation needed because of local conditions. Where no national standards have been developed, he may refer for guidance to a sample set of standards (such as those of table C-1 or table C-2) in order to judge whether the proposed standards are internally consistent and in accord with the expected traffic demand.

TABLE C-1. GEOMETRIC DESIGN FOR ROADS IN LESS DEVELOPED AREAS

Design Controls and Elements	Class A Roads* Four-Lane Road: Flat	Rolling	Mountainous	Class B Roads** Two-Lane Road: Flat	Rolling	Mountainous	Class C Roads** Two-Lane Road: Flat	Rolling	Mountainous	Class D Roads** Two-Lane Road: Flat	Rolling	Mountainous	Class E Roads** Two-Lane Road: Flat	Rolling	Mountainous	Class F Roads** Single-Lane Road: Flat	Rolling	Mountainous
DESIGN CONTROLS:																		
1. Traffic composition 1/																		
T-0%																		
Average daily traffic	6700	6700	6700	4800-6000	4800-6000	4800-6000	3000-4800	3000-4800	3000-4800	1000-3000	1000-3000	1000-3000	70-1000	70-1000	70-1000	Under 70	Under 70	Under 70
Design hourly volume 2/	1000	1000	1000	720-900	720-900	720-900	450-720	450-720	450-720	150-450	150-450	150-450	10-150	10-150	10-150	Under 10	Under 10	Under 10
T-10%																		
Average daily traffic	6000	5100	4000	4400-5500	3700-4600	2800-3500	2700-4400	2300-3700	1800-2800	950-2700	770-2300	600-1800	60-950	53-770	40-600	Under 60	Under 53	Under 40
Design hourly volume 3/	900	770	590	650-820	550-690	420-530	410-650	340-550	270-420	140-410	115-340	90-270	9-140	8-115	6-90	Under 9	Under 8	Under 6
T-20%																		
Average daily traffic	5600	4200	2800	4000-5000	3000-3700	2000-2500	2500-4000	1900-3000	1250-2000	870-2500	630-1900	400-1250	55-870	40-630	27-400	Under 55	Under 40	Under 27
Design hourly volume 3/	840	620	420	600-750	450-560	300-380	380-600	290-450	190-300	130-380	95-290	60-190	8-130	6-95	4-60	Under 8	Under 6	Under 4
T-30%																		
Average daily traffic	5100	3500	2100	3700-4700	2500-3200	1500-2100	2300-3700	1600-2500	970-1500	770-2300	570-1600	330-970	47-770	34-570	20-330	Under 47	Under 34	Under 20
Design hourly volume 3/	770	530	320	550-700	380-480	230-310	340-550	240-380	145-230	115-340	85-240	50-145	7-115	5-85	3-50	Under 7	Under 5	Under 3
2. Design speed, mph	70	60	50	70	60	50	60	50	50	55	45	35	55	45	35	30	25	20
3. Average running speed, mph	49	45	40	49	45	40	45	40	40	43	37	30	43	37	30	27	23	19
CROSS-SECTION ELEMENTS:																		
4. Pavements																		
Minimum width of traffic lanes, 4/ ft																		
With barrier curbs	12	12	12	12	12	12	12	11	11	10	10	10	10	10	10	10	9	8
Without barrier curbs	12	12	12	12	12	12	12	11	11	10	10	10	10	10	10	12	11	10
Minimum distance between barrier curbs, 5/ ft	53	53	53	29	29	29	28	26	26	24	24	24	20	20	20	13	14	13
Desirable lateral clearance to obstructions, ft	6	6	6	6	6	6	6	6	6	4	4	4	2	2	2	2	2	2
Normal cross slope, in./ft	1/8 to 1/4									3/16 to 3/8			1/4 to 1/2					
5. Shoulders 6/																		
Minimum width, shoulders on roads without barrier curbs, ft	10	10	8	10	8	8	10	8	8	8	6	4	6	6	4	4	4	4
Normal cross slope, in./ft	3/8 to 1/2									1/2 to 3/4			3/4 to 1					
Type	Dustless and stable for all-weather use									Stabilized with select material			Compacted soil					
DESIGN ELEMENTS:																		
6. Sight Distance																		
Minimum stopping sight distance, ft	600	475	350	600	475	350	475	350	350	415	310	240	415	310	240	400	300	200
Minimum passing sight distance, ft				2300	2000	1700	2000	1700	1700	1850	1500	1050	1850	1500	1050			
7. Horizontal alignment																		
Horizontal curves																		
Maximum curvature																		
Desirable maximum 7/	1°30'	2°00'	3°00'	1°30'	2°00'	3°00'	2°00'	3°00'	4°00'	2°30'	3°30'	6°00'	2°30'	3°30'	6°00'	8°00'	8°00'	12°00'
Absolute maximum 7/																		
Where snow and ice are not factors	4°00'	5°30'	8°00'	4°00'	5°30'	8°00'	5°30'	8°00'	8°00'	7°00'	10°30'	18°00'	7°00'	10°30'	18°00'	25°00'	36°00'	58°00'
Where snow and ice are factors	3°00'	4°30'	7°00'	3°00'	4°30'	7°00'	4°30'	7°00'	7°00'	5°45'	9°00'	16°30'	5°45'	9°00'	16°30'	21°00'	31°00'	58°00'
8. Vertical alignment																		
Grade																		
Desirable maximum																		
Percent	3	3	4	3	3	4	4	5	6	4	5	6	5	6	7	6	6	7
Critical length 8/ ft	1035	1035	720	1035	1035	720	720	550	450	720	550	450	550	450	375	450	450	375
Absolute max for permanent installations																		
Percent	5	6	6	5	6	6	6	7	8	7	8	9	8	9	10	10	10	13
Critical length 8/ ft	1000	660	450	1000	660	450	875	575	500	850	550	275	900	600	400	450	325	225
Absolute max for temporary installations																		
Percent				6	7	8	6	7	8	8	9	10	10	11	12	12	12	12
Critical length 8/ ft				825	550	325	875	550	500	750	500	250	700	525	375	450	300	200
Minimum percent	0.3									0.5								
Vertical curves 9/																		
K for determining safe length																		
Crest vertical curves	240	150	80	240	150	80	150	80	80	115	65	40	115	65	40	28	24	15
Sag vertical curves	140	100	70	140	100	70	100	70	70	85	60	45	85	60	45	35	20	18
Minimum length, ft	210	180	150	210	180	150	180	150	150	165	135	105	165	135	105	90	75	60

Note:

* The design hourly volume (DHV) shown for class A roads is in vehicles per hour per lane for direction of heavier flow.

** The DHV shown for classes B, C, D, E, and F roads is in total vehicles per hour for all lanes in both directions.

1 The symbol "T," with percentage limitations, represents the proportion of total traffic composed of [illegible] & trucks; the remainder are light delivery trucks and passenger cars.

2 The DHV is equal to approximately 15% of the average daily traffic (ADT).

3 These values show the mixed traffic volume which requires the same operational area as that required by traffic composed of light delivery trucks and passenger cars. These DHV's are based on the indicated percentage of the daily volume and may be overconservative in some instances because the percentages of trucks, track-laying vehicles, etc., during peak hours are generally considerably lower than the average percentage during all hours.

4 The traffic lane widths indicated are for use on roads where the traffic will consist principally of vehicles with maximum over-all widths of 8 ft or less. For determining traffic lane width for excessive-width vehicles.

5 Distance shown is the minimum distance between face of curbs.

6 There should be a color or textural contrast between pavement and shoulder surface sufficient to clearly define the pavement and shoulders in all types of weather.

7 Absolute maximum values shown were calculated on the basis of a maximum rate of superelevation of 0.10. Absolute value for horizontal curves will have to be recalculated if a maximum rate of superelevation other than 0.10 is used.

8 The term "critical length" is used to indicate the maximum length of a [illegible] which a loaded truck can operate without an unreasonable reduction in speed.

9 The minimum lengths of vertical curves are determined by multiplying "K" times the [illegible] difference of grades (in percent).

TABLE C-2. GEOMETRIC DESIGN FOR STREETS IN LESS DEVELOPED AREAS

Design Controls and Elements	Class A Streets* Four-Lane Street		Class B Streets** Two-Lane Street		Class C Streets** Two-Lane Street		Class D Streets** Two-Lane Street		Class E Streets** Two-Lane Street		Class F Streets** Two-Lane Street	
	Flat	Rolling	Flat	Rolling	Flat	Rolling	Flat	Rolling	Flat	Rolling	Flat	Rolling
DESIGN CONTROLS:												
1. Traffic composition[1]												
T-5%												
Average daily traffic	10,000	10,000	8,400-10,000	8,400-10,000	6,300-8,400	6,300-8,400	2,100-6,300	2,100-6,300	210-2,100	210-2,100	Under 210	Under 210
Design hourly volume 2/	1,200	1,200	1,000-1,200	1,000-1,200	750-1,000	750-1,000	250-750	250-750	25-250	25-250	Under 25	Under 25
T-10%												
Average daily traffic	9,100	7,700	7,600-9,100	6,400-7,700	5,700-7,600	4,800-6,400	1,900-5,700	1,600-4,800	190-1,900	160-1,600	Under 190	Under 160
Design hourly volume 3/	1,090	920	920-1,090	770-920	680-910	580-770	230-680	190-580	23-230	19-190	Under 23	Under 19
T-20%												
Average daily traffic	8,300	6,300	6,900-8,300	5,200-6,300	5,200-6,900	3,900-5,200	1,800-5,200	1,300-3,900	170-1,800	130-1,300	Under 170	Under 130
Design hourly volume 3/	1,000	760	830-1,000	625-760	620-830	470-625	220-620	160-470	21-220	16-160	Under 21	Under 16
T-30%												
Average daily traffic	7,700	5,300	6,500-7,700	4,700-5,300	4,800-6,500	3,300-4,700	1,600-4,800	1,100-3,300	160-1,600	110-1,100	Under 160	Under 110
Design hourly volume 3/	920	640	780-920	560-640	580-780	400-560	190-580	130-400	19-190	13-130	Under 19	Under 13
2. Design speed, mph	60	50	50	40	50	40	40	30	40	30	40	30
3. Average running speed, mph	38	36	36	32	36	32	32	25	32	25	32	25
CROSS-SECTION ELEMENTS:												
4. Pavements												
Minimum width of lanes, 4/ ft												
With barrier curbs												
Traffic	12	12	12	12	12	12	11	11	10	10	10	10
Without barrier curbs												
Traffic	12	12	12	12	12	12	11	11	10	10	10	10
Minimum distance between barrier curbs, 5/ 6/ ft												
Without parking lanes 5/	53	53	29	28	28	28	25	25	20	20	20	20
Desirable lateral clearance to obstructions, ft	6	6	6	6	6	6	4	4	2	2	2	2
Normal cross slope, in./ft	1/8 to 1/4						3/16 to 3/8				1/4 to 1/2	
5. Shoulders 7/												
Minimum width, shoulders on streets without barrier curbs, ft	10	10	10	8	10	8	8	8	6	8	6	8
Normal cross slope, in./ft	3/8 to 1/2						1/8 to 3/4				3/4 to 1	
Type	Dustless and stable for all-weather use											
DESIGN ELEMENTS												
6. Sight distance												
Minimum stopping sight distance, ft	475	350	350	275	350	275	275	200	275	200	275	200
7. Horizontal alignment												
Horizontal curves												
Absolute maximum for normal crown section 8/	0°15'	0°30'	0°30'	0°45'	0°30'	0°45'	0°45'	1°30'	0°45'	1°30'	0°45'	1°30'
Absolute maximum for superelevated section 8/	4°00'	5°30'	5°30'	9°15'	5°30'	9°15'	9°15'	17°15'	9°15'	17°15'	9°15'	17°15'
8. Vertical alignment												
Grade												
Desirable maximum												
Percent	3	3	3	3	3	3	4	4	5	6	6	7
Critical length, 9/ ft	800	600	900	550	900	550	750	475	400	200	700	450
Absolute maximum for permanent installations												
Percent	4	5	4	5	5	6	6	7	7	8	10	10
Critical length, 9/ ft	900	600	675	200	600	300	500	200	450	175	400	250
Absolute maximum for temporary installations												
Percent			6	6	6	7	7	8	8	9	12	12
Critical length, 9/ ft			900	275	500	275	450	200	200	150	400	200
Minimum percent	0.3											
Vertical curves 10/												
K for determining safe length												
Crest vertical curves	150	80	80	50	80	50	50	28	50	28	50	28
Sag vertical curves	100	70	70	50	70	50	50	35	50	35	50	35
Minimum length, ft	150	150	150	120	150	120	120	90	120	90	120	90

Notes:

* The design hourly volume (DHV) shown for class A streets is given in vehicles per hour per lane for direction of heavier flow.

** The DHV shown for classes B, C, D, E, and F streets is given in total vehicles per hour for all lanes in both directions.

1 The symbol "T", with percentage limitations, represents the proportion of total traffic composed of buses and trucks; the remainder are light delivery trucks and passenger cars.

2 The DHV is equal to approximately 12% of the average daily traffic (ADT).

3 These values show the mixed traffic volume which requires the same operational area as that required by traffic composed of light delivery trucks and passenger cars. These DHV's are based on the indicated percentage of the daily volume and may be overconservative in some instances because the percentages of trucks, track-laying vehicles, etc., during peak hours are generally considerably lower than the average percentage during all hours.

4 The traffic and parking lane widths indicated are for use on streets where the traffic will consist principally of vehicles with maximum over all widths of 8 ft or less. Traffic lanes of streets without curbs in warehouse areas shall not be less than 12 ft regardless of class. The total width of streets with curbs adjacent to warehouses shall not be less than 30 ft between curbs regardless of class. The values given for width of parking lanes is the distance between the outside edge of the adjacent traffic lane and the face of the curb for Type IV curbs. The width of gutter is combined curb and gutter (Types I and III curbs) may be included in the width of parking lane provided the gutter is as strong structurally as the adjoining pavement, otherwise the width of parking lane shown will be the distance between the outside edge of the adjacent traffic lane and the inside edge of the gutter.

5 Distance shown is the minimum distance between face of curbs.

6 Where class E or F streets are designed with barrier curbs, curb offsets are not required adjacent to traffic lanes.

7 There should be a color or textural contrast between pavement and shoulder surface sufficient to clearly define the pavement and shoulders in all types of weather.

8 Absolute maximum values shown were calculated on the basis of a maximum rate of superelevation of 0.0?. Superelevation rate of 0.04 or 0.06 may be used on streets in which case the absolute maximum values for horizontal curves will have to be recalculated.

9 The term "critical length" is used to indicate the maximum length of a designated upgrade upon which a loaded truck can operate without an unreasonable reduction in speed.

10 The minimum lengths of vertical curves are determined by multiplying "K" times the algebraic difference of grades (in percent).

APPENDIX D. AVERAGE COST MODULES: HIGHWAY AND STREET CONSTRUCTION

Several tables reflecting average costs experience are presented in this appendix. The scarcity of data in most LDC's may require reliance on generalized cost data of this type. If some but not all components of costs are available, tables D-3 and D-5 may be used to supplement local cost data. In any case, the tables in this appendix can be useful as a check on locally developed cost estimates and on the completeness of the list of cost components.

Should it become desirable or necessary to assess the costs of a proposed project in greater detail than is possible from the data in table D-1, the grading and drainage, the bases, the surfaces, and the structures would each have to be divided into subelements, and the unit price of each subelement would have to be developed. Table D-2 gives these subelements and the unit prices associated with the cost averages shown in table D-1.

It also may become desirable to estimate the total initial cost of a road project from data based on only a portion of the project. To accomplish this, the percentages for the major items of construction have to be developed. If a fairly firm estimate is available for one major element, the total initial cost of a highway project can therefore be estimated. Table D-3 shows the distribution of costs by major highway construction item.

An important phase in the assessment of highway projects is the estimating of material requirements so that domestic sources may be geared to supply such materials. The usage factors, in terms of units of the various materials per million dollars of construction cost, when multiplied by the number of millions of dollars in the project, will generally result in reasonably accurate estimates of material requirements. These usage factors are shown in table D-4.

Table D-1. Estimated Average Costs Per Mile Highway Construction on New Location

(in thousands of dollars).

Type of construction[a]	Type of terrain		
	Flat	Rolling	Mountainous
Secondary - 24 ft.			
Grading and drainage...............	32	42	101
Base and surfacing..	15	15	16
Structures..........	42	45	58
Total.............	89	102	175
Primary			
24-ft. medium type			
Grading and drainage..............	48	65	154
Base and surfacing.	36	37	39
Structures.........	47	49	63
Total............	131	151	256
24-ft. high type			
Grading and drainage..............	55	71	166
Base and surfacing.	102	104	110
Structures.........	54	56	70
Total............	211	231	346
Four 12-ft. lanes - divided			
Grading and drainage...............	251	296	531
Base and surfacing..	217	220	225
Structures..........	311	317	348
Total.............	779	833	1,104

a/ Definitions of surfacing:
Secondary - 1.5" bituminous surface treatment on 8" gravel base, and shoulders.
Primary, medium type - 3" bituminous plant mix medium surface on 5" macadam base on 4" gravel subbase with 6" gravel shoulders each 6 feet wide.
High type - Average of 3" bituminous concrete surface on 18" of base and subbase and 9" portland cement concrete surface on 6" gravel base, each including necessary shoulder construction.

Source: Derived from Department of Transportation, Federal Highway Administration, Bureau of Public Roads Source Data.

Table D-2. Average Bid Prices for Major Items on Highway Construction Projects, 1968

Major items[a]	Unit	Weighted average contract unit price
Grading and drainage		
Roadway excavation:		
Borrow....................	Cubic yard	$ 0.77
Common....................	Cubic yard	.57
Unclassified..............	Cubic yard	.74
Solid rock................	Cubic yard	2.17
Culvert pipe:		
Clay - 6" diameter.......	Linear foot	2.68
Reinforced concrete - 24" diameter............	Linear foot	9.01
Corrugated steel - 24" diameter............	Linear foot	8.35
Bases and surfaces		
Bases:		
Gravel and clay gravel...	Ton	1.80
Macadam or stone..........	Ton	2.63
Portland cement concrete.	Square yard[b]	4.48[c]
Bituminous plant mix.....	Ton	5.84
Sufaces:		
Bituminous concrete......	Ton	6.77
Portland cement..........	Square yard[d]	4.76[c]
Pavement reinforcement...	Pound	.117
Liquid bitumens:		
Prime, tack and seal.....	Gallon	.183
Structures[e]		
Structural concrete[f]......	Cubic yard	71.81
Structural reinforcement...	Pound	.131
Structural steel...........	Pound	.249
Steel H-piling.............	Pound	.136
Prestressed concrete I-beams:		
36-inch depth............	Linear foot	17.76
45-inch depth............	Linear foot	20.95

a/ Total cost of major items is 65.3 percent of total contract cost
b/ Weighted average thickness is 7.0 inches.
c/ Excludes costs of reinforcement and joints.
d/ Weighted average thickness is 8.8 inches.
e/ Includes bridges, box culverts, retaining walls, tunnels, etc.
f/ Includes superstructure concrete, substructure concrete, and concrete for foundations and footings.

Source: Derived from BPR Source Data.

Table D-3. Distribution of Costs for Highway Construction Items

Major items	All primary		
	Rural	Urban	Total
	------- percent ---------		
Grading and drainage			
Roadway excavation:			
Borrow	8.6	6.5	7.7
Common	9.5	6.3	8.2
Unclassified	18.9	11.8	16.0
Solid rock	0.9	1.0	1.0
Culvert pipe:			
Clay - 6"	0.1	0.1	0.1
Reinforced concrete - 24"	0.4	0.3	0.4
Corrugated steel - 24"	0.1	0.1	0.1
Subtotal	38.5	26.1	33.5
Bases and surfaces			
Bases:			
Gravel and clay gravel	5.8	3.8	5.0
Macadam or stone	4.1	1.5	3.1
Portland cement concrete[a/]	0.2	0.9	0.5
Bituminous plant mix	4.6	2.6	3.8
Surfaces:			
Bituminous concrete	7.8	4.4	6.4
Portland cement concrete[a/]	12.2	10.3	11.4
Pavement reinforcement	2.3	1.6	2.0
Liquid bitumens:			
Prime, tack, and seal	0.7	0.3	0.5
Subtotal	37.7	25.4	32.7
Structures[b/]			
Structural concrete[c/]	12.4	23.3	16.8
Structural reinforcement	4.1	8.0	5.7
Structural steel	6.0	14.6	9.5
Steel H-piling	0.9	2.2	1.4
Prestressed concrete I-beams:			
36-inch depth	0.1	0.1	0.1
45-inch depth	0.3	0.3	0.3
Subtotal	23.8	48.5	33.8
Total	100.0	100.0	100.0
Ratio of total amount bid for major items to total amount bid for all items	68.0	60.6	64.8

continued--

Table D-3. Distribution of Costs for Highway Construction Items continued --

a/ Excludes costs of reinforcement and joints.
b/ Includes costs of bridges, box culverts, retaining walls, tunnels, etc.
c/ Includes costs of superstructure concrete, substructure concrete and concrete for foundations and footings; excludes cost of reinforcing steel.

Source: Derived from BPR Source Data.

Table D-4. Usage Factors for Ascertaining Amounts of Materials and Labor for Roads

Items	Unit	Number of units per million dollars of construction cost[a/]
Cement (excludes cement in concrete pipe)...............	Barrels	15,200
Bituminous material..........	Tons	933
Aggregates:[b/]		
Purchased (by contractors)..	Tons	49,000
Produced (by contractors)..	Tons	35,000
Steel:		
Structural (shape, plates, H and sheet piling).......	Tons	183
Reinforcing (pavement and structural reinforcement).	Tons	232
Culvert pipe (corrugated metal and structural plate, pipe arches and arches)..................	Tons	20
Miscellaneous joint devices, tubular piling, etc.....................	Tons	24
Concrete pipe (plain and reinforced)..................	Tons	369
Clay pipe and tile...........	Tons	11
Lumber (all lumber products except timber piling).......	Board feet	54,000
Timber piling................	Linear feet	1,000
Petroleum products[c/].........	Gallons	131,000
Explosives (excludes weights of caps and fuses)..........	Pounds	43,000
Fencing (all types)..........	Linear feet	10,400
Guardrail (all types)........	Linear feet	4,200
Bridge railing (all types)...	Linear feet	840
Corrugated aluminum culvert..	Pounds	220
Cast iron pipe...............	Tons	5
Signs (complete in place)....	Dollars	9,200
Lighting (complete in place).	Dollars	7,700
Labor.......................	Man-hours	72,000

a/ Right-of-way, preliminary engineering and construction engineering costs excluded.
b/ Includes sand, gravel, clay gravel, slag, crushed stone, etc. used for all highway construction including bases, subbases, concrete surfaces, bituminous surfaces, structural concrete and drainage work.
c/ Fuel and lubricants for equipment and trucks. Grease converted to gallons on basis of 8 pounds per gallon.

Source: Derived from McGraw-Hill Source Data.

Table D-5. Distribution of Costs for Materials, Labor and Equipment for Highway Projects

Items	All primary		
	Rural	Urban	Total
	---------- percent -------		
Cement[a/]	4.3	2.7	3.6
Aggregates purchased[b/]	9.1	8.3	8.7
Bitumens[c/]	2.0	0.4	1.4
Lumber	0.5	0.9	0.6
Timber piling	0.1	0.1	0.1
Corrugated steel culvert pipe.	0.9	0.3	0.7
Reinforcing steel[d/]	3.5	4.7	4.0
Structural steel	2.6	6.1	4.0
Ready-mix concrete	3.7	6.8	4.9
Premixed bituminous paving materials	4.0	2.7	3.4
Aggregates produced[e/]	0.6	0.2	0.4
Concrete culvert pipe	0.8	1.5	1.1
Clay pipe	0.1	0.1	0.1
Miscellaneous steel	0.8	1.6	1.2
Fencing	0.8	0.2	0.6
Guardrail	1.4	1.1	1.3
Bridge rail	0.5	0.4	0.5
Petroleum products[f/]	4.9	2.6	4.0
Explosives	2.2	0.2	1.4
Materials not reported	2.1	9.0	4.9
Total materials	44.9	49.9	46.9
Labor	25.8	25.1	25.5
Equipment, overhead, and profit	29.3	25.0	27.6
Total	100.0	100.0	100.0

a/ Does not include cost of cement in ready-mix concrete or in concrete culvert pipe.
b/ Does not include cost of aggregates in ready-mix concrete, premixed bituminous paving materials, or concrete culvert pipe.
c/ Does not include cost of bitumens in premixed bituminous paving materials.

continued--

Table D-5. Distribution of Costs for Materials, Labor and Equipment for Highway Projects continued--

d/ Does not include cost of reinforcing steel in concrete culvert pipe.
e/ Includes estimated royalty payments only. Other costs are included in items of "petroleum products," "labor," and "equipment, overhead, and profit."
f/ Costs of fuel and lubricants for equipment and trucks.

Source: Derived from McGraw-Hill Source Data.

Table D-6. Cost Factors for Geographic Areas

Location	Factor	Location	Factor
Algeria	1.30	Jamaica	1.20
Ascension Is	2.50	Korea	0.90
Azores:		Kunsan	0.90
Lajes	1.10	Osan	0.90
Bahama Is	1.50	Seoul	0.90
Bermuda	1.60	Laos	0.80
Bikini	2.40	Liberia (W. Africa)	0.80
Bolivia	1.70	Libya:	
Brazil	1.50	Tripoli	1.10
British Guiana	1.20	Line Is:	
British Honduras	1.20	Palmyra	2.00
British West Indies:		Majuro Is	2.40
Antigua	1.40	Morocco	1.00
Barbados	1.20	Nicaragua	1.00
Trinidad	1.20	Pakistan:	
Burma	1.40	West	1.20
Caroline Is:		Palmyra Is	2.00
Truk	2.00	Panama	1.30
Ceylon	1.10	Paraguay	1.60
Chile	1.50	Peru	1.50
Christmas Is	2.20	Philippine Is	1.10
Colombia	1.30	Ryuku Is:	
Costa Rica	1.00	Okinawa	1.00
Ecuador	1.50	Saipan	2.00
El Salvador	1.00	Samoa	2.20
Eniwetok	2.40	Saudi Arabia:	
Ethiopia	0.90	Dhahran	1.50
French Guiana	1.20	Somaliland	1.20
Athenai	1.10	Taiwan	0.70
Iraklion	1.10	Thailand:	
Greenland:		Bangkok, Sattahip	1.50
Ice Cap	4.00	Other areas	1.80
Narsarssuak	3.50	Tinian (Marianas Is)	2.00
Sonderstrom	3.10	Trinidad (BWI)	1.20
Thule	3.50	Uruguay	1.60
Guatemala	1.00	Venezuela	1.30
Iceland	3.00	Vietnam:	
India:		Saigon areas	2.20
Bombay	0.90	Other areas	2.50
Iran:		Volcanic Is:	
Tehran	0.90	Iwo Jima	2.20
Iraq	1.30	Wake Is	2.20

Source: Extracted from DOD Source Data.

APPENDIX E. RELATIVE COST OF OPERATING AUTOMOBILES ON VARIOUS TYPES OF ROADS

Types of Roads

Vehicle operating costs vary with respect to the types of roads on which they operate. For the purpose of the preliminary assessment of proposed projects, roads have been classified into three types: high, intermediate, and low.

High-type roads are heavier, more durable and more costly. They are commonly referred to as pavements. Portland cement concrete (PCC), sheet asphalt, asphaltic concrete (A/C) brick and the various block pavements are high-type surfaces. The high-type road is composed of a foundation with a long life and renewable wearing surface that permits overlayment when the original surface needs replacing. High-type roads are designed to support large traffic volumes of automobiles and heavy trucks. The initial cost of high-type roads range from two to ten times the cost of intermediate roads. However, over the years, with heavy traffic, the decreased annual maintenance costs and the lower vehicle operating costs may more than offset the initial expenditure.

Intermediate-type roads are all-weather roads with flexible surfaces and with a life expectancy of 5 to 15 years. Typical intermediate-type roads consist of heavy section gravel and broken stone surfaces (surface-treated or untreated) and bituminous surfaces, road mix or penetration macadam. The untreated surfaces are suitable for traffic of 50 to 200 vehicles per day. Treated and bituminous surfaces are capable of carrying mixed car and truck traffic to a maximum of approximately 2,000 vehicles per day.

Low-type roads are composed of natural soil, gravel-coated earth and stabilized soil. Traffic on these types of roads is light, and such roads are generally used to carry vehicles to an intermediate- or high-type road.

Cost of Operating Vehicles

For the preliminary assessment of highway projects it is desirable to know the average cost of operating motor vehicles. To develop an average cost, it is necessary to postulate the types of vehicles that will operate over a highway. Accordingly a composite car is postulated. For LDC's it is assumed that smaller and more economic cars would be used. Therefore, the composite car would weigh 2,500 pounds; it would travel 20 miles on 1 gallon of gas and would use 1 quart of oil per 1,000 miles, with a complete oil change every 2,000 miles; and it would travel about 7,000 miles per year. The cost of operating such a car per mile is shown in table E-1.

It is recognized that prices for the various items comprising the cost of operating a motor vehicle will vary from country to country. It is, therefore, necessary for figures to be generated that can be used to judge the general relative costs of operating motor vehicles independent of licensing, storage, interest and insurance payments. The cost variables, therefore, consist of gasoline, oil, tires (and tubes), maintenance and depreciation. A standard table showing cost estimating relationships for the variables and the constants for various types of road surfaces is developed in subsequent paragraphs.

Cost of Operating Vehicles Over Various Types of Roads

Tractive Resistance

To determine the relative cost of operating vehicles over the three different types of roads described above, it is necessary to determine the average tractive resistances, in pounds per ton, for a vehicle speed of 35 miles per hour:

Surface type	Tractive resistance (lb. per ton)
Low.............	160
Intermediate.....	110
High............	70

Gasoline Consumption

If the gasoline consumed in traveling a given distance on a high-type surface were 1 gallon, the corresponding amount consumed in traveling the same distance on intermediate- and low-type roads would be 1.2 and 1.47 gallons, respectively. This gives an indication of the relative difference in cost when only one cost parameter is considered. The cost of operating a vehicle on various types of surfaces for all cost parameters is shown in table E-2.

Relative Costs

As previously stated, gasoline, tires, maintenance and depreciation vary with respect to the type of road. The following tabulation shows these relationships. The lowest figure has been normalized to unity for the purpose of comparison.

Item	High	Intermediate	Low
Gasoline..........	1	1.2	1.47
Tires (and tubes).	1	2.2	2.89
Maintenance.......	1	1.2	1.40
Depreciation......	1	1.1	1.24

Table E-1. Cost of Operating Composite Automobile

Item	Cost		Percent of total cost
	Approximate annual ($)	Per mile (¢)	
Gasoline ($.65 per gallon)................	227.00	3.24	16.8
Oil ($.60 per quart)....	14.20	.22	1.1
Tires (and tubes).......	83.00	1.18	6.1
Maintenance.............	236.00	3.37	17.4
Depreciation............	315.00	4.50	23.3
License.................	25.00	.36	1.9
Garage or parking space ($17/mo).........	204.00	2.91	15.1
Interest................	150.00	2.14	11.1
Insurance...............	96.60	1.38	7.2
Total................	1,340.80	19.30	100.0

Table E-2. Relative Cost of Operating Automobiles on Various Types of Roads

Item	Approximate cost on three types of surfaces		
	High	Intermediate	Low
	----------- cents per mile -----		
Gasoline (65 cents per gallon).........	2.78	3.34	4.10
Oil...........	.22	.22	.22
Tires (and tubes)....	.80	1.76	2.31
Maintenance..........	3.95	4.75	5.83
Depreciation.........	3.48	3.84	4.33
License..............	.36	.36	.36
Garage...............	2.91	2.91	2.91
Interest.............	2.14	2.14	2.14
Insurance............	1.38	1.38	1.38
Total.............	18.02	20.70	23.58

COSTS: RAILWAYS

Major components of railway construction costs are presented in this appendix. The unit cost estimates are based on experience in the United States at prices prevailing in 1968. Thus the unit costs are not likely to be directly applicable in most LDC's. To the extent that the unit costs reflect labor inputs, the figures given are probably higher than those which will be encountered in most LDC's, although productivity per man-day -- as well as daily wage rates -- must be considered in making the adjustment to local costs. On the other hand, imported materials, equipment, and the cost of foreign engineers and supervisory personnel are likely to be higher in the LDC's than the estimates cited in table F-1.

Clearing and Grubbing. Due to variations in the type and density of foliation, the price for clearing and grubbing may range between $315 and $1,260 per acre.

Earthwork. When the grading is light, fills are frequently made from borrow pits (excavations near roads), and the material in cuts is wasted. The price per cubic yard then applies to the sum of the yardage of cut and fill plus shrinkage. This price is usually $2.00 to $3.50 per cubic yard for earth, about $6.00 to $8.00 for loose rock, and $9.00 to $18.50 for solid rock. When earthwork is heavy, care is taken to make the fills from the material in the cuts. Excess fill is disposed of as directed, and the contractor is paid according to the amount excavated.[1/] Much depends on length of haul and on local conditions. Projects in the proximity of cities and on lines currently in use will usually be more costly. As an example of the range of costs, the cost per mile of grading for all the railroads in a 191,733-square-mile diversified area with a population of 15 million varied significantly, from $35,000 to $93,000 per mile.

Tunnels. The total cost of this item is affected by many variable factors. Unit costs, however, should not vary

1/ A higher amount may be charged for excavation work if the contractor is also required to construct embankments from the excavated materials.

[illegible]

No.	Description of item	Cost	
		Per foot	Per mile
1.	Rail, 100 lb. per yd. @ $140 per ton...........	$4.65	$24,640
2	Spikes, plates, bolts and splice bars.............	1.40	7,390
3	Ties, 6"x8"x8' - 6', 22" on center @ $5.15 each...	2.80	14,790
4	Ballast, 0.5C.Y. (crushed stone @ $2.50/ton).......	1.60	8,450
5	Labor 1.5 hours @ $3.85 per hour.................	5.75	29,960
	Cost for basic items......	16.20	85,536

VARIABLE ITEMS

No.	Description of item	Cost per mile		
		Flat	Rolling	Mountainous
6	Clearing and grubbing, grading and drainage (average prices)......	$55,000	$71,000	$166,000
	Cost of basic items....	86,000	86,000	86,000
	Total cost of 1 mile of track................	141,000	157,000	252,000
7	Land; right-of-way, yards and terminals[a].	60,000	60,000	60,000
	Total cost of 1 mile of track including land[a] (item 7)................	201,000	217,000	312,000

a/ Varies according to location and land use. These figures are based on a right-of-way 100 feet wide. This gives 12.1 acres per mile @ $5,000 per acre. This item, as well as others, must be adjusted for local conditions.

significantly. The average of a large number of cases is shown in tabel F-2, condensed from Drinker's Tunneling, and updated to reflect 1968 costs. All costs are for U.S. standards using conventional mining techniques.

Table F-2. Average Cost of Tunnel Construction

Material	Cost per cubic yard				Average total cost per linear foot	
	Excavation		Masonry			
	Single track	Double track	Single track	Double track	Single track	Double track
Hard rock..	$60	$55	$120	$ 83	$700	$144
Loose rock.	31	35	90	104	810	122
Soft ground	36	46	150	105	1,380	1,880

Rails. Tons (2,000 pounds) per mile of track equal 1.76 times the weight of rail per yard in pounds. An allowance of an additional 2 percent for cutting and waste should be made. The freight from mill to delivery point is frequently a considerable gross item. The present mill price for standard 100-pound-per-yard rails is $140 per ton. Light rails are $5 to $44 per ton more than the 100-pound rails. Prices of rail fastenings are about $1.40 per foot.

Crossties. Creosoted ties range in cost from $5.15 to $8.00 per tie.

Frogs, switches and crossings. Switches in place will cost from $2,000 to $4,800 per switch. The cost of a crossing of two railroads will depend on the angle of intersection, and will cost from $1,500.

Ballast. The cost of ballast may run from $8,400 to $15,000 per mile for the best of broken stone. An ordinary average is $10,000 per mile of track. Quantities and unit costs are given under the heading Track laying.

Track laying. This item includes track laying, surfacing, and hauling track materials from the point of delivery to the places where used. The contract price for track laying alone is frequently $3,500 per mile at present U.S. prices for labor. However, there are many records of track laying by means of special track-laying cars for as little as $600 per mile. Ballasting is sometimes deferred until the road is in operation. The surfacing may then be a separate contract at about $5,050 per mile. Allowing an average figure of $2,210 per mile for the train service, the total cost to the company for these items will average about $7,150 per mile.

Fencing. The cost of fencing will average about $1,750 per mile of fence, or about $3,500 per mile of road when both sides are completely fenced. Often only a small fraction of the total length is fenced.

Buildings and miscellaneous structures. Station buildings and fixtures average $6,650 per mile. Unit allowance for a small frame passenger station is $15.50 per square foot; for platforms, $2.10 per square foot. The unit cost of six section and tool houses averaged $3.90 per square foot of area. The cost of water stations of ordinary capacity will vary from 39 to 51 cents per gallon of capacity. Sign boards cost $70 to $90 each, and whistle posts, mile posts and rail rests cost about $25 each. A Y configuration can take the place of a turntable providing land is available. Using a radius of 300 feet with 100 feet of track for the engine at the tail of the Y, about 1,050 feet of track plus three switches will be required. The tail of the Y will require land for 400 feet from the main track.

Turntables. This item may cost anywhere from $26,300 to $55,000. The turntable itself is made either of cast iron or structural steel, or sometimes of a combination of structural steel trusses with a cast-iron center.

Coaling stations. Coaling stations for steam railroads may vary from a mere platform or bunker from which the coal is shoveled into the tender (although at a considerable cost per ton) to the very elaborate and costly coal pockets in which coal is deposited by coal conveyors or dumped from cars drawn up an incline, and from which the coal slides through chutes to the tender. The cost must be computed for individual cases. Ash pits likewise vary from a mere pit between the rails to an elaborate adjunct of a coaling station by which the ashes are immediately transported on a conveyor to an ash car.

Terminal grounds. Although the area of terminal grounds may be not more than 3 or 4 percent of the total property area, its gross cost, or its cost per mile of road, may be more than the cost of all the remaining right-of-way. In an 80,000-square-mile area served by a railroad, the valuation of terminal grounds was 71 percent of the total valuation of all the line right-of-way, gravel pits, station grounds and terminal grounds.

Miscellaneous. Shops, roundhouses, and shop tools and machinery will average about 3 percent of the total cost of a road. Snow fences, bridge ticklers, track scales, mail cranes and bumping posts must be allowed for on all large roads, but their relative cost is insignificant. For signals the cost is so variable, depending on the degree of elaborateness of the system, that average unit prices per mile of road would only be misleading.

Telegraph lines. A conservative estimate is $4,400 per mile of road for a single-wire line, or significantly less if poles are very cheap.

Freight on construction materials. This item applies chiefly to transportation of track material such as crossties, rails, etc., and may amount to 1 percent of the cost of the road. Frequently this item is ignored, the freight being added to the cost of each item.

Contingencies. Contingencies are usually estimated at 5 to 10 percent of the total of the preceding items.

Engineering, superintendence and legal services. The cost of these services is frequently 5 percent of all the construction work. The legal work will cost about 1 percent.

<u>Organizational expenses</u>. A minimum of 1 to 1.5 percent of the cost of all construction work is allowed for organizational expenses.

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APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II - TELECOMMUNICATIONS

Agency for International Development

September 1971

CONTENTS

FOREWORD

The project analyst using these guidelines should first read Part I, General Guidelines. It provides insights into key considerations for capital project appraisals (CPA's) in all sectors, and includes a detailed discussion of the methodology for calculating the internal rates of return, the cost-benefit ratios, and other relevant measures of the worth of a project.

For telecommunications projects, internal rates of return should be computed from the viewpoint of the business enterprise, and from the standpoint of the national economy. These two criteria for project appraisals are described in Chapter III and illustrative computations are presented in Chapter VIII of the General Guidelines. The analyst should be familiar with the conceptual and computational differences between the two measures.

These guidelines deal expressly with those matters relevant to telecommunications. They tell the analyst how to think about a project in telecommunications; what to look for; and how to assure consideration of all elements essential to a project. They suggest the importance of recognizing institutional, cultural, political, and other factors which can weigh heavily on a project. They encourage concentration on big issues in broad orders of magnitude, leaving details and matters of lesser importance to be explored in a subsequent study.

The CPA is most efficiently undertaken by multi-disciplinary teams, e.g., social scientists (economists, financial analysts, political scientists, etc.) and technical specialists (engineers, agriculturists, etc.). The structure of the individual multi-disciplinary team can only be detailed within a specific analytical and project context. The term project analyst or analyst, used herein, refers to a member of a team engaged in a CPA.

I. INTRODUCTION

Purpose and Scope

These guidelines are applicable to all elements of common-carrier communications systems, including investment in outside and inside physical plant, operations and maintenance, management and technical personnel, operating procedures, financial analysis and systems planning.

The General Guidelines deal extensively in chapter I with features of a CPA: that which distinguishes a PPA from the feasibility study; the merits of the CPA; and the depth of inquiry and the degree of sophistication of analysis that are appropriate. The comments there are equally pertinent to these guidelines for telecommunications and should be reviewed.

Certain economic concepts and tools are needed for a CPA in telecommunications, such as shadow pricing, sensitivity analysis, discounting, etc. They are described in the General Guidelines and are not repeated here.

Using the basic approach of the General Guidelines. for CPA's, these guidelines will outline the following:

- Data required for preliminary appraisal of telecommunications projects.
- Considerations affecting telecommunications projects.
- Steps in conducting a CPA.

The analyst should concern himself primarily with assessing the need for the project, examining alternative ways to satisfy the need, making preliminary estimates of capital and operating costs, quantifying the identifiable benefits and discussing the merits of various concepts with reasons for selecting the proposed approach. The analyst should seek to avoid the need to use costly engineering investigations in the CPA.

General Characteristics of Telecommunications

The needs met by telecommunications can be filled by a wide range of services, namely:

- Mail -- local, intercity and international
- Telephone -- local, intercity and international
- Telegraph -- intercity and international
- Telex -- intercity and international
- Special services -- radio, telephone, pay stations, PBX, PABX, facsimile equipment and automatic answering and recording devices.

Although these guidelines are not concerned with mail, it is clear that the quality of mail delivery (reliability and speed) will affect the need and demand for other services.

These guidelines are only concerned with public services, but it should be recognized that in situations of very low demand and important communications needs, alternatives to public facilities exist in the form of individual radio installations.

Telecommunications projects, like other infrastructure projects, generally require comparatively large amounts of capital relative to direct employment generated; and the labor force for such projects is generally one in which there is a comparatively high proportion of skilled workers. In most LDC's, the equipment required for telecommunications projects must be imported. In at least the construction, installation and initial phases of operation, foreign labor inputs may also be required.

In the early stages of development of the telecommunications sector -- and even at later stages -- proposed projects may involve investment of oversized equipment capacity.

These characteristics necessitate that the analyst give careful attention to:

- The possible need for the use of an accounting rate or shadow rate for foreign exchange in valuation of imported capital inputs.

- The availability of skills required for the project, and the proper wage rates to be used in pricing both domestic and foreign labor inputs.

- The use of an appropriate rate for the opportunity cost of capital which is especially important because of the large capital requirements of telecommunications projects.

Telecommunications, in common with other infrastructure, is highly complementary with other activities in the economy. The return on investment in telecommunications facilities depends greatly on the levels of other economic activities.

Overinvestment in telecommunications facilities may result in relatively good service but a poor rate of return, i.e., a waste of scarce resources. Underinvestment may lead to traffic overloading and poor service. Because of maintenance and other difficulties, high operating costs may result, again leading to low rates of return. In addition, rates of return are sensitive to the skills of management and other personnel, to the rate structure, and to the quality of planning.

Telecommunications facilities provide common services to both consumers and to productive enterprises; such services, therefore, are both consumers' and producers' goods. From the standpoint of the role of telecommunication facilities in economic growth and development, the two categories of service merit different priorities. In practice it may prove difficult to reflect this in the valuation of the benefit to be provided by the project. However, as some portion of the service has a greater economic value than others, pricing policy should be designed to reflect the government's priorities on the categories of services to be encouraged and those to be discouraged. That is, in order to restrain demands on a limited capacity, higher rates should be imposed on nonessential (residential) users than on industrial and commercial users where efficient communication makes a more direct contribution to economic development.

There is a special relationship in the telecommunications sector between demand and quality of service. The economic value of the system is reduced for all concerned if demand is permitted to overload available circuits. Beyond some point in traffic loading, a system's performance deteriorates extremely fast. Though it is difficult to quantify the total loss from deteriorated service, it is still meaningful for a target level of quality to be set. Systems planning should be geared to prevent performance from falling below this level.

In many -- if not most -- LDC's, telecommunications facilities are governmentally owned and operated. Where they are not so owned and operated they are almost invariably a monopoly, subject to varying degrees of government regulation. Moreover, the domestic service -- and the domestic component of international service -- cannot be supplied by imports as is the case with most commodities. These features have important implications for the valuation of output. Specifically:

- Prices of the output are administratively determined, either directly or by regulation.

- Different prices may be established for the various categories of users.

Frequently, telecommunications services are underpriced, posing continuing financing problems for maintenance and for new additions. Another frequent error is mispricing among competing telecommunications services, causing uneconomic shifts among modes. The pricing of services should be considered in the CPA.

A particular telecommunications facility may be desired for purposes of national defense or to promote integration of different regions of the nation. In such a case techniques to determine the least-cost alternative could be applied.

Macroeconomic Development Strategy

National and regional economic development policies have an important influence on the total demand and the distribution of demand for telecommunication services.

- The rate and composition of economic growth will greatly influence the demand for telecommunications. To take one case, government emphasis on fostering manufacturing and exports will result in different telecommunications requirements than will comparable emphasis on agricultural activities.

- Regional development plans of the country will have large effects on the total amount and geographic location of investment in telecommunications facilities.

- Government policies on exchange rates and import policy will substantially determine access to and the cost of imported equipment, supplies and technical expertise.

- Government policies on the pricing of telecommunications services will determine not only the revenues yielded by the system but also the extent of excess demand, the availability of internal funds for expansion of capacity, and the pattern of use of the services.

- The size of the government's investment budget will help to fix the funds available for telecommunications.

- Growing emphasis on international trade and investments can cause an extraordinarily high rate of increase in demand for international telecommunications services. In turn, these will exert an impact on domestic services, particularly on its quality.

The project analyst's task is to appreciate and measure the links between macroeconomic matters and the project he has to appraise. How will these matters affect the size, timing, cost, profitability, and technical characteristics of the project?

lations and significant additions to telecommunications capacity be selected only after intrasectoral relationships are considered. For example, installation or expansion of an urban phone system will undoubtedly create demands for long-distance and international communications. Must these related systems be introduced simultaneously? Or, in the matter of band use, should the project contemplate a band width wider than that needed for one telecommunications mode in order to accommodate another?

The very close interrelation between needs in the various forms of telecommunications suggests that, by the time a project is proposed, there has been an overview study of the telecommunications sector. A comprehensive sector study will provide the project analyst important information on related telecommunications needs and availabilities. It will:

- Identify principal factors affecting demand for telecommunications services, providing historical data and projected requirements.

- Describe the character, condition, and location of the existing plant, including an inventory and brief description of the existing common-carrier and privately owned facilities. (A list of typical system elements is presented in appendix A.)

- Provide a description of the operating characteristics of the system. At a minimum, it will include information on the population, topography, climate, and economic characteristics of the area served; existing service to cities, towns, and villages recorded in an area schematic diagram or on maps; and indications of potential new service areas.

- Describe the quality of the existing services. (A list of characteristics relevant to the quality of existing services is given in appendix B.) This has an important bearing on the revenue of the system. Poor quality causes loss of customer confidence, and therefore reduces use. Poor service may also divert a customer to other possible competing services, such as telegrams, privately owned radio circuits, or direct messengers for short distances.

assessment of the adequacy of telecommunications training institutes; if none exist, a specification of training programs may be required. Programs which require foreign technical assistance should be subjected to the same evaluation criteria. To the greatest extent possible, personnel training should be coordinated with project implementation in order to minimize future bottlenecks in requirements or waste where future supply may exceed demand.

. Provide historical revenue data along with past and present rate structures and an assessment of the adequacy of revenues to meet current operation, maintenance, and development costs. Government subsidies, if any, should be noted and a determination made of the reason for their existence. If a sector study is quite detailed, the revenue structure will be analyzed in terms of basic charges, extension, private-line rental, PBX, service connections, trunk calls, telegraph, telex, radio licenses, international charges and uncollectible revenues. For applicable types of charges, the analysis should attempt to determine if the costs of providing the particular services are covered.

. Include an analysis and recommendations on manual versus automatic operation of the switching, recording, and billing functions in the system. The question of manual versus automatic operation can easily be reduced to a determination as to which represents the least-cost alternative, given the opportunity cost of capital and the shadow prices of other factors in the country concerned (see chapter V of General Guidelines for type of calculation).

. Include an evaluation of the existing numbering plan or the design of a new one. These factors will affect the characteristics of proposed projects, and decisions pertaining to them should be available to project planners.

. Analyze system users by type and location. Telecommunications is a rapid-growth industry because of the increasing number of users, more intensive utilization, and greater variety of communications facilities. Detailed knowledge of the kinds of users and their particular demands is also helpful for the purpose of rate structuring, a subject to be discussed subsequently.

. Provide estimates of costs of physical resources necessary for the implementation and operation of projects.

Only approximate estimates of costs will be available. Usually cost data are readily available from manufacturers for most types of inside and outside plant equipment. For system and project planning it will be useful to have data in forms amenable to rapid cost calculations. Examples of such "modules" or broad-gauge units are the cost of required inside or outside plant facilities per one thousand urban or rural telephone subscribers, the cost per mile of wire or cable in flat or hilly terrain, the cost of microwave transmission per hundred miles of coverage, etc.

. Indicate the major respects in which the existing system needs modifications, apart from future expansion. Such modifications could embrace changes in the system's configuration and also cover:

1. Changes in schedules of user charges or means for achieving higher rates of return that would provide resources for future expansion and reduce marginal demand that may be overloading the system;

2. Administrative means of keeping demand down to levels that do not overload the system if rates themselves cannot be used to achieve a check on overloading;

3. Improved maintenance, inventory control, changes in personnel policy, training or other management practices;

4. Correction of imbalances or deficiencies in the sector (geographic, segmental, peak hour, spare parts, equipment, etc.).

. Project future total demand for services and coefficients of intensity of traffic for these services. The distinction between "demand" and "traffic" is important. The former term generally refers to equipment requirements which are necessary to serve existing and potential customers. The latter term refers to the frequency and the way in which the equipment is utilized. A comparison of the existing capacity and usage of the system with forecasts results in an identification of future requirements for inside and outside plant. Projects should generally cover future needs for a minimum of 10 years, but there may be reasons for short-run programming to meet unusual near-term requirements.

Traffic and revenue data should be available for:

1. Local telephone service, cities and towns
2. National toll, intercity
3. International toll
4. Telegraph, local and intercity
5. Telegraph, international
6. Telex, intercity
7. Telex, international
8. Special services.

Each of the above eight categories needs to be projected separately because of the different factors underlying their respective rates of growth. The typical problems faced by planners in developing countries are (1) the lack of historical data for local and intercity traffic, (2) lack of knowledge concerning the real level of pent-up demand, even where subscriber waiting lists are kept, (3) uncertainties with respect to regional or industrial development plans, (4) equipment-traffic relationships, and (5) the changing proportional distribution of major types of subscribers.

. Identify the constraints within which the project will have to be carried on. Many constraints arise at the national or macro level. The analyst should be aware of what macro and sector planners are doing that will relieve constraints affecting telecommunications systems, e.g., increasing the government's investment budget for the sector, or easing foreign exchange regulations. If today's constraints are likely to be removed by macroeconomic developments, today's rejected project might become tomorrow's eligible candidate. The General Guidelines include a discussion of those aggregates and policies in a macro plan which can affect sectors and projects.

Constraints frequently plaguing projects could be such matters as shortages of investment funds, licensing of imports and great delays in connection therewith, endemic shortages of materials, faulty management and untrained labor force, overly political weight in the setting of rates, or threat of nationalization of foreign-owned enterprise. The analyst will have to focus on key constraints. It is the severity of the problem that he must isolate.

While it is not to be expected that all of the information described above will be available from available sectoral studies or plans, the analyst should rely to the maximum extent possible on such sources. Where sectoral studies are not available or are deficient in important respects, the analyst should identify the data required to permit an appraisal of the project. In the following section, the steps in a CPA are discussed; when these steps involve estimates, data and projections, it should be understood that if these are available from sectoral or special studies, they should be used unless they are deemed inadequate. The adequacy of such data should be evaluated in terms of the underlying assumptions, methodology and timeliness of the sector study.

III. STEPS IN THE CAPITAL PROJECT APPRAISAL

As outlined in the General Guidelines, project preparation and appraisal consist of the following:

1. Identification of need for project and category of project
2. Formulation of promising physical resource flow plans
3. Pricing the project
4. Selection of the most promising alternatives
5. Computation of rates of return
6. Sensitivity analysis of rates of return
7. Evaluation summary.

While the above steps can be discussed as discrete steps that will occur in the stated order, it should be recognized that in the course of carrying out these steps there will be considerable interaction. For example, in carrying out step 4, the analyst may find that other alternatives suggest themselves, so that he may find it necessary to return to step 2.

Identification of Need for Project and Category of Project

The need for the services to be provided by the project will be indicated by the relation of projected capacity to projected demand. Because of the substitutability of means of communication, projections should reflect what will be done in competing forms. An improvement in mail service, for example, will reduce the demand for telegrams. Similarly, improved telephone service will affect demand for telegram service. In projecting trends or using correlations based on the past, it is important to allow for such changes.

Unsatisfactory levels of service from existing facilities, excessive waiting time for access to long-distance facilities, long lists of potential subscribers, etc., indicate that some kind of action is called for and may offer important clues as to what kind of action is most promising.

Where sector studies or surveys have established needs for the future, or where the scope of work controlling the CPA identified the need, the analyst can generally take this as given for the purposes of the preliminary appraisal.

However, projects may fall into one of several categories, and an established need for, say, increased local telephone service does not necessarily determine the specific form of project best suited to meet the need. Established needs for telecommunications services may be met, generally, by a project falling in one of the following categories:

- Original installations
- Additions to and/or modernization of existing plant
- Improved operation of existing facilities, e.g., by better management, training, operation and maintenance manuals.

Each of these categories is discussed below.

Original Installations

Projects involving original installations are most likely to be encountered in rapidly developing subcenters in LDC's. Such projects may emerge as components of the government's program to alter the regional pattern of economic development; as infrastructure to facilitate the exploitation of mineral or other natural resources at some distance from existing telecommunications facilities; or simply to meet long-felt needs that have gone unsatisfied because of budgetary or other constraints.

The absence of established data in the service area will complicate the task of project appraisal for original installations. The potential for general economic development and population growth in the service area should be the focus of the CPA. If the original installation is designed primarily to serve a new land settlement and development scheme, or an industrial estate-worker housing development, it may be advisable to consider telecommunications as an integral component of the overall scheme, rather than as a separate "project."

Plant Additions

The major emphasis of these guidelines will be on plant additions. Presumably, the analyst who prepares a proposal will have access to such historical information as system demands, system peaks, and usage information, and will be well acquainted with the present system equipment and configuration. Any new additions to the system should work effectively with the existing system.

For a plant addition, required background information will include:

- The long-range sector plan
- A near-term plan if one has been prepared
- The most recent estimates of future system demands
- A discussion on requirements and deficiencies of the present system.

Within this framework the analyst should probe the necessity for the proposed additions to the telecommunications system. What is the need to be first satisfied?

Improved Operations

Improvements in operating techniques leading to more efficient use of facilities and personnel usually command an important position in operational studies. They are no less deserving of attention in CPA's. The need for operational improvements can be the basis for proposals to study and make recommendations through technical assistance channels. It is not uncommon, for example, for some developing countries to have new or almost new telecommunications equipment that is operated inefficiently or below intended capacity levels. Such a situation might be improved at relatively low cost by employment of technical advisers to offer training courses and to prepare operating manuals.

Projected Requirements for the Service

A project proposal which involves investment in facilities and plant must be based on existing and projected traffic covering those geographic areas in which telecommunications services are to be upgraded or newly supplied. When projections in a sector study are resorted to, they should be updated and verified by using the most recent projections of relevant socioeconomic variables and growth rates from the national plan. Where price changes are projected for a particular service one should allow for any effects on demand that can be expected. Several useful approaches to the development of projections are suggested below.

Telephone Services

Demand for telephone service is influenced by general economic and demographic variables. Implicit relationships which might be explored for any given country include the correlation of number of subscribers, number of instruments or volume of traffic with such variables as:

- GNP, including per capita GNP and the wage share of GNP
- Foreign trade, imports and exports
- Nonagricultural domestic output and the manufacturing share of this output
- Electric power consumption
- Population growth, including densities and number of households
- Literacy rates.

Historical attempts to obtain explicit relationships, i.e., estimation formulas with reliable coefficients, have not met with much success in LDC's. The difficulties encountered in obtaining reliable statistical measures of the relationship of growth in demand for service to growth in the economy arise, in part, from:

- Suppression of demand by rationing of the available service, i.e., the actual demand is not evident in statistical information.
- The "lumpy" nature of investment in facilities which gives rise to discontinuities in the growth in telecommunications services.

Long subscriber waiting lists and overloaded circuits resulting in poor service and frequent breakdowns curtail demand. In cases where expanded facilities have been implemented, there is usually a quantum jump in subscribers and traffic which eventually stabilizes at a 10 to 20 percent average annual growth rate.

International traffic, however, can sometimes be estimated through correlating it with the level of foreign trade or by fitting an appropriate curve to the usually available historical data. Even here, quantum jumps may be evidenced and, if so, historical data prior to the jump should not be used for trend purposes.

In place of such correlative analyses, projections of demand can be based on interviews of would-be subscribers. Interviews are conducted with commercial, industrial and governmental subscribers concerning their future requirements, and a review is made of economic development plans. This exercise is designed to produce generalized economic growth rates applicable to various geographical areas of the country. Existing use is then projected into future demand using these growth rates; however, if the intended service area is small, a "block-to-block" analysis can be made, especially if a land use plan has been made. The proportional distribution by class of subscriber is usually a guessed-at estimate, with domestic subscribers accounting for larger, and business and governmental subscribers smaller, proportions of the total.

The above methods, while widely used, should be considered as providing the lower limit of the long-range growth rate. Almost universally, telephone growth substantially exceeds growth of other aggregative economic or demographic variables. In addition, provision should be made for the quantum jump, which might be reckoned as 25 to 50 percent greater than the existing waiting list. This pent-up subscriber demand can usually be satisfied within the first year or two following completion of the project.

The foregoing suggestions for projections are based on the assumption that no constraints are imposed through government policy to limit the total volume of service even after new facilities are installed. If such a policy does exist then, of course, projections should be made on the basis of the policy assumptions stated in the national economic plan or sector study.

The second step, after projecting the number of subscribers and instruments, is to project local and long-distance traffic volume. Local traffic is expressed in the number of calls per telephone per month and usually varies directly with the number of subscribers. Historical data in the country are used, or are borrowed from a similar country. Local traffic projections usually follow the same long-range growth patterns as demand. However, if sufficient data are available, a time trend (covering, say, 10 years) of the growth in the average number of calls per instrument per month or year can be extrapolated.

Long-distance calls (national toll), on the other hand, are generally projected in a matrix covering all pairs of intended service areas. Here the forecasting method of gravity modeling is used. Models are based on well-established evidence that the volume of traffic is a function of the number of instruments or subscribers in each of the city pairs and the distance (or square of the distance) between the cities. Another variable, the tariff between two cities, can also be introduced. An article "Evaluating the Volume of Traffic by a Simple Formula", published by A. Jipp in the January 1960 International Telecommunication Journal gives the suggested Jipp model as the following empirical formula that represents quite well the traffic between European nations:

$$V = \frac{K+M_1M_2}{Wr^2G}$$

where

V = Estimated volume of traffic between M_1 and M_2 on selected date.

K = Constant for international calls on selected date.

W = Frontier obstacle factor.

M = Number of subscribers (telephone instruments).

r = Distance.

G = Tariff.

One drawback to this formula is the difficulty in estimating the factor W. This factor represents political affinities, currency restrictions, language differences, and custom barriers. Such a factor is not appropriate to within country interurban traffic.

A good feature of Jipp's model is the inference that telephone traffic is dependent upon the product (M_1M_2) of the number of subscribers at each end of a route. Logically, the traffic might be expected to follow this pattern since the number of conversation paths between pairs of talkers is equal to M_1M_2.

A second traffic model, developed by R. I. Hart, is contained in an article "Traffic Forecasting and Its Application to the Design of Communication Satellite Systems," <u>International Conference on Satellite Communications</u>, London, particular route. This model is similar to Jipp's, but utilizes a different functional relation:

$$V = A + BM_1M_2$$

where A is a constant and B is a regression coefficient in which distance between cities, tariff and any other factors influencing volume of traffic are taken into account. The above function assumes a linear growth of telephone traffic. However, most analysts have concluded that international traffic tends to grow exponentially rather than linearly.

Neither Jipp's nor Hart's model may be appropriate for forecasting interurban traffic for a country having relatively few telephones. However, they do suggest avenues of approach for the development of a mathematical model applicable to such circumstances. A model, developed by Kalmann Schaefer, Checchi and Company, Washington, D.C., staff econometrician, provided a solution to the problem of establishing a completed traffic matrix and predicting interurban telephone traffic.

Schaefer established a high degree of correlation (ranges .82 to .87) between the product of subscribers and the number of telephone calls for each of three pairs of cities in Chad, Africa. The correlation analysis revealed that as a product of subscribers of two cities grows, the number of telephone calls between them grows at the same rate and at a constant proportion. Mathematically, the relationship is expressed as follows:

$$Y = aN_1N_2$$

where

Y = number of telephone calls between a pair of cities

a = constant (determined to be 0.0208 in Chad in 1967)

N = number of subscribers in each city or town.

This relationship means that if the number of telephone subscribers in each of two population centers and the constant a can be established, Schaefer's formula can be used to predict interurban traffic between these two centers.

Telegraph

Generally, historical data on telegraph traffic are available for internal and international volume, and time series projections are acceptable. For the purpose of revenue estimating, it is desirable to disaggregate messages into regular, special delivery, and night letters. The gravity model explained above may also be used in projection of required capacity. International traffic requirements are particularly sensitive to growth in the country's foreign trade.

Telex

Telex (teletypewriter) services are used in businesses, government agencies and embassies, with the former two types of users generating internal as well as international messages. Telex communication has experienced rapid growth in recent years, and projections of either the number of subscribers or traffic volume for any given country are likely to involve a substantial margin of error. A conservative and very rough rule-of-thumb for a developing country is that total volume will increase at an average annual rate of 35 percent for the first 5 years and 20 percent per year thereafter.

Formulation of Promising Resource Flow Plans

A basic pattern of using forecasts of demand for service is to place such forecasts in relation to increments of additional capacity of a particular kind. This is illustrated in chart 1, where additional increments for feeder cable for a particular route are charted in relation to projected demand.

Because the balance of economic factors will differ among different elements of the system (cables, central station, switching equipment), decisions on increments of installation will vary.

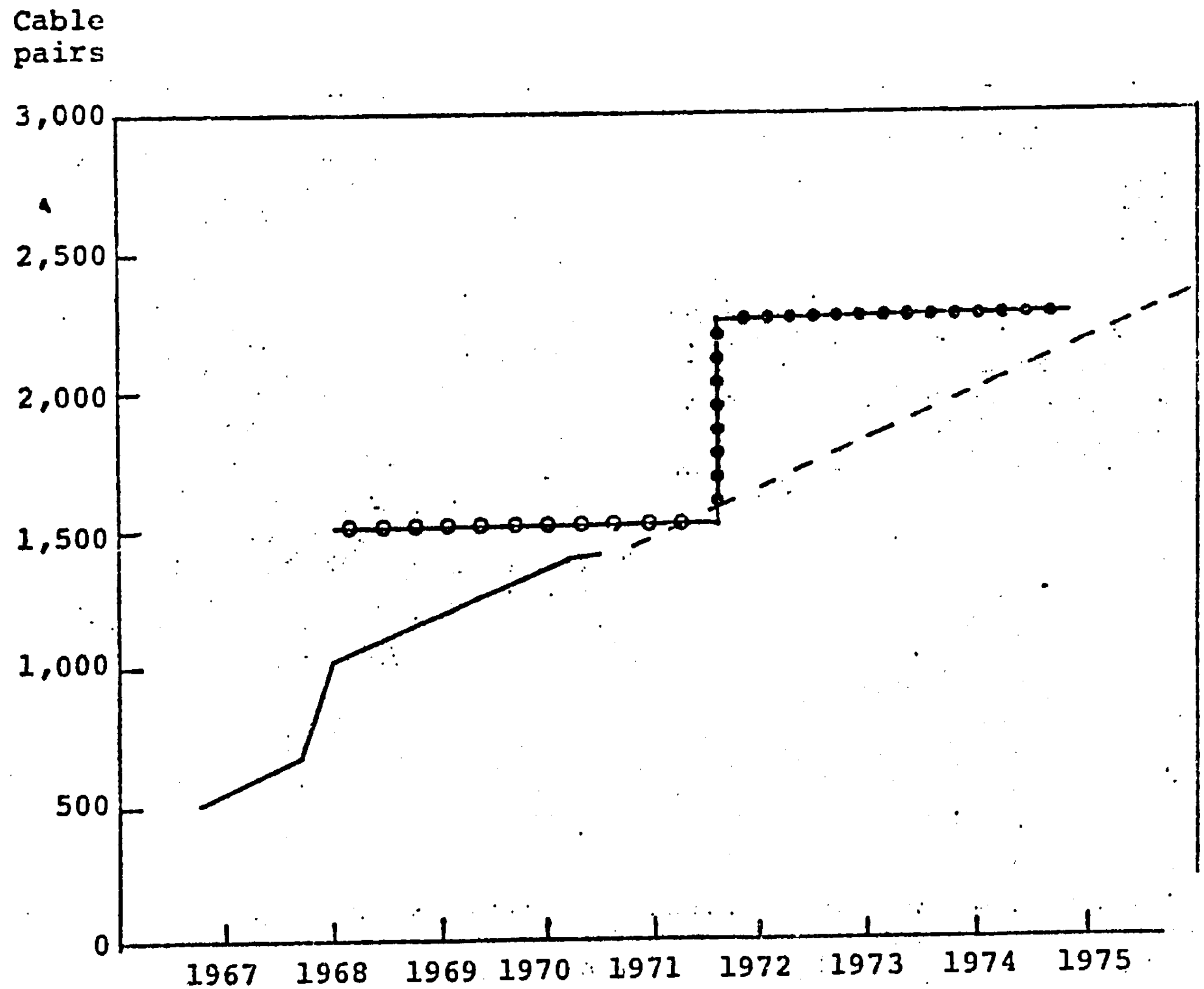
In addition to increments of installation (size and quantity), there are opportunities of tradeoffs between increased investment and lower operating costs, equipment with longer life or shorter life, or alternative locations of facilities.

Some typical choices faced by the analyst are:

- Aerial versus underground cable
- Conduit versus direct buried cable
- Two large trucks versus three small ones
- Linoleum versus terrazzo flooring
- Carrier versus metallic circuit
- Expanded central office versus new center
- Five years versus 10 years growth

Route Area No. 5

(Illustrative figures)



Key:

Actual pairs in use ————————
Forecast ------------
Feeder cable capacity at 85 percent -o-o-o-o-o-o-o-
Capacity added by project at 85 percent[1/] -•-•-•-•-•-•-•-•-

1/ Estimated ceiling on utilization, based on circumstances.

may require new conduit reinforcement; the other, more cable, one in existing conduit. One method may provide foreseeable growth for 5 years; the other, 12 or more years.

Since ordinarily there are a large number of choices, the analyst must exercise judgment on which alternatives are worth considering, based on compatibility with characteristics of existing equipment and local circumstances.

In considering alternative ways of meeting the forecast demand, certain subchoices within the project can be made, based on technical grounds. Others are linked with other choices, pointing toward alternate projects.

In formulating promising alternatives, the analyst must avoid using "rules of thumb" which may be based on substantially different circumstances. Developing countries have a substantially different structure of costs (foreign exchange, capital, labor), making it necessary that formulations reflect the costs of the particular country. In the formulation process the analyst will make substantial judgments that reflect a "feel" for possible costs.

A limited number of technical considerations must be integrated in the formulation of alternatives. They include a knowledge of present switching equipment installed on the system to determine its compatibility with proposed equipment, as well as the consequences of the new installation. The nature of a telecommunications system inherently involves a message transmission loss of intensity called attenuation. Additionally, a quick evaluation should be made of the amount of attenuation associated with the proposed installation and the possibilities of noise.

Quality of service is a function of customer satisfaction in establishing a successful connection and maintaining the intelligibility of a message from its point of origin to its destination. Technical design of the system can compensate for attenuation, including in some cases the amplification of the signal to bring it up to acceptable levels. Other technical factors causing loss of quality involve the introduction of such undesirable factors as echo; singing; noise and

Another important technical factor is the provision of adequate power supply and the means provided for its continuation in the event of interruption of the normal power supply. Potential technical problems which cannot be evaluated effectively without extensive engineering work should be singled out for detailed consideration in a subsequent feasibility study.

Pricing the Project

Conversion to Value Flows

At this point in the CPA it is important for the analyst to be familiar with pricing methods described in chapter II and appendix B of the General Guidelines. It is especially important to distinguish between the pricing of inputs and outputs for computation of the net national rate of return (where shadow pricing may be required) and the pricing of inputs and outputs for the computation of the business enterprise rate of return (where shadow pricing is not used).

Use of Costing Modules

In estimating costs, the analyst should avail himself of typical macro-unit prices to the maximum extent possible for which reasonably representative figures can be obtained within the country, based on similarly sized plants and features. A knowledgeable extrapolation of existing plant costs to present-day prices and an evaluation of the impact of variation in plant parameters should be sufficiently accurate for the purposes of the CPA guidelines. A construction cost index is particularly useful for costing facilities and appurtenances.

Operating and maintenance costs should reflect local labor costs and capabilities. The most important factor in preparing cost estimates for CPA purposes is that the same basis must be used for all the concepts being considered; the differences in cost between the various concepts will then point to the one with lowest costs regardless of the degree of accuracy of the estimate itself.

Typical quantities for the above unit prices are:

- Cost per loop-circuit of complete switching center
- Cost per unit volume of buildings
- Cost per kilowatt of emergency diesel- or gas-turbine-driven generator
- Cost per ampere-hour of battery plus charger
- Cost per channel of carrier equipment
- Cost per mile of pole line
- Cost per duct-mile of underground duct bank
- Cost per channel-mile of cable
- Cost per microwave terminal
- Cost per satellite ground station.

The estimates developed by the above unit prices will require some additions to recognize cost elements which are necessary to round out the order-of-magnitude capital cost estimates.

Capital Cost Estimates

The capital cost estimate should represent the total installed cost, that is, include all costs associated with design, engineering, construction and startup. The unit prices should reflect the shadow prices for imported equipment and for construction and installation manpower which may have to be obtained from outside the country. Additionally, for imported equipment, a separate item should be shown for import duties, taxes and other charges applicable to such items. These elements of cost are included in computation of the business enterprise rate of return; they do not constitute costs from the standpoint of the economy. It is recommended that allowances for contingencies be added and identified as such, taking into consideration the degree of uncertainty in the cost estimate based on local conditions.

From the national point of view, shadow pricing of telecommunications inputs is important because the foreign exchange component of investment is usually large, and total investment is high, relative to other factor inputs. In this connection, shadow pricing of the imported content of domestic inputs and exclusion of taxes on domestic inputs should be undertaken.

Annual Operating and Maintenance Costs

The following costs would be entered in operating statements, but in accordance with the procedures established in the General Guidelines, would not be treated as costs either from the point of view of the business enterprise or the national economy:

- Interest on borrowed investment capital
- Depreciation on plant and equipment.

Taxes on real property, if paid, would be treated as a cost from the point of view of the business enterprise, but not as a cost in the net national rate of return.

Fire and casualty insurance would be treated as a real annual fixed cost for both the business and the national point of view even though the policy of the company is to self-insure its property.

The operating and maintenance costs for each alternative should also include the following items:

- Operating labor, skilled and unskilled
- Maintenance labor, skilled and unskilled
- General and administrative costs
- Maintenance materials and supplies

The operating and maintenance labor should include the cost of supervision as well as payroll extras to account for vacation, sick leave, and other fringe benefits. If significant inputs of foreign technicians are involved, shadow pricing of foreign exchange components of wages may be required. If money wage rates for domestic labor do not reflect accurately the marginal opportunity cost of labor inputs, these factors should be priced at appropriate accounting wage rates in computing the national rate of return.

In addition, the analyst should estimate the number of additional people required to properly operate and maintain the equipment and facilities included in the proposed project.

<u>General and Administrative Expenses</u>

In order to account for these items, it is recommended that the analyst include an amount equal to some percent of the operating and maintenance labor costs, including fringe benefits and payroll extras, based on local experience. A typical allowance is about 25 percent.

Maintenance materials and supplies are intended to cover spare parts and other items of equipment as well as lubricants, chemicals, paint, etc., to keep the plant in good operating condition. Usually an approximate figure of 0.8 percent of plant investment is indicative of adequate maintenance standards.

Economic Lifetimes

The period of time that equipment or facilities can be expected to be operated economically under projected conditions is called the economic lifetime. The assumed economic lifetime of equipment or facilities has an impact on the rate of return. Assuming that equipment will be well maintained and repaired with proper spare parts where necessary, the following economic lifetimes are recommended as appropriate for estimation of outlays to be required for replacements during the period for which rates of return are to be calculated.

	Years
Buildings	40
Switching equipment	25
Switchboards	25
Station apparatus	15
Remote or emergency electric generators	20
Microwave radio equipment	12
Pole lines	25
Cable	25
Underground ducts	50
Vehicles	7

If, due to local conditions, the experienced life of equipment in the above categories has been found to be significantly less than shown, it is recommended that the shorter lives be used, with the cost of replacement (including labor) treated as an investment in the expected year of occurrence.

Rate Schedules

As noted in an earlier section, "prices" of the services provided by telecommunications are administratively determined, subject to the constraint that the rate for a particular service cannot be set at a level above that which users are willing to pay in order to obtain the service. As an integral part of the CPA, the analyst should examine the rate structure in the light of the following criteria:

1. Does the level of rates yield revenues sufficient to cover total costs of the services to be provided by the project, including a return to capital equal to at least the marginal opportunity cost of capital and other factors used, valued at their respective shadow prices? If not, would demand for the service fully utilize the planned capacity of the project at rate schedules adequate to cover total costs as defined above?

2. Does the level of rates restrict demand for the service to quantities (and service levels) that the system can supply? Does the level of rates curtail demand to the point that excess capacity exists?

3. Do comparative rates for alternative (substitute) services (e.g., long-distance toll rates for telephone and telegraph service) reflect the relative costs of the alternatives and thereby provide users the basis for a rational economic decision, i.e., a minimum-cost selection of a communications mode, taking into account their needs and the characteristics of the alternate modes?

There is a tendency in LDC's for government to establish rate levels and structures that do not meet the criteria noted above. In particular, there is a tendency to set rates below total costs (as defined above). Rates that are, in general, too low have two major effects: (1) the demand for the service(s) is stimulated beyond the systems capabilities possibly necessitating rationing; and (2) the revenues generated are inadequate to permit replacement of equipment, much less to permit expansion of capacity to meet the rapid growth in demand stimulated by less-than-full cost pricing. The results are accumulated backlogs of unfilled demands, deterioration of service, and continuous drains on the general revenues of government to supplement the revenues of the facility.

There is also a widespread tendency to underprice the less essential uses relative to the uses which make a more direct contribution to economic growth.

Revenue

Revenues should be estimated at the schedule of rates likely to prevail and at the schedule that the analyst has estimated to be appropriate for the service. Revenue, along with costs, can be projected in worksheets such as those suggested in the General Guidelines (chapter VIII).

In the calculation of the net national rate of return, the problem arises of how to value the services to be provided by the project. If rates likely to prevail are higher than costs, including the opportunity cost of capital, the value of services can be taken to be at least equal to the revenue since those using the service would not pay for it otherwise. In this case, the calculation of the net national rate of return presents no problem. One can even ask whether lower rates would not add to the net national return, if there will be unused capacity with the higher rates.

If the demand is fully satisfied at the rate likely to prevail, then one cannot place a higher value on the service, since the marginal user values the service at this rate.

A more typical and difficult situation occurs when rates are set at levels which do not yield revenues sufficient to cover all costs, including the opportunity cost of capital. In this case, we can be sure that the outputs have a value for the marginal user that is at least as large as the rate charged. An upper limit of the value of such services may be estimated from the "purchase" of telephone services that takes place on an unofficial basis, e.g., buying and selling of telephone installations on a quasi-black-market basis. A more valid valuation may be determined from a carefully designed questionnaire answered by a representative group of waiting customers and nonusers. It would seek to discover the rate customers would be prepared to pay for various kinds and frequencies of service.

Selection of Most Promising Alternatives

The methods for choosing among alternatives that are outlined in the General Guidelines allow a wide scope in searching for the most promising alternatives in telecommunications projects.

Telecommunications projects are characterized by relatively large investments, long life of equipment, economies of larger capacity equipment and substantial foreign exchange requirements. These characteristics make the shadow price of capital and foreign exchange relatively important in choosing alternatives.

Consideration of the value flows of the promising alternatives may indicate that more than one alternative is worth further consideration either because the choice requires further study of important variables and/or because different levels of service make it desirable to keep the matter open.

Inasmuch as telecommunications systems historically have had steadily increasing demands, they are faced with the need for increasing their facilities to meet the ever-larger demands. The analysis of the scale of a facility should deal with the concept of size relative to requirements and spare capacity. Timing is tied to scale by the length of time required for growth in demand to absorb the excess capacity.

By discounting the values of inputs and outputs of installations of varying capacities, the optimum scale can be ascertained; the methodology is illustrated in chapter VI of the General Guidelines. The benefits and costs of postponing the installation of a proposed project can also be assessed by the same type of computation.

A sound investment policy places a limit on the early provision of unused capacity. Unnecessary operating costs are avoided prior to the anticipated need for larger facilities, and capital is not diverted from other projects. Associated with the scale and timing of facilities is the economic feature whereby larger units usually can be installed at a lower unit cost. The analyst should explore the implications of size, timing and financing in order to:

- Provide a suitable interval between successive projects
- Take advantage of increased efficiency
- Achieve lowered unit costs
- Minimize wastes in tying up scarce capital in unproductive excess capacity
- Look for possible savings in manpower
- Provide adequate capacity for system growth, while at the same time avoiding unnecessary premature investments or large amounts of spare capacity.

Computation of Rates of Return

For the alternative(s) that are indicated as worth further consideration the analyst will compute the business enterprise and net national rate of return as described in the General Guidelines (Chapter III).

Sensitivity Analysis of Rates of Return

The question of uncertainty in project appraisal was discussed at length in chapter VII of the General Guidelines. Sensitivity analysis was recommended in cases of high-cost inputs and high-risk elements. For telecommunications projects, the following items might be considered for a sensitivity reveiw:

Imported equipment. This is a high-cost input which should be adjusted by the shadow price of foreign exchange. Variations in the landed cost of the equipment and/or the shadow exchange rate can produce considerable variations from the original cost estimate.

Site location. For proposals involving location of facilities at new sites there may be a difference in the cost of site preparation or in the convenience and accessibility of the site, or in the cost of bringing in the outside plant installations. All of these elements as well as others such as cost of property, taxes, community acceptance and special construction can be site sensitive and should be identified in the analysis.

Rate of capacity utilization. This could be a factor involving a large unit (e.g., cable) with extra capacity at low incremental cost versus a smaller unit with a correspondingly shorter time interval before the need for additional expansion. Overcapacity is often costly when present value calculations are used; therefore, the sensitivity analysis should cover alternative demand and traffic projections.

Evaluation Summary

In accordance with the General Guidelines (Appendix C), an evaluation summary should be presented in which the major findings are presented for consideration.

APPENDIX A: TELECOMMUNICATIONS SYSTEM ELEMENTS

A listing of the more important elements in a common-carrier type of telecommunications system is given below. This listing covers inside and outside plant facilities, system-improvement items and principal management functions. These elements should be included in the required inventory of a sector study and may be used for identifying possible interface points in plant addition proposals.

Inside Plant

Buildings
Switching Equipment
Switchboards
Carrier Equipment
Transmission Equipment
Power Supply
Signalling Equipment
Recording and Billing Equipment
Test Instruments
Radio Equipment
Satellite Ground Stations

Outside Plant

Pole Lines
Aerial Cable
Underground Cable and Conduit
Buried Cable
Submarine Cable
Coaxial Cable
Antenna Towers and Guys

User Equipment

Telephone Instruments
Call-Directing Units
Private Branch Exchanges
Private Automatic Branch Exchanges
Teletypewriters
Teletypewriter-Associated Equipment
Data Input and Output Equipment.
Facsimile Equipment

System Improvement

Plant Betterment
Protective Facilities
Operating Manuals and Procedures
Maintenance Manuals and Schedules
Training Programs and Classes
Maintenance Equipment
Test Instruments

Management Functions

Planning
Rates
Accounting
Billing/Collection
Customer Services and Public Relations
Purchasing
Personnel
Legal
Engineering
Operations

APPENDIX B: TELECOMMUNICATIONS SYSTEM OPERATING CHARACTERISTICS

For the purpose of assessing the operating quality of a common-carrier telecommunications system, a listing is provided below of relevant characteristics. These items are especially useful at the level of a sector study or systems analysis. Such data as may be recorded or collected establish the type and level of needed improvements from the viewpoint of both the operating company and the subscriber. Furthermore, these guidelines recommend that minimum acceptable levels of quality be included in the planning process whether that planning be project or sector. A number of the items below might be included in such planning:

- Grade of service required (lost-call probability)
- Number of completed connections in an average day; peak day; below-normal day
- Average holding time, expressed in seconds per call
- Number of completed connections during busiest hour
- Duration of short-term traffic peaks
- Daily and seasonal message patterns
- Waiting time for idle channel on-peak
- Average time to establish a connection
- Tolerable delay for subscribers
- Interfaces with other telecommunications systems
- International circuits and traffic
- Time zone diversity.

APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II - ELECTRIC POWER

Agency for International Development

September 1971

CONTENTS

FOREWORD

The project analyst using these guidelines should first read Part I, General Guidelines. The General Guidelines provide insights into key considerations as to the methodology for valuation of inputs and outputs and for calculating the internal rates of return.

These guidelines deal expressly with matters relevant to electric power. They tell the analyst how to approach a power project proposal; what to look for; and how to assure consideration of the factors essential to an appraisal of a project. They suggest possible institutional, cultural, political, and environmental constraints. They encourage concentration wherever possible on big issues in broad orders to be explored possibly in a subsequent study. The lead the analyst through the input and output quantification and the computations of the estimated rate of return for the project, in terms of which the desirability of future action on the project can be determined.

The CPA is most efficiently undertaken by multi-disciplinary teams, e.g., social scientists (economists, financial analysts, political scientists, etc.) and technical specialists (engineers, agriculturists, etc.). The structure of the individual multi-disciplinary team can only be detailed within a specific analytical and project context. The term project analyst or analyst, used herein, refers to a member of a team engaged in a CPA.

mission and distribution of electrical energy. Power systems are a basic part of a nation's economic infrastructure. Electric power is employed for the performance of essential electronic, thermal, and mechanical functions in industry, communications, and commerce, as well as for a variety of purposes in the home. Electricity has contributed to the phenomenal growth in human economic productivity and to enhanced creature comforts during the last century. The manifold benefits of electric service are recognized and sought in the LDC's; in fact, increased production of electric power is often regarded as an index of economic development and rising standards of living.

Scope of Guidelines

These guidelines are applicable to all elements of electric power systems, including investment in outside and inside physical plant, operations and maintenance, management and technical personnel, operating procedures, economic and financial analyses, and system planning. "Long-range system planning" would encompass many of the analytical aspects included in these guidelines.

Using the basic approach of the General Guidelines (Part I) for CPA's, the electric power guidelines will cover the following:

- The relation of the project to macroeconomic variables and national economic goals and strategies
- Contributions of sector studies to power project appraisals
- Political considerations and power projects
- The principal factors to be examined to disclose the strong or weak points of the project
- The fundamental mechanics of project preparation and appraisal
- A summarization of hard core data requirements.

Characteristics of Electric Power Systems

Electric power systems include relatively expensive components. They are the epitome of a high capital-intensive low employment type of project. The range of choice in the investment decision-making process for altering the relative inputs of labor and capital is very limited. A listing of typical electric power system elements and alternatives is given in Appendix A.

The physical function of power generation is the transformation of primary energy into electrical energy. Projects in this sector are very heavy users of fossil fuels (coal, oil, gas), falling water for hydroelectric production, and energy from nuclear fuels.

The power sector possesses its own system of transportation in the form of transmission and distribution facilities. This may be for the purpose of conducting power to farm areas over a rural electrification system or a high voltage transmission network serving intermediate voltage feeder lines conducting power from one or more sources to large urban areas. If fossil fuels are used, electric power utilities may also put heavy demands on the transport sector. In many countries, rail transport is, in turn, a heavy electric power consumer.

Another characteristic of electric power is the considerable hourly and seasonal fluctuation in consumer demand. This, combined with associated peaking problems and system load duration curves, requires that the attention of the analyst be directed to measures of capacity in the technical appraisal of projects in the power sector.

Electric power is frequently supplied or distributed through system networks or grids. It is often desirable for interconnections to be made between them, thereby improving the operations of both systems through the sharing of excess capacity. Such interfaces and the technical considerations associated with them are typical of the more important engineering design problems encountered in the power sector.

The quality of electric service has an important impact on the revenues and the rates of return earned by projects. If delivered voltage to the consumer is too low, his equipment may not only operate at lower levels of efficiency, it may also be impaired. Interruptions of electric power not only reduce revenue but also result in loss of customer confidence. If the supply is of poor quality or suffers frequent interruptions, increased use of electric power through additional electrical appliances and facilities is discouraged. In the extreme, major consumers may decide to invest in their own electric supply system. In the latter event the national cost of electricity is increased, with the increase in cost representing an impediment to development.

The characteristics noted above have important implications for project analysis. First, the heavy capital investment in such projects requires a careful consideration of the availability and costs of funds for construction and installation. Second, in most LDC's, a very large part of the equipment -- and some of the skilled labor required in construction, installation and operation in the early years of the project -- must be imported. If foreign currency is incorrectly valued at the market prices, the use of shadow or accounting prices is of critical importance because of the large import content of total investment; if fuel is imported, shadow pricing is equally important in the valuation of inputs for operations.

In computing the project rate of return to the national economy, shadow or accounting prices should be used in place of actual market prices in pricing inputs and outputs when market prices do not provide an accurate measure of costs or benefits. Shadow pricing is discussed in the General Guidelines (Chapters II, III and Appendix B).

The potential economies of scale available with large-scale installations and the rapid rates of growth in power demands -- experienced and expected -- lead to proposals involving the installation of considerable excess capacity in the early years of project operation. To prevent uneconomic commitments of capital, the analyst must evaluate the "cost" of different levels of excess (or reserve) capacity through the use of the discounting procedures explained in Chapter III and Appendix A of the General Guidelines.

As compared to relatively large and interconnected power systems occurring in the more developed countries, small, isolated power systems in LDC's may require relatively greater reserve capacities for unscheduled outages and maintenance purposes. This may be particularly true when a system has just installed new and more complicated units of much larger than customary size and considerable time is required for the acquisition of proficient operation experience.

The high fixed cost -- and comparatively small variable cost -- mix of power systems poses special problems and opportunities in pricing of output. These are discussed in a later section and in Appendix B.

Decisions about the type, scale, location and rate structure may be influenced by social, regional and political -- as well as economic -- considerations. Economic rates of return along with such considerations will form the basis for final decisions. The CPA can point up the economic consequences of different alternatives in juxtaposition with these other considerations.

II. RELATIONSHIP OF PROJECTS TO MACROECONOMIC VARIABLES, NATIONAL ECONOMIC OBJECTIVES AND POLICIES

If a national economic plan exists, development goals will have been established and national resource allocations planned to achieve these goals. Power projects can be affected in a number of ways by such a plan:

1. The planned rate of overall economic growth is an important factor in projecting the rate of increase in the demand for electric power.

2. The pattern of change in industrial structure will influence the future location of power projects and the magnitude of increases in power requirements. For example, a heavy commitment to industrial development will imply faster growth in power requirements than a similar emphasis on agriculture.

3. Policy guidelines for investment decisions may impose certain restraints on power projects. For example, national policy may place heavy emphasis on labor-intensive projects, on projects requiring small foreign exchange inputs, on projects that can be completed quickly, and on projects yielding a high rate of return. Some or all of these may have a constraining effect on power projects.

4. If the national plan also provides for regional development, this will clearly affect the spatial pattern of future power requirements and the location of projects. As an essential component of infrastructure for industrial development, power projects may be used to accelerate development in specified regions, but the economic possibilities of such efforts will depend in part on the location of primary energy resources.

5. Policy measures to limit imports and conserve foreign exchange may influence the choice between thermal and hydro installations, and between the use of domestic and imported fuels.

6. Projected government revenues and current expenditures will set the planned flow of government funds available for direct investments and/or loans for power projects.

7. Policy measures to restrain domestic production of nonessential consumers' goods (e.g., electric washers, driers, refrigerators and air conditioners) and high import duties on appliances will restrain the rate of increase in residential and commercial power requirements.

If a national economic plan exists the analyst should examine the implications for power projects. If there is no formal plan, objectives, policies and strategies will have to be inferred from such sources as budgetary documents, the statements of government officials, "white papers" and the actual pattern of economic decisions during the recent past. Whatever the source of his information, the analyst should seek a perspective from which the project can be viewed in the context of the general economic situation.

III. SECTORAL STUDIES AND THE PRELIMINARY PROJECT APPRAISAL

Project appraisals are preferably made in the context of a sectoral plan or comprehensive study of the sector. If such a plan or study has been properly undertaken, it would include the basic elements of a CPA. Power sector studies are generally equivalent to the long-range systems planning concept, long utilized by electric power utility operations in many parts of the world. The analyst should examine its contents in terms of the following considerations:

1. Does the power sector plan or study at the national, regional, and local level include the following features:

- Projections of power demand
- Optimum methods of meeting demand based on engineering and economic criteria
- Appraisal of indigenous sources of primary energy
- Integration of local and regional power supplies into a national grid
- Standardization of engineering and power supply characteristics
- Optimum phasing of additions to generating capacity and extensions of transmission and distribution systems.

2. Was the power sector plan prepared by professionally competent engineers and economists, with proper balance between the two, and with sufficient objectivity to eliminate possible bias in terms of recommended alternatives for the supply of electric power? Was it sponsored by or were its findings accepted by international financing institutions?

3. Was the power sector plan developed in concert with a national economic development plan to insure mutual consistency and coordination of all essential elements, including projected growth in demand, phasing of additions to capacity, regional and national priorities, the supply of fuel or other primary energy from indigenous sources or imports, etc.?

4. Assuming the existence of a power sector plan meeting the above requirements, is the proposed project in conformity with that plan? If it is not, what rationale or justification is presented for deviating from the plan? Has this been examined and approved by the authorities at the national level having responsibility for national planning, economic policy, and administration of the development of the power sector?

5. Have alternative methods of meeting the prospective demand for power been examined which might permit postponement of the proposed project through improved use of present facilities? Among these, the following should be considered:

- Improved management and operation of existing plant to reduce or eliminate interruptions in service
- Flattening out the daily and seasonal load curve by shifting peak requirements to periods of low capacity utilization through incentive pricing and administrative changes
- Load sharing through interconnection with other plants or systems if required capacity is available.

6. Has selection of the proposed investment been based on equal consideration of all possible alternatives, including all the economic variables? Among these alternatives are the choice of fuel, the source of fuel, the type of generator, the size of generator, and the choice of increased generating capacity versus interconnection.

7. Were the cost-estimating techniques and methodology employed for such widely divergent alternatives as hydroelectric, nuclear, or fossil fuel, and interconnection versus increased generating capacity, on a comparable basis? Are underlying assumptions on future costs of fossil and nuclear fuels equally reliable?

8. Is the proposed technology adaptable to the technical capabilities and requirements of the country? What would be the effect of a different technology on investment and operating costs?

9. Is the project fully integrated with all related elements, and are these taken into account in estimates of investment and operating cost? Are all elements of generation, transmission, and distribution taken into account? Have possible additional investments in fuel production and transportation facilities been taken into account?

10. Has attention been given to manpower training programs required to improve efficiency of existing operations and to assure efficiency in the operation of new plants at all management, technical, and clerical levels? Have the costs of such programs been taken into account?

11. If a new plant is proposed, has adequate provision been made in both land and building structures for future capacity expansion? The same consideration applies to the planning of investment in transmission and distribution facilities.

12. Have the economies of scale applicable to the production of electrical generating equipment been fully taken into account in the selection of generator size? Have the economies of scale been fully evaluated against the diseconomies of investment in excess capacity?

As mentioned previously, a power sector study normally incorporates the basic elements of a CPA. If this is confirmed by the analyst, the next step is check the work that had been done previously, perhaps bringing the project study up to date or providing whatever the previous study lacked to upgrade it to a CPA.

If a power sector study or plan has not been made, the project analyst should identify the minimum informational requirements for a preliminary appraisal as a guide in assembling data. Much of the required data can be developed from operating statistics from existing power systems in the country and from population and industrial censuses. Comparative information for other countries at comparable stages of economic development and with similar economic structures may be useful in providing benchmarks for testing the reasonableness of such generated data.

IV. STEPS IN THE CAPITAL PROJECT APPRAISAL

Project preparation and appraisal consist of the following steps:

1. Identification of need for project and category of project
2. Formulation of promising physical resource flow plans
3. Pricing the project
4. Selection of the most promising alternatives
5. Computation of rates of return
6. Sensitivity analysis of rates of return
7. Evaluation summary

While the above steps can be discussed as discrete steps that will occur in the stated order, it should be recognized that in the course of carrying out these steps there will be considerable interaction. For example, in carrying out step 4, the analyst may find that other alternatives suggest themselves, and he may find it necessary to return to step 2.

Identification of Need for Project and Category of Project

Evaluation of Existing Demand-Supply Situation

The first step in the appraisal is to review the existing demand-supply situation. This includes the demand for power (average weekly and peak) for recent years compared with the available capacity. Special attention should be given to instances where the available capacity was insufficient to meet demands. Based on scheduled additions to present capacity (less scrapping), the scheduled capacity (without further additions) can then be determined.

Of particular importance are indications of unsatisfactory quality and dependability of electric service, such as power rationing, "brown-outs," and the number of industrial plants and institutions with their own generating equipment (usually a high-cost source of power). These indications and information on unavailability of installed capacity due to breakdowns may indicate the need for improved maintenance, training and other corrective measures involving supplementary investments. Correction of diagnosed deficiencies or improvements in management can yield very high returns with little investment and therefore deserves very high priority.

Where there are sharp but short peaks in demand and the peaks can be directly related to industrial users, it may be practical to require industries to reschedule their operations and thereby reduce their power demand. Suitably designed rate adjustments can be helpful in achieving such reduction.

It may be worthwhile to relate the existing demand-supply situation to previous forecasts, indicating the underlying basic assumptions and endeavoring to analyze the rationale for substantial differences in the results, if any.

Demand forecasts available from a previous sector study should be reviewed for completeness and timeliness in the light of current conditions. Certain underlying economic factors may have changed since the original demand estimates were made. The analyst should check the original data sources and update or modify the estimates as necessary. For example, a recent census may show population growing at a slower rate than was previously projected, or it may be found that a planned industrial complex is materializing on a scale different from that originally anticipated. The CPA should reflect the latest developments or plans in the proposed service area.

As part of the review one should attempt to note slippages in scheduled installation of capacity and the current status of such installation, including uncertainties in the completion dates.

Demand Projection

For the purpose of a CPA, it is very important that future demand for electric power is projected as accurately as existing data permit. Demand projections should be disaggregated by class of consumer: domestic, commercial, small industrial, large industrial, institutional, and governmental. Each of these classes will usually have a different peak loading period for which electric system capacity must be provided. If the intended service area is large, estimates should be made for subregions within the overall proposed geographic service area.

Power projects that are original installations or plant additions must be reviewed for engineering and performance characteristics in the light of the demand for power for at least the next 20 years. This time frame is required as a minimum because of the long lead time required for construction of facilities and the long economic life of the equipment. The estimates for the early years will be most critical.

In many LDC's the principal growth in demand is associated with requirements arising in the industrial sector. A project analyst, therefore, should be familiar with those aspects of the national economic plan which deal with industrial (including mining) development and with an industrial sector study (if existent). Of particular importance is the type -- and timing -- of proposed industrial schemes.

In other countries rapid urbanization makes domestic use an important part of growth of demand. In projecting demand for electricity, it is necessary to analyze trends in both the number of house connections and the usage per connection.

Demand projections for power might be developed in several ways, each with its own logic and limitations.

For additions to existing plants, a basic approach in projection of demand is the extrapolation of a historical trend. This involves fitting a curve to past data either graphically or by the method of least squares. The most common form is a semilogarithmic curve which in effect determines an annual rate of increase over time.1/ A trend is the result of long-term, slow-moving forces and therefore can be used where it is expected that such forces will continue into the future. Where there are categories of demand for which discontinuities in growth patterns can be anticipated, it is better to exclude such past usage from the base and extrapolated years and to project the excluded categories separately.

The so-called sector approach projects electricity demand either through the extrapolation of a trend for each sector or the calculation of demand from national or regional

1/ See Annex III, "Summary of Some Main Types of Statistical Projections Used in Energy Forecasting," in Methods and Principles for Projecting Future Energy Requirements (New York: United Nations, 1964), ST/ECE/Energy 2.

plans, using coefficients. Such coefficients preferably should be based on country experience, although they may have to be taken from the experience of similar countries.

In projecting historical trends one must be sensitive to changes in the future that will change both average and peak usage (e.g., introduction of air conditioners on a substantial scale).

It may be useful to project values based on past data and to make adjustments for expected changes based on information on plans.

Any segments of demand that are sensitive to deliberate policy should be estimated on the basis of specific assumptions about such policy so that estimates can be readily updated as changes in assumptions appear necessary.

Another approach to projecting demand is to do so using past correlation of usage with variables such as GNP; nonagricultural gross domestic product; value added by industry, mining and agriculture; national income, per capita income; population, etc. It may be useful to use one or more of these variables plus time as independent variables. The relationship of demand for electric power and specific independent variables can then be projected into the future using values for these variables given by the country's plans or based on what are considered reasonable expectations.

An important advantage of using mathematical projections is that one can also readily obtain bands of uncertainty based on the standard error of estimate of the projected demands.

Atypical industrial developments that are foreseen, e.g., an aluminum smelter, should be projected separately and then be added to the originally projected series.

Peak load requirements differ widely among the various classes of consumers, and it is necessary to analyze past records in the country to determine the magnitude and timing for the largest users in each of the classes. It is difficult to estimate possible peak demand from new industrial undertakings, but reasonably satisfactory estimates can be based on similar industries in the country or elsewhere. The project analyst should be alert to the potential for large blocks of power requirements; he should anticipate -- if possible -- the timing of these demands to assess the optimum timing of projects.

Chart 1 depicts the type of situation faced by a project planner. He has a projection based on an extrapolation from past data. If there is a large user of electricity scheduled for future operation, the projected demand might have a bulge. The step-like line is the installed capacity less allowance for repairs and maintenance, with the last step representing the scheduled installation of new capacity. The estimated upper and lower limits of the demand projection are based on a computed standard error of estimate of a mathematical projection or on informed judgments of the range of prospects. The latter often is arrived at by adding and subtracting percentage increments, as estimated by the power company, to the firm capacity defined herein under the heading, "Spinning Reserve, Firm Capacity".

A comprehensive review of 75 projections of the demand for electric power in various developing countries by the Sector and Project Studies Division of the IBRD[1/] indicates that one out of three forecasts of growth in demand diverge by more than one-third from the actual growth; that is, if the actual demand increase was 100, one out of three forecasts of the increase is either more than 133 or less than 67. There was no discernible tendency for the divergence to be over or under the actual increase in demand.

The study cited indicates the need to reckon with a substantial risk that demand estimates will be either too high or too low.

In the situation depicted in chart I, additional capacity (beyond that to be provided by the expansion already scheduled) will be required by 1980 if the higher limit of the projected demand is realized, and by about 1985 if demand grows at a rate approximating the lower limit of the projection.

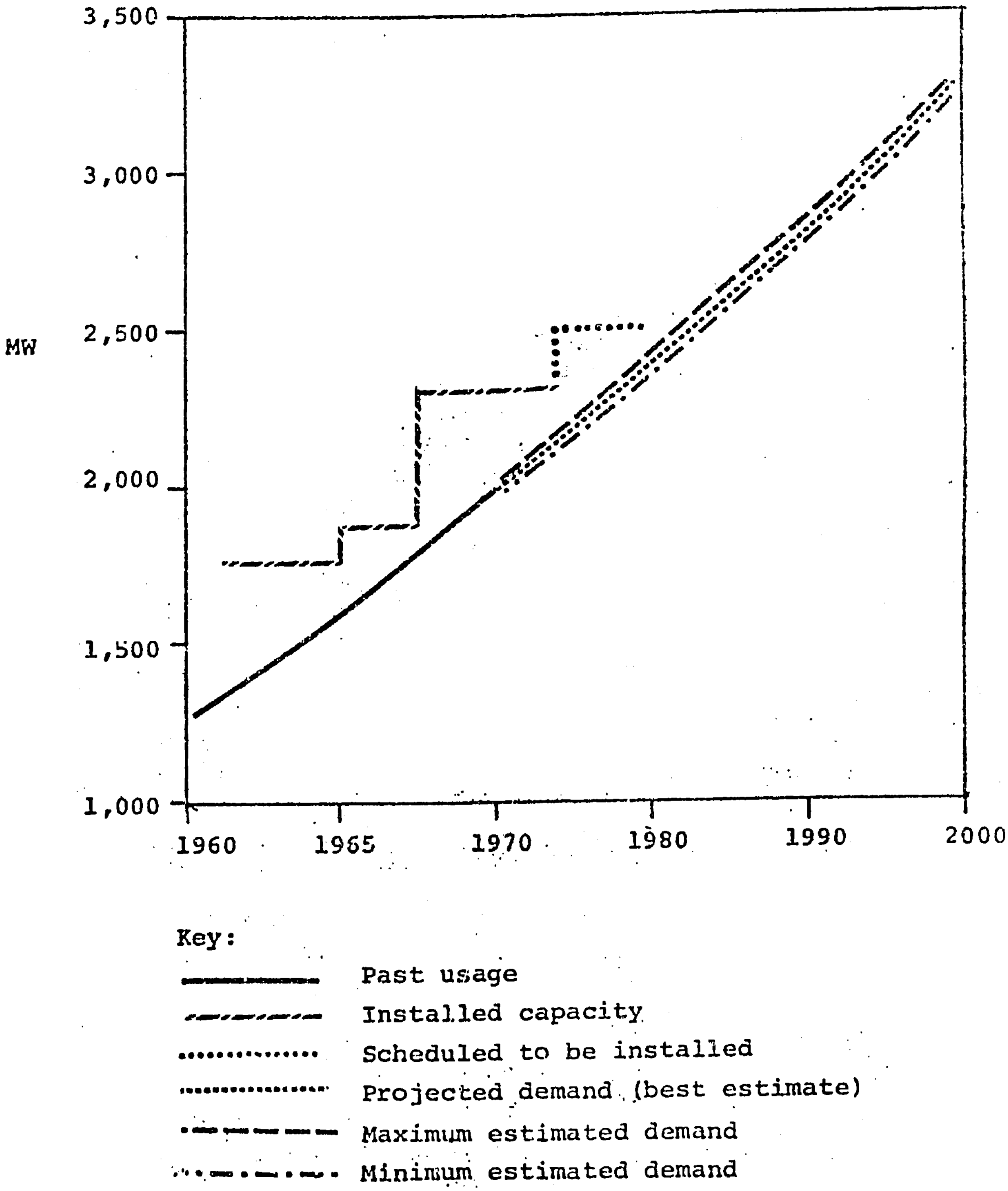
If a CPA for additional power were being undertaken in 1971, an important element of the appraisal would be the determination of the latest date at which a decision on the project must be reached if the projected requirement is to be met.

A first step is to consider (1) different ways to achieve the expansion and (2) the amount of time needed from the time that the decision to go ahead is reached until the time power is available from the planned project. It may be that certain alternatives (say hydro) would leave little time to spare in reaching a decision if 1980 requirements are to be met. Other

1/ IBRD, Ex-Post Evaluation of Electricity Demand Forecasts, No. 79, Washington, D.C., June 18, 1970.

Chart 1. Forecast of Annual Demand (MW) in Relation to Capacity

(Illustrative figures)



alternatives may permit more time for a decision to be reached and construction to begin. The preliminary appraisal can determine the most promising form of expansion and its required lead time. This provides a provisional schedule for plant expansion which is adjusted on the basis of actual growth in demand in subsequent years. For example, the preliminary appraisal may indicate that if actual demand develops as projected in the best estimate, the detailed engineering study should begin in 1974. The actual date of such a study would be adjusted at a later time depending on the growth of demand actually experienced.

Identification of Types of Projects

When best estimates -- or a range of estimates -- of existing and projected requirements have been prepared, attention should be directed to the determination of the general type of project most appropriate in the circumstances.

An established need for, say, increased service does not necessarily determine the specific form of project best suited to meet this need. Projects fall into one of the following categories:

- Original installations
- Additions to and/or modernization of existing plant
- Emergency measures
- Improved operation of existing facilities, e.g., by better management, training, preparation and use of operation and maintenance manuals.
- Establishment or amendment of legal requirements; e.g., review or establish interest rates for rural electrification developments, amend boiler inspection regulations to recognize modern methods and controls in the manufacture of boilers, etc.

Original Installation

Proposals for original installations are commonly put forward as a part of an infrastructure program for regional development. The analyst will generally have a somewhat broader range of choice in consideration of alternatives for projects of this type than for projects involving additions to existing systems.

The possibility of serving the area by the extension of transmission lines from existing (or expanded) installations should not be ignored. Moreover, the possible integration of the original installation in future system networks should be borne in mind.

Plant Additions

Because of the rapid growth of power demands in many countries, additions to existing municipal or regional systems are the most common type of project proposals. Additions impose technical interface problems for a project appraisal. Existing equipment and its configuration must be well understood. When an addition to a system requires new generating capacity, the project analyst must evaluate not only capacity requirements but also the possible kinds of generation (thermal, hydro, etc.) and alternative fuels.

Formulation of Alternative Physical Resource Flow Plans

Physical flow plans should relate physical requirements of resources to needs. Appendix B outlines some of the special technical considerations that will influence alternatives to be considered in electric supply projects. While the technical aspects impose important constraints on the selection of alternatives, the choice is for the most part economic, based on the least-cost procedures described in the General Guidelines.

Scale of Project

One of the most important tasks facing the analyst is that of subjecting the proposed scale of the project to evaluation in terms of economic and financial criteria. Although economies of scale, rapid growth in demand, and the desire to avoid short time intervals between additions have merit, the undeniable advantages of early, large-scale installations must be weighed against the cost to the national economy of committing large amounts of capital (and foreign exchange) to the creation of capacity that will not be fully utilized for several years.

Alternative Operational Features

In the comparison of the operational features of alternatives it is important that recognition of the potentialities and limitations of existing operations be considered. The CPA should include a discussion of how a possible alternative will affect system operation.

Peaking Versus Base Loading

If the new capacity is to be used for peaking purposes, the primary objective would be reduced unit cost of the capacity and simplified operation, even at the expense of economy of operation. On the other hand, if the added capacity is to be used as a base-load unit, then economy of operation is of paramount importance, and system operating practice would call for the new unit to be operated at full load for as long a period as possible.

Spinning Reserve, Firm Capacity

A new generating unit will have an appreciable impact on system operating practices. In general, electric power systems are operated with firm capacity equal to the total generating capacity in the system which is connected and operating less the capacity of the largest operating generating unit. Usually spinning reserve1/ is also maintained for use in the event of a nonscheduled loss of an operating generating unit.

Diversity of Loads

Interconnections between separate power systems and between separate elements of the same power system will often pay a dividend by taking advantage of the diversity of peak loads of the two systems. This is especially true if the interconnected elements are located in different time zones or have complementary system load characteristics. In comparing an interconnection with additional generating capacity, the analyst should be alert to such features of load diversity and should account for the relative advantages and disadvantages.

Generator Unit Priority Scheduling

For peaking purposes, it is possible to utilize (1) older, less efficient units, (2) hydro units where there is a minimum availability of water, and (3) specially installed peaking units, such as gas-turbine-driven generators. The analyst should not develop detailed priority schedules for system operation of generator units, but an evaluation of the benefits and costs of operation and scheduling of the various alternatives in relation to existing units should be included in the appraisal.

1/ Spinning reserve is generating capacity that is kept running; is connected on the bus; and is ready to supply electricity immediately when needed.

Maintenance Requirements

The analyst should compare the maintenance requirements for the various alternatives under consideration to highlight their relative advantages and disadvantages.

Pricing the Project

Although it may be possible for the analyst to choose among some alternatives on physical grounds alone, there will be choice situations that will require pricing of alternatives before decisions can be made; i.e., the choice will involve economic as well as technical considerations.

Conversion to Value Flows

Use of Cost Modules

In preparing cost estimates, the project analyst should avail himself of macro-unit prices, or cost modules, to the maximum extent possible. These should be reasonably representative figures obtained within the country. Such cost modules may be based on similarly sized plants and features, with the existing plant costs extrapolated to present-day prices by the use of, for example, a construction cost index.

Typical quantities for macro-unit prices are:

- Cost per kilowatt of gross generating capacity for thermal plants
- Cost per mile of transmission line for the voltage being considered
- Cost per kilovolt-ampere of transformer capacity
- Cost per position for a switch yard
- Cost per feeder circuit in a distribution substation
- Cost per mile of primary distribution circuit
- Cost per kilovolt-ampere for secondary distribution circuits.

The estimates developed by the above unit prices will require some additions to recognize cost elements necessary to round out the order-of-magnitude capital cost estimates.

The cost of a dam will have to be approximated by estimating the unit cost of the dam volume for a gravity-type dam, or by approximating a cost based on span and height for an arch-type dam. For a hydroelectric station, the distinctive large cost item is the cost of the dam, an item that is not present in the thermal alternative.[1] Either the unit price can be made broad enough to accommodate the cost of penstocks, gates, forebays, tailraces, and powerhouse structure, or these items can be estimated separately if so desired. Of necessity, the analyst will need to include approximate costs for compensation in removing residents and their habitations and in establishing alternate routes for railroads, power lines, communication facilities, etc.

Other Cost Elements

Other elements for which costs should be approximated include the following:

- Cost of site, including site preparation
- Cost of cooling water intake structure and intake and outfall circulating water lines for steam electric stations
- Cost of cooling towers where required
- Cost of transmission line rights-of-way
- Cost of special relay equipment, supervisory control equipment, and communications equipment.

The capital cost estimates should represent the total installed cost, that is, should include all costs associated with design, engineering, construction and startup. Additionally, for imported equipment, a separate item should be shown for inport duties, taxes, and other charges applicable to such items.

All allowances for contingencies should be tailored to the local conditions. The contingency should depend on the degree of reliability of the cost estimates and should reflect the analyst's evaluation of the unknown factors. These unknowns should be identified in the analyst's report and the contingency should be identified as such. Factors which might influence the contingency include reliability of data, population growth, future market

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1/ This item, peculiar to hydroelectric projects, is on the average about 59 percent of the total cost of U.S. projects. This figure varies considerably, both in the United States and in other countries, according to the location and size of the dam.

demand and others. Where the effects of these factors might be large, the recommendation should be made that they be investigated in a later and more detailed study. In hydroelectric projects, the two major uncertainties are likely to be dam construction costs and water flows.

Operating and maintenance costs which run over the life of the project can also be approximated by the project analyst on the basis of such knowledge as local labor costs, capability and availability. In developing the cost of operation the following categories may be used:

- Operating labor, skilled and unskilled
- Maintenance labor, skilled and unskilled
- General and administrative costs
- Maintenance materials and supplies
- Fuel costs.

The operating and maintenance labor should include the cost of supervision as well as payroll extras to account for vacation, sick leave, and other benefits.

General and administrative expenses can be estimated as a percentage of operating and maintenance labor; in lieu of available specific cost estimates a figure of 35 percent of the operating and maintenance labor costs may be taken for thermal plants, and 25 percent for hydroelectric plants.

Maintenance materials and supplies are intended to cover spare parts and other items of equipment (excluding interim replacements), as well as the lubricants, chemicals, paint, etc., necessary to keep the plant in good operating condition. In lieu of available data, an overall average figure of about 1.0 percent of plant investment for both thermal and hydro power stations may be utilized. For other facilities, such as transmission and distribution lines, 0.5-1.0 percent of the capital cost should be used.

Fuel costs should be estimated on the basis of actual delivered costs at the site and should be calculated by estimating the heat rate for the type of unit under consideration. The source of fuel and possible alternative supplies should be identified. If all or some of the fuel must be imported, then the analyst should highlight this situation.

The following costs should be entered in operating statements but, in accordance with the procedures established in the General Guidelines, Part I, should not be treated as costs when computing either the business enterprise or the net national rate of return:

- Interest on borrowed investment capital
- Depreciation on plant and equipment.

Taxes on real property, if paid, should be treated as a cost from the point of view of the business enterprise but not the net national rate of return unless the tax is, in effect, identified with the cost of a governmentally provided service which, if not provided by government, would necessitate an expenditure by the project.

Fire and casualty insurance should be treated as a real annual fixed cost for both the business and the national points of view, even though the policy of the company is to self-insure its property. Insurance values are normally based on assessed values as determined by local and regional demands and economies. Therefore, a fixed value should be determined at the time of construction through the aid of a local economic and real property study.

Economic Lifetimes

The economic lifetimes of equipment or facilities selected for economic analysis have an impact on the rate of return. Assuming that equipment will be well maintained and repaired with proper spare parts when necessary, the following economic lifetimes are generally used:

. Thermal electric stations	35 years
. Hydroelectric stations	50 years
. Dams	50 years
. Transmission lines, wood poles	35 years
. Transmission lines, steel tower	50 years
. Substations	35 years
. Distribution lines	25 years
. Underground installations	35 years

If, because of local conditions, the experienced service life of equipment in the above categories is found to be significantly less than shown, it is recommended that the shorter lives be used, with the cost of replacement (including labor) treated as an investment in the expected year of occurrence.

Accounting or Shadow Pricing of Inputs

As has been noted, calculation of the net national rate of return (NNRR) will probably require shadow pricing of several inputs for a power project. The rationale for so doing is explained in Chapters II, III and Appendix B, and the methodology is illustrated in Chapter VIII of the General Guidelines.

In countries where the domestic currency is overvalued, shadow price adjustments should be made to the cost of imported original and replacement equipment and to those wages, fringe benefits, and travel costs of foreign technical advisors not paid for in local currency.

In the case of a high national unemployment rate, a shadow price for unskilled labor is appropriate. Here the pricing adjustment reflects the lower (than market wage rates) real cost of such laborers. On the other hand, if administrative and technical personnel necessary to the project are in short supply and institutional or other forces impose a ceiling on the money wages of such workers, a shadow price higher than the money wage may need to be applied to obtain a better measure of the real costs of using these workers.

Valuation of Outputs of Power Projects

The outputs of a power project consist of:

- New or additional revenues from the sale of electricity
- Benefits external to the project itself.

Revenues from Sales of Electricity

Original facilities and additions to existing plant will generally produce growing revenues over time as a result of steadily increasing loads on the system. Such revenues are a measure of the value of output.

Improvement of existing service, such as raising the formerly substandard voltage levels in consumers' premises to standard levels, can increase the revenue quite directly. Revenue projections should reflect such changes.

Benefits External to Project

If the generation and distribution of electric power might result in the utilization of previously dormant national resources or make possible a higher value added by industrial consumers, such benefits or linkages are appropriate for inclusion in the value-of-output stream of the project. However, this is true only if no change would occur in the status quo in the absence of the project. One example is the utilization of an existing but untapped source of fossil fuel suitable for a thermal plant. If this fuel source is to be developed for the purposes of a steel mill or for export, a linkage effect should not accrue to the power project. (For a more detailed discussion of the treatment of linkages and multiplier effects of capital projects, see General Guidelines, Chapter III.)

A hydroelectric facility may give rise to such benefits as increases in fishing or recreational opportunities or possible irrigation for improved agricultural production. The nation or region may gain more than the electric power itself. Such economic gains should not be included in the CPA unless the enhanced benefits are included as definite elements in the total scheme (and, of course, costed out on the project's input side as well). The value of economic gains that are unequivocal and do not require additional investment or expenditures can be added on a gross basis to the benefits of the project.

Another external benefit, that is a benefit that does not accrue in monetary terms to the project, is the reduction in customer costs attributable to the implementation of the project. Improved service reliability will normally reduce the operating costs of industrial firms served by the electric power utility. Changes in the rate level because of such system improvements are unlikely to be sufficient to assign all these benefits to the electric power utility. Caution should be exercised to avoid double counting of benefits attributable to this type of improvement.

In connection with rural electrification programs in the United States, experience has shown that there have been benefits to other than the ultimate user. Sales and services in connection with electrical appliances and equipment purchases which would not have been needed if rural electrification had not been introduced is a prime example. Equipment is now being manufactured for rural uses whereas before the advent of rural electrification the rural user had to adapt equipment developed for urban users. The likelihood of unanticipated uses developing was often present in the U.S. experience, e.g., mechanization of manual operations, new industrial establishments, etc. While alternate energy sources may be available the factor of convenience and easy availability cannot be discounted in evaluating the effect of electricity as a source of energy in inducing the widespread use of new appliances and equipment.

It should be noted though that the development of the rural electrification sector in the U.S.A. took considerable time. The introduction of electric power into the rural areas in the LDC's will require extensive efforts at sales promotion, appliance demonstration and similar endeavors to convince the consumer that electric power means more than light to read or cook by. Too often these aspects have been treated as insignificant or as givens by analysts. The contents of Chapter IV (Social Criteria) of the General Guidelines are also particularly relevant to rural electrification projects.

Selection of the Most Promising Alternatives

In considering the various possible physical arrangements, the analyst will have formulated alternatives that appear promising. In this process attention is narrowed to relatively few promising projects. By applying the techniques of comparing alternatives and choosing the least-cost alternative as described in the General Guidelines (Chapter V), the analyst will select one or possibly two alternatives which are most promising. Where the margin of difference between alternatives is considered sensitive to cost estimates, it may be desirable to consider a particular choice as open, to be resolved at a later time by means of more detailed engineering studies.

The concept of finding the least-cost alternative is applicable to alternatives on equipment, technology, scale, timing, location and variables.

The least-cost alternative concept is extremely useful even where, as a matter of national or regional policy, electric power projects are operated with revenue schedules that yield a present low rate of financial return, (BERR) say 6 percent. The decision on how the required amounts of power are to be generated and distributed must be based on the opportunity cost of capital to the economy rather than on the financial rate of return for power projects as a whole or the rate at which capital is borrowed. For example, suppose that national policy prescribes a 6 percent financial return for power projects and the question arises as to whether a large generator or a smaller generator should be installed. If the opportunity cost of capital is estimated to be 12 percent in the country, that would be the discount rate adopted in calculating the least-cost solution, assuming that benefits are identical for both alternatives. If the benefits of the alternatives are not identical, then the difference in surplus flows (Chapter V, Part I) should be utilized. If the present value of the difference in surplus flows at 12 percent is negative, this indicates that the earlier investment required by the larger generator is economically inefficient at this time. Thus, even if a decision is made to sell electric power on a concessionary price basis, a decision on the design of the facility should be based on getting a return at least equal to the opportunity cost of capital on the investment which is optional under existing policy.

Revenues: Charges for Electric Power

Revenues should be estimated at the schedule likely to prevail and at the schedule the analyst has estimated to be appropriate for the service. The dual revenue flows are necessary in this sector because actual power rates (prices), being administratively determined, may or may not reflect the real value of output. Revenue, along with costs, can be projected in worksheets such as those shown in the General Guidelines (chapter VIII). In the calculation of the net national rate of return, the problem arises of how to value the services to be provided by the project.

If rates likely to prevail yield revenues that are higher than costs, including the opportunity cost of capital, the value of services can be taken to be at least equal to the revenue because those using the service would not pay for it otherwise.

In this case, the calculation of the net national rate of return presents no problem.

A more typical and difficult situation occurs when rates are set at levels that do not yield sufficient revenues to cover all costs, including the opportunity cost of capital. In this case, we can be sure that the outputs have a value, for the marginal user, that is at least as large as the rate charged. The problem is to determine if the real value of the electric power is higher for some or all classes of users than the actual rates in effect. If there is a waiting list for connection, or if power service to connected customers is rationed by some non-price technique over long periods of time, these factors may indicate that electric power rates understate the real value of the service to users and would-be users. In these circumstances a shadow or accounting set of (higher) rates is indicated.

By estimating the costs of the alternative source of supply, upper limits on the value of electric power might be estimated for certain classes of consumers (e.g., commercial, institutional, and industrial) who are able to self-supply their requirements with their own diesel generators.

As noted above, "prices" for electric power are administratively determined, i.e., they are established by formulas reflecting one pricing theory or another that has been developed for public utilities. As an integral part of the CPA, therefore, the analyst should examine the existing rate structure in the light of the following questions:

- Does the level of rates yield sufficient revenues to cover total costs of the services to be provided by the project, including a return to capital equal to at least the marginal opportunity cost of capital?

- If the project is to rely on private sources for (nonconcessional) capital, are rates sufficiently high to attract necessary funds?

- Is the structure of rates such that it reflects the government's priorities with respect to the essentiality of different categories of users (e.g., residential versus industrial consumers)?

There is a tendency in LDC's for government to establish rate levels and structures that do not meet the criteria noted above. In particular, there is a tendency to set rates below total costs (as defined above). Rates that are, in general, too low have two effects: (1) the demand for power tends to outstrip the systems capacilities possibly necessitating a power rationing; and (2) the revenues generated are inadequate to permit replacement of equipment, much less expansion of capacity to meet the rapid growth in demand stimulated by the low level of rates. The results are accumulated backlogs of unfilled demands, deterioration of service, and continuous drains on the general revenues of government to supplement the revenues of the facility.

The review of rate levels and structures recommended above may indicate modifications in the valuation of outputs for power projects. If so, these should be presented as alternative formulations of the project. (Rate structures are discussed in some detail in Appendix B of these guidelines.)

If the project is to be subsidized in any way (perhaps for social or political reasons), the analyst must still assure himself that operational funding requirements will be available from national or local treasuries when needed to make up for annual deficits. Lack of any type of current financing can lead to an inefficient, a deteriorating, or even an abandoned project.

<u>Sensitivity Analysis of Rates of Return</u>

The basic technique and rationale underlying sensitivity analysis are discussed in Chapter VII of the General Guidelines. In the power sector, the larger, more technically difficult, and more costly the project, the greater is the need for sensitivity analysis.

The project analyst should bear in mind, however, that the purpose of such an analysis is to isolate only those major input or output elements which can very importantly influence rate of return calculations if realized values turn out to be substantially different from the best estimates used in the computations of rates of return. The end objective of a sensitivity analysis at the CPA level is to indicate those project elements critical to possible further study. If the CPA is favorable, it may be worthwhile to try to narrow or eliminate the uncertainty concerning critical elements. For noncritical elements the CPA approximate estimates may suffice.

Examples of possible critical elements should be viewed with caution. One cannot know a *priori* with certainty exactly what elements are critical to any given power project. The following examples are put forward, nevertheless, because a good deal of uncertainty is usually associated with them:

- Fuel costs, especially when fuel is imported
- Heat rate, as related to fuel costs
- Site conditions, depending on the accuracy of geological data
- For hydroelectric projects, the height, foundation, and spillway of a dam due to uncertain hydrologic records and geological and subsurface conditions
- Spinning reserve requirements
- Anticipated revenues, related to both the growth in demand and possible future rate structures.

The project analyst should recognize that there may well be uncertainties that cannot be dimished by further intensive study. In such cases, a proper sensitivity analysis in the CPA consists of the presentation of values for those elements or variables which span the likely range of uncertainty. This requires the attachment of the estimated probability values as illustrated in the General Guidelines, Chapter VII.

Evaluation Summary

In accordance with the General Guidelines (Appendix C) an evaluation summary should be prepared in which the major findings are presented for consideration.

APPENDIX A. TYPICAL ELEMENTS IN ELECTRIC POWER SYSTEMS

To provide a uniform approach to the analysis of proposals for electric power system additions, this appendix includes a listing of typical electric power system elements and alternatives. The analyst may use this checklist to assure that the elements in the proposed project comprise a complete system or a relevant portion of a system.

Obviously, in a CPA, time will not permit the gathering of all of the following information. The list is included as a guideline. Those items of greater importance are followed by an asterisk.

I. <u>Generating Plants</u>

A. Steam boiler and turbine-driven generators*

1. Fuel type*
   a. Coal
   b. Oil
   c. Gas
   d. Nuclear
2. Fossil fuel storage (quantity)
3. Nuclear fuel care
4. Condenser cooling water source (and temperature)*
   a. Sea water; ______ °F to ______ °F
   b. Fresh water; ______ °F to ______ °F
   c. Cooling towers; dry bulb, ______ °F to ______ °F
      wet bulb, ______ °F to ______ °F
5. Number of generating units and size of each unit*

B. Hydroturbine-driven generator*

1. Dam type and height*
   a. Gravity; ______ feet
   b. Arch; ______ feet
2. Stream flow*
   a. Maximum ______ cfs
   b. Minimum ______ cfs
3. Impoundment ______ acre feet
4. Number of generating units and size of each unit*

C. Internal-combustion-engine-driven generator*

1. Fuel*
   a. Oil; _____ gallons storage
   b. Gasoline; _____ gallons storage
2. Engine type*
   a. Hp.
   b. R.p.m.
3. Number of generating units and size of each unit

D. Gas-turbine-driven generator*

1. Number and size of generating units*

E. Atomic energy generator*

II. Substation

A. Type of service*

1. Transmission step-up*
2. Transmission step-down*
3. Transmission switching*
4. Distribution

B. Equipment and facilities*

1. Transformer*
   a. Type*
   b. Number installed*
   c. Size
   d. Voltage rating
   e. Tap changing under load
   f. Cooling provisions
2. Switchgear*
   a. Voltage rating*
   b. Current rating*
   c. Breaker interrupting capacity
   d. Number of breakers installed
   e. Number of air break switches installed
3. Structure, protection, etc.
   a. Prefabricated
   b. Custom designed
   c. Metal-enclosed unit type

III. Transmission Lines*

A. Application data*

1. Voltage and frequency*
2. Delivered power and power factor
3. Length*
4. Conductor size and material
5. Number of conductors per phase

B. Physical data*

1. Structures*
   a. Single circuit
   b. Double circuit
   c. Metal*
   d. Wood*
   e. Concrete*
2. Overhead ground wire*
   a. None
   b. One
   c. Two
3. Right-of-way
   a. Character of terrain

IV. Distribution Lines*

A. Principal characteristics*

1. Is new substation or transformer capacity needed?*
2. Line voltage*
3. Length to most distant proposed load*
4. Total immediate load*
5. Type of area served*
   a. Residential-urban
   b. Commercial
   c. Light industrial
   d. Suburban
   e. Rural
6. Load distribution
   a. Uniform
   b. Lumpy
   c. Sparse
   d. Few large loads
   e. Large industrial load
7. Potential for load growth*

V. <u>System Management and Operation*</u>

A. Plant improvement

1. Generating plants
2. Transmission lines
3. Transmission substations
4. Distribution substations
5. Distribution lines

B. Protective facilities

1. Equipment
2. Coordination

C. Operation

1. Manual of procedures
2. Supervision
3. Training and classes
4. Load dispatching
5. Communications

D. Maintenance

1. Manual of procedures
2. Spare parts
3. Schedules
4. Supervision
5. Training and classes

E. Planning

1. Long-range
2. Near-term

F. Management

1. Staff
   a. Legal
   b. Planning
   c. Public relations
   d. Rates
2. Administration
   a. Accounting
   b. Finance
   c. Billing/collection

   d. Customer service
   e. Purchasing
   f. Personnel
3. Engineering
   a. Studies and procedures
   b. Design
   c. Construction
4. Operations
   a. Generation
   b. Transmission
   c. Substations
   d. Distribution
   e. New connections
   f. Emergency service

APPENDIX D. SPECIAL TECHNICAL CONSIDERATIONS FOR POWER PROJECTS

Physical Plant and Equipment

The character of the existing system will in many instances dictate the nature and features of a proposed power system addition. The age, condition, size and efficiency of presently operating generating units on the system have an important bearing on the features of any proposed additional generating capacity. Frequently, the proposed additional generating capacity is intended to operate as a base-load unit because of its greater efficiency. This permits older, less efficient units to be operated fewer hours and as supplements to the base-load unit. Some of the older units may be operated simply as peaking units that can be operated on peak for a limited period of time and then shut down until the next peak. A thorough understanding of the efficiency and operating conditions of existing units is mandatory for the effective analysis of proposed new generating capacity. This information should be included in the supporting data for the CPA. Similarly, the existing transmission, subtransmission, and distribution voltages represent a vital constraint on the range of technically feasible alternatives in any extension of or additions to these facilities.

For the purposes of a CPA, the present system can be thought of as comprising two basic categories:

- The supply system, including generating plants, transmission and subtransmission lines, and transmission substations

- The distribution system, comprised of the distribution substations and distribution lines.

For ease in understanding proposed additions to a power system, it is recommended that a system diagram of the related category be included with the CPA for the respective electric power system addition. The supply system diagram should include sufficient information for an understanding of the technological and operating features, including estimates of normal power and reactive kilovolt-ampere flow on transmission lines which have redundant paths.

The distribution system diagram generally includes equipment information on the distribution substation and data on all outgoing distribution circuits to show circuit length, conductor size, and sectionalizing and protection facilities. Almost every project will have some impact, and the analyst should carefully analyze the entire spectrum of operations to find and bring to light such impacts. The following list shows some of the things to be looked for:

- More efficient generation resulting in rescheduling of generating units
- Fewer generating units due to an interconnection or to a new unit of larger size
- Light load problems on a large new baseload generating unit
- Greater flexibility in operation
- Reduced hazards
- Simplified operation.

The above list is far from exhaustive; it is included to indicate the types of influences on system operation that might bring forth alternatives for comparison by the discounted surplus flow technique.

It is possible that the effect of an alternative project will be a deterioration of service rather than an improvement because of the nature of the installation. For example, a new substation may be installed on a subtransmission system for supply of power to a large industrial customer. On peak demand, this load may cause an additional voltage drop on the subtransmission line, which could lower the supply voltage to the customers on this circuit. If the resulting supply voltage is still within acceptable limits, then there is no problem. However, it is possible that coincident peak loads or a demand greater than estimated may create problems of low voltage. Alternatively, if available transformer taps are changed to increase supply voltage at certain installations, a shutdown of the new load may create an unacceptable high voltage condition.

The project analyst should be certain that alternatives are sound from an engineering point of view. Such technical consideration would include a knowledge of the interrupting capacities of existing breakers on the system and the effect, if any, of the proposed project on these capacities. A quick calculation should be sufficient to determine the extent of any added interrupting duty. If existing breakers have adequate capacity for any added interrupting duty, this should be stated. On the other hand, if existing breakers will be overstressed, then measures should be taken to reduce the duty by conventional engineering techniques, or provisions should be made for modernization or replacement of the overstressed breakers, and costs included for this purpose.

Another technical factor is the effect of a new transmission line which may create a loop with other lines. A cursory calculation should be made to arrive at a rough estimate of the real and reactive power flow,[1] and the advantages of any improved voltages should be pointed out.

There may be situations in which the supply of reactive power is a problem. In general, it is desirable that transmission lines and generators carry only a small amount of inductive reactive power. If the lines or the generators carry an excess amount, consideration should be given to the installation of capacitors or synchronous condensers to relieve this situation. If a high voltage cable is being considered for installation, it may supply too much charging reactive power. If large loads which could seriously affect the amounts of reactive power on the line are anticipated, power factor correcters should be considered when arriving at the incremental cost of kilowatt demand.

It is recommended that the analyst should include in his cost estimate provisions for tap-changing-underload on the receiving transformers on all interconnecting transmission lines with neighboring power companies and on all receiving substations from new generating plants.

It is very important that suitable consideration be given to the need for special protective equipment (such as carrier or pilot wire relaying) so that necessary cost estimates for such equipment are included. Also, if supervisory control equipment,

1/ Reactive power is the amount (KVAR) by which the current and voltage are out of phase and represents a loss in the system.

load control equipment, or communications equipment is necessary or desirable in the opinion of the analyst, then the associated cost estimates should be included and the reasons for the installation explained.

Long-Range Planning

It is extremely important that the preparation of the project be based on the long-range system development plan so that the facilities that are proposed in a specific alternative for preliminary appraisal will be compatible with existing and planned future facilities. In preparing the CPA, the analyst should point out the salient features of the proposal and the way in which the proposal fits in with long-range requirements and plans.

Alternatives in Scale and Timing of Projects

Two of the more difficult factors to deal with in the analysis of power projects are determining the optimum size or scale of physical plants and the timing of their construction. Power system planners are usually faced with ever-increasing demands and the frequent need to add to installed capacity. (Capacity here refers to output of generating units and to higher voltages on transmission lines, etc.) An important feature of generation installation is that larger units usually are more efficient and can be installed on a lower unit cost per kilowatt. Similarly, higher voltage transmission lines increase capacity by the square of the voltage ratio, whereas costs are usually a more direct function of voltage.

Improved Operations

Improvements in operating techniques leading to more efficient use of facilities and personnel merit high priority because benefits can sometimes be large and immediate. The need for operational improvements can be the basis for proposals to study and make recommendations through technical assistance channels. It is not uncommon, for example, for some developing countries to have new or almost new electric power installations that are operated inefficiently or below intended capacity levels.

Consideration of Alternatives

A preliminary appraisal of a specified power project should point out alternative solutions without detailed technical investigations, but with sufficient technical rationale to reflect the judgment of the analyst regarding the probable technical and economic feasibility of the alternatives.

Equipment

The following sections identify some of the technical features of equipment that should be considered and, when applicable, subjected to the discounting method to determine differences in surplus flows resulting from alternative equipment. The relevant techniques for computations of difference flows are discussed in chapter V of the General Guidelines.

Alternative solutions to a power production installation will be influenced by the terrain and the type and cost of fuel that is most readily available. However, the analyst should consider the following questions:

- Can the plant operate on natural gas rather than diesel fuel?
- Is steam more cheaply obtained from gas or coal boilers?
- Is a gas turbine more practical and/or cheaper than a steam turbine?

Size, Number, and Types of Generating Units

For a proposal recommending the installation of additional generating capacity, it is most important that the analyst give consideration to various sizes and types of generating units and their location and relationship to existing units in the system. First, consideration must be given to whether the additional generating capacity is to be installed as another unit in an existing generating station site, in a new station, or at a new site. The obvious advantages of installation at an existing site include reduced labor costs, possible improved utilization of transmission line capacity by fuller transmission line loading, possible reconductoring of existing transmission circuits, and improved reliability due to diversification if an additional transmission facility is installed.

If a new location is proposed, it is important that the new site and its availability be assured; it is also important that the point of connection to the existing electric power system be identified and provisions made for the required transmission and substation installations.

On systems where there are many small generating units and where load growth is rapid, it is possible that a significantly larger sized unit may be considered as the next unit on the system, thereby requiring a large amount of spinning reserve to derive the benefits of the larger unit's presumed lower unit cost and greater economy of operation. In such an instance, it is important that alternatives include consideration of an intermediate-sized unit for the next installation. In assessing this alternative, the opportunity cost of capital and the rate of increase in demand are critical factors.

If peak capacity is a problem (i.e., the source of the need), consideration may be given to peaking-type units, such as gas-turbine-driven generators, which can start up in a short period of time, operate at full load during the peak period, and then shut down until the next peak requirement. The choice should be arrived at through a comparison of the discounted stream of surpluses from installation of peaking-type and regular-type facilities. Restructuring of rates to shift peak demands to off-peak periods may also be considered.

When existing stream flow conditions appear to warrant the installation of hydro units, the analyst should include the probable longer time of construction; the possible longer transmission distance; the reliability of stream flow data, particularly with respect to maximum and minimum flow conditions; and the economic factors from savings in fuel and operating and maintenance costs, as well as from possible additional losses in transmission lines.

Cooling Water, Location

For a steam generating plant, it is important that an adequate supply of cooling water be available. This is a prime requirement in the selection of a site. The body of cooling water should have sufficient capacity to accept the thermal discharge without impairment of the ecology. In addition, the highest temperature of the available cooling water should be determined in order to take into account the possibility of larger condenser installation. When cooling towers must be installed, the wet bulb temperature should be determined. Economic damages which may result from the plant's effect on the local ecology should be included in the cost or input projections.

Fuels

The cost of fuel is an important consideration on the input side of a project. The dependability of supply should be carefully explored, and sufficient storage capacity should be provided for these fuels to afford some protection against interruptions in delivery. If gas is available, its interruptibility should be evaluated and a suitable standby supply of oil provided as backup.

Transmission Voltages

For proposals involving transmission lines, a review should be made of the AC-DC alternative and of the existing transmission voltages on the system to determine their adequacy in relation to the proposed new facility. As the distance which power may be transmitted will vary greatly, both AC and DC current should be considered. With new development in rectification and conversion to alternating current, direct current might well prove to be the most economical method for long-distance transmissions. If a long-range plan exists, it is probable that provision already has been made for one or more higher voltages. The analyst should be cognizant of such plans and should explore the reasons in the CPA for the selection of the voltage for the proposed facility in the context of its relationship to future system growth.

Providing the existing structures have the required additional strength, it is frequently possible to increase the capacity of a transmission line by utilizing bundled conductors. The additional capacity achieved in this manner is generally lower in cost than capacity achieved from higher voltage or additional line construction, but it does not provide the reliability that a separate line would provide. These factors should be explored in establishing alternatives for transmission line construction and should be discussed in the CPA.

Transmission Line Tower: Single/ Double Circuit, Steel/Wood/Concrete

The type of transmission line towers that are selected can result in significant cost differences. When planning for load growth indicates substantially higher future needs, it is generally possible to install double circuit towers with conductors for only one circuit, thereby providing the capability for a low-cost future increase in transmission line capacity. A double circuit tower does not provide the reliability of two single circuit towers, but the large cost savings may justify a calculated risk. However, the decision must reflect the cost of capital sunk in unutilized capacity and the length of time before the excess capacity will be absorbed by growth in demand.

Generally, wood structures are less expensive than steel or concrete structures, particularly if wood is available locally and steel or concrete must be imported. The benefits and costs of the available materials should be explored and subjected to standard discounting techniques to ascertain the most economical of the alternatives.

Plant Retirements

If there is generating capacity, a substation, or a transmission facility that indicates the need for retirement, consideration should be given to any possible salvage of suitable equipment and materials for future use. In addition, the alternative should include a discussion of the effect of such a retirement on the system and the provisions, if any, for replacement.

Rate Structure

In estimating the rate basis for the revenue of an electric power system it is important to recognize that the salable quantity is composed of two parts:

- The amount of kilowatt capacity which must be available to supply the customer's kilowatt demand

- The amount of energy which the customer's equipment consumes in terms of kilowatt-hours.

Residental rate schedules are generally structured to meter only kilowatt-hours of consumption, with the cost of a kilowatt-hour being relatively high for the first few consumed kilowatt-hours and then decreasing in subsequent blocks of kilowatt-hours. The industrial user, on the other hand, generally is required to pay, in addition to kilowatt-hours of consumption, a kilowatt demand charge that is based upon his peak demand for a 15-minute period or, alternatively, a 1-hour period; this charge is then billed to the customer for an established period, usually 6 or 12 months, regardless of lower kilowatt demands during this period, or even no demand for the rest of the period. For this reason industrial customers have an incentive to keep their maximum demand at the lowest possible value.

To arrive at the figure to be used for the kilowatt demand charge in the rate, it is necessary for the system to have established accounting procedures to provide the basis for the kilowatt demand charge. For purposes of a CPA, the fixed investment portions of the proposed facility should be evaluated on an annual cost basis, and this figure should then be divided by the kilowatt capacity of the facility to arrive at a figure for the incremental cost of kilowatt demand.

The incremental figure obtained in this manner should be compared with the established kilowatt demand basis; if the incremental figure is lower, this should be used as an indication that the new facilities will have a tendency toward lower rates or increased profit margins or will provide a cushion for escalating costs. If the incremental cost per kilowatt demand is higher, this should be a danger signal that profit margins may be lowered and rates may have to be increased, depending upon the magnitude of the investment in relation to total system investment. In instances where a facility may be subjected to significantly varying loads over its lifetime, it is desirable to utilize present-worth discounting for annual kilowatt demand costs.

The variable charges generally include a portion of the annual operating and maintenance costs, exclusive of fuel costs. In the United States it has been determined that the variable portion of operating and maintenance costs exclusive of fuel for thermal power plants amounts to approximately 35 percent of the total. Local conditions can make a substantial difference in this percent. In the absence of definitive data on the power system being considered for expansion, this figure may be applied. For hydroelectric plants the variable costs are usually neglected.

The sum of the variable portion of the annual operating and maintenance costs exclusive of fuel (35 percent or the locally determined figure) plus the annual fuel cost represents the total annual variable costs. In determining the incremental cost per kilowatt-hour for the proposal being considered, the total annual variable costs are divided by the annual kilowatt-hours to be produced. These calculations preferably should be made on a present-worth basis because generating facilities are loaded quite heavily during the early portion of their lifetimes, and are then loaded to a lesser extent (possibly only for spinning reserve) during the latter portion of their lifetimes; other system facilities may be loaded in the reverse manner.

The kilowatt-hour incremental energy cost determined on the above basis should be compared with the basis for the energy charge per kilowatt-hour in existing industrial rates to establish whether the incremental cost is higher or lower than the existing cost basis.

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APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II (B)

AGRICULTURAL PROJECTS

WATER & SEWERAGE PROJECTS

MANUFACTURING PROJECTS

PUBLIC HEALTH

EDUCATION PROJECTS

Agency for International Development

September 1971

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APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II - AGRICULTURE

Agency for International Development

September 1971

CONTENTS

FOREWORD

The project analyst using these guidelines should first read Part I, General Guidelines. It provides insights into key considerations for capital project appraisals (CPA's) in all sectors, with a detailed discussion of the methodology for calculating the internal rates of return, the cost-benefit ratios, and other relevant measures of the worth of a project.

This set of guidelines deals expressly with those matters relevant to agriculture. They tell the analyst how to think about a project in agriculture; what to look for; and how to assure consideration of the elements essential to a project. They will assist him in recognizing institutional, cultural, political, and other factors which can weigh heavily on a project. They encourage him to concentrate on big issues in broad orders of magnitude, leaving details and matters of lesser importance to be explored, if necessary, in a subsequent study.

The CPA is most efficiently undertaken by multi-disciplinary teams, e.g., social scientists (economists, financial analysts, political scientists, etc.) and technical specialists (engineers, agriculturists, etc.). The structure of the individual multi-disciplinary team can only be detailed within a specific analytical and project context. The term project analyst or analyst, used herein, refers to a member of a team engaged in a CPA.

I. INTRODUCTION

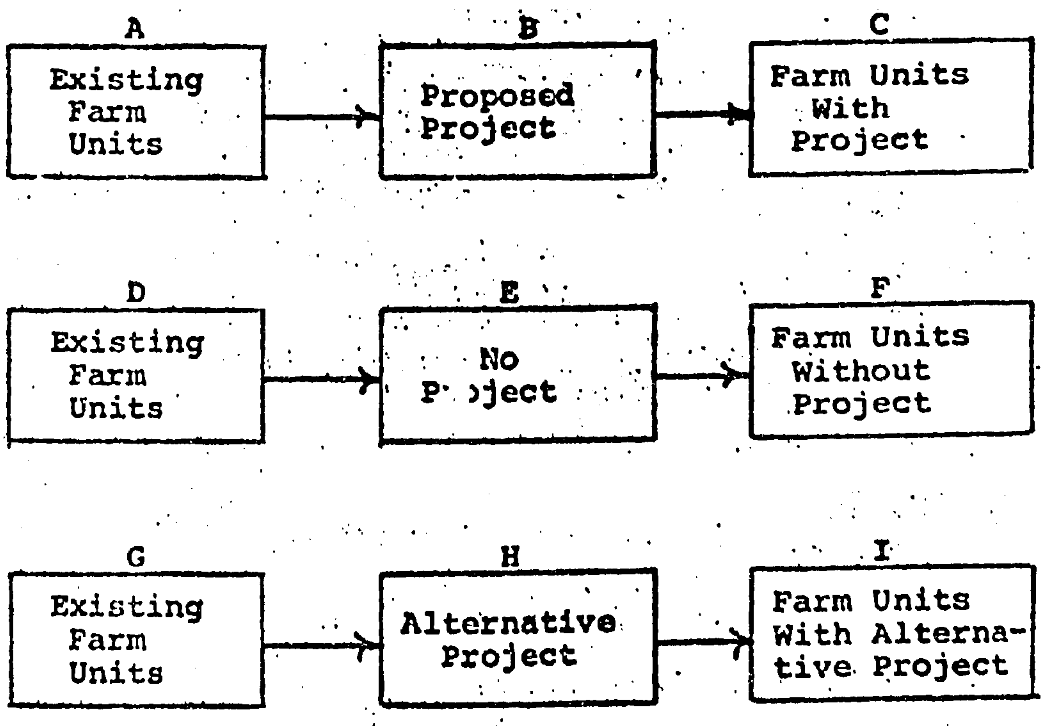
These guidelines are designed to aid in the evaluation of agricultural projects for which a need has been identified, or for which active sponsorship has developed.

The appraisal of projects in the agricultural sector involves careful weighing of many factors. Of these, the most apparent is the fact that institutions and national policies supporting agricultural development are, in the final analysis, frequently more important than the physical qualities and specification of the project itself. The project analyst must draw a conclusion as to whether these institutions and policies will strengthen, impair, or be neutral toward the project.

Agriculture requires much more than mere hard work. There are many who believe that a successful agricultural venture depends solely upon a plot of land, an energetic and land-hungry peasantry, and a moderately tolerable climate. The world is blemished with thousands of unsuccessful agricultural ventures based on the premise that a series of "farms" is all that is essential for successful agriculture. Cultural-hazard questions are rarely raised, and in addition many projects fail because of factors external to the project, such as lack of roads or transport, credit, and extension services.

The project analyst should not be wedded to the project at hand. He has several options: to do nothing, or to do something else. Chart 1 sketches the way the analyst should approach the appraisal. He should consider alternatives like B, E, and H, etc., and determine which results, C, F, I, etc., are preferred.

Chart 1. Logic for Appraising a Project



II. RELATION OF THE PROJECT TO AN AGRICULTURAL SECTOR STUDY AND TO MACROECONOMIC PLANS AND STRATEGY

Macroeconomic Factors

Agriculture does not exist as an economic enclave. Invariably its development is influenced greatly by general economic factors such as:

- The growth of GNP, per capita income, and population
- Export possibilities, demands from other sectors, and the amount of capital available for investment in agriculture
- The development strategy of the country
- The development needs in other sectors, investments in health, transport, education, power development and manufacturing, which are almost always required to make agriculture more productive
- The foreign exchange and exchange rate policies that will affect import costs of inputs, export potentials, and import substitution opportunities
- Tax and price policies, which can cause income generated in agriculture to be diverted elsewhere, or outside income to be directed into agriculture
- Credit costs and availabilities
- Policies on land tenure
- International competitive developments which will affect the markets for export crops.

The project analyst must keep these and other important macroeconomic factors in mind and seek to quantify their importance to the project. He must identify still other key factors likely to affect the project (e.g., investments in infrastructure, such as roads and water, which are vital to agriculture).

The Importance of the Sector Study

Ideally, the CPA would have the benefit of guidance from a sector study. However, sector studies are frequently not found and, even when available, they vary greatly in depth, coverage, and detail. Therefore, the kinds of information that should be sought will be described below.

- A time series of area under cultivation, yields per hectare, total production by crop, size of livestock herds and total output and sales of agricultural products
- Measures of the income in cash and in kind for farmers, which are useful as benchmarks. In many situations, earnings from nonfarm activities provide an important supplement to farm family incomes from farming
- An inventory of the soil, the climate, the rainfall, and markets that are or can be made accessible
- Needs for roads and other infrastructure
- Marketing facilities, including storage facilities
- Indications of the technological processes that are employed and how they relate to potentially more productive (and profitable) technological processes
- The levels of education of farmers, the size of farms, the land tenure and institutional arrangements (sharecropping, leadership, credit patterns), and the availability and skills of extension workers
- Water and range policies
- Policies designed to bring infrastructure to the countryside
- The country development strategy and the role of agriculture in it

- Taxation and credit policies affecting farm ownership and income
- Research and extension facilities available to farms.

If this information is not available from a sector study, it may be available from overall country reviews prepared by the IBRD, IMF, AID, or other international organizations.

Useful sources of background macroeconomic and sectoral economic data were cited in the General Guidelines. For the needs of agriculture, the analyst should study agricultural censuses or sample studies made in connection with agricultural censuses. The census data available may be obsolete or may be in insufficient detail for the purposes of the CPA.

If certain data are not available but are vitally needed, the analyst may have to obtain data for a sample of farms which can be used to make projections for the target locality. The size of the sample will depend very much on the homogeneity of farm units in the area with respect to the characteristics of interest. The analyst is well advised to stratify farm units on the basis of important variables (large or small farms, hilly or flat land, irrigated or dry land). One can start with a small sample and, based on the homogeneity of this small sample, decide whether the sample should be increased and, if so, which strata need a larger number of cases.

III. BASIC CONSIDERATIONS IN APPRAISAL OF AGRICULTURAL PROJECTS

To a greater extent than is the case for projects in most other sectors, the feasibility of agricultural projects depends on complex relationships among such factors as natural resources, the endowments of large numbers of individuals (their attitudes, education, cultural attachments and receptivity to new technologies and values), government economic development policies and practices, and international markets.

Broad Tests of Feasibility

While projects in the agricultural sector can be rejected on the basis of one test, the decision to go ahead with the project cannot be made on the basis of any single, simple test, economic or physical. A number of tests are needed. These are:

- Physical feasibility. Can resources be organized for an agricultural project with the chances of continuing productivity and success being high? If the project involves major construction such as irrigation or drainage, do the works that have been designed meet the requirements of the project, and can they be provided and operated at reasonable cost?

- Enterprise feasibility. Can the project be profitably operated as an enterprise?

- Institutional feasibility. Can the existing or projected institutions develop the capability to perform the functions required by the project?

- Economic feasibility. Do the prospective annual benefits of project operation exceed the annual costs of project operation?

- Political feasibility. Will the institutions and policies of the government permit the proper organization and profitable operation of the project?

. International feasibility. Is the project feasible when considered in its international setting, e.g., trade patterns?

These matters are expanded upon in the sections following.

Factors Affecting Success of Agricultural Sector Projects

It is not possible in these guidelines to identify every principal factor important to the CPA. Instead, we will identify classes of considerations, suggesting that the analyst prime himself to think of the relevant factors within each class.

Environmental Factors

Soils and Topography Data

The analyst must obtain the results of field surveys to identify or provide:

. An approximate estimate of the acreage (size) of the proposed development and at least a general description of configuration, slope, crop or wood coverage, drainage, etc.

. A general notion as to the basic fertility and associated soil management problems

. The hazards to be encountered in the agricultural proposal being considered. For example, is the land subject to flooding? If the proposed project involves irrigation, can the soils be drained or will waterlogging be a problem? Are there any known chemical problems in the soil, such as high concentrations of salt, boron, or other harmful chemicals? When natural cover is removed, will erosion become a hazard, and will protection from erosion be an unbearable economic burden? Is the topography so rough that it either prevents suitable land conditioning or makes its cost excessive?

These questions need initial answers as an integral part of planning. If none are so adverse as to make the project demonstrably infeasible, the CPA can proceed.

Size and Shape of Farms as They Have Evolved and Now Exist

The analyst must be clear as to whether the size and shape of the farms will affect the project's viability. The practice of dividing farms among heirs from generation to generation as practiced in many sections of the world has weakened the agricultural sector in many countries. The analyst may conclude that the project's outcome hangs on a successful effort to recombine land parcels into economically viable and physically tillable fields and farms.

In some sections of the developing world, farm shapes prevent the use of modern machinery and, in some, access to a farm or field must be gained through someone else's property. The elimination of uneconomic sizes and shapes of farms and fields and the provision of access to reconstituted farms could do much for, and indeed be vital to, the success of some types of projects.

Temperature, Annual Extremes, and Length of the Growing Season

These factors largely determine the crops that can be grown and the combinations of enterprises that can be profitably followed. As in the case of soils and topography, good preliminary data on these subjects should be available early in the planning process. The size of farms will also be materially influenced by these factors. For example, if the growing season is so short that crop selection is restricted to grains, grass, and forage, it is obvious that larger farm units should be established than would be indicated if the growing season permitted the planting and production of fruits, vegetables, and specialty crops.

Rainfall — Amount and Distribution and/or Availability of Irrigation

These factors may indicate whether an area is susceptible to closer settlement and more intensive use; whether it is adapted to extensive livestock raising alone; and, of course, whether irrigation is required, is available, or can be made available to supplement natural rainfall.

The Location of the Project With Respect to Roads, Transportation, and Markets

The location of the project with respect to roads, transportation and markets must be given early attention in project evaluation. It is a prime determinant of crops that can be produced and sold. Generally, the more remote the project, the less intensive will farming operations be, and the larger will the farm unit have to be to attain reasonable goals.

Vegetative Cover

The species and density of the natural cover and the likelihood of encroachment of unwanted vegetation become major cost factors for range livestock operations or for jungle-clearing where land settlement is contemplated.

Social and Institutional Factors

National Agricultural Policy

Nothing is more important to agriculture than the government's attitude and actions toward the essential elements of the project. The analyst must determine what they are and are likely to be. In some developing countries, for example, influential trading families' control over the importation of agricultural products tends to limit domestic production of various commodities. On the other hand, shortage of foreign exchange may force a government to undertake and subsidize by high protective tariff or import quotas domestic production that on the surface appears to be uneconomic.

Government policy is highly important for the success of projects involving range livestock operations. Government policy would have to be enunciated or developed fixing the terms and conditions under which the public range could be used; what kinds of livestock would be accepted on it; what individual-sized herds and flocks would be permitted; whether use of the public range should be conditioned upon the availability of a privately owned or controlled feed base; and whether provision would be made to supply essential credit, livestock markets, and advice on how to improve the quality of the herds and the yield of the animal.1/

1/ See appendix A for an example of the pervasive need for government action and the importance of the government's attitude towards a viable livestock industry.

The Willingness and/or Ability of the Government To Support Agricultural Projects

The project analyst must identify how vital the following services are to the project and express a judgment as to their likely availability and adequacy.

Training and extension service programs. Agriculture has become an activity requiring training for even modest success. Today's farmer must have knowledge of agriculture in general and specialized knowledge of the particular activity in which he wishes to engage. Additionally, he must be versed in credit, marketing, management, and other related subjects. He has to rely on information from agricultural specialists and from research and experimentation best made understandable to him by an extension agent or an irrigation, crop or livestock specialist. The analyst must ask whether these services are available or what it will cost to create them.

Agricultural machinery and large physical projects such as irrigation and drainage projects require prior training programs for mastery of the operating and maintenance problems. Trained people must be available or training programs must be undertaken if agricultural projects requiring advanced skills are to be undertaken.

Agricultural experimental stations and demonstration farms. The analyst must determine whether the project will have available to it the vital information on the best and relevant methods of farming and ranching. Also, can the farmer readily obtain answers to hundreds of practical what, why, how, when, where, and who questions? In a year of high calf losses, he must learn why; if his grain seems to be growing entirely to stems, he must learn why; if he needs to increase the production of his pastures, he must learn what can be done, what fertilizer is needed, how much should be applied, when it should be applied, who can supply the essential data, etc.

Agricultural credit. What credits are needed, when, for how long, on what terms, and can the project meet them?

As agriculture has been modernized and has become market oriented, machinery has increasingly replaced most animal power. For this and other reasons, the need for credit has expanded. Generally, farmers or ranchers cannot finance mechanization and other capital needs with their own resources. The need for adequate credit is a fact of life. It must be provided or agricultural projects will be likely to fail. Three types of credit are usually required:

. Short-term credit to finance the current crop year's operations: seed, fertilizer and farm-family expenses until the crop is sold. This type of agricultural credit is frequently provided by suppliers and/or middlemen who thereby acquire a prior claim on the harvest. Rates of interest are frequently usurious. High interest rates, together with the farmer's lack of freedom to dispose of his crop in the market and in the manner that will give him the greatest return, are highly detrimental to projects relying on the initiative of small-scale farmers. The amount may not be large, but lack of this type of credit is most acutely felt by the low-income groups who have little or no savings upon which to draw. Without adequate short-term credit on reasonable terms, agricultural projects cannot succeed and should not be undertaken.

. Short-term credit equivalent to a minimum of 25 percent of the estimated gross crop value should be anticipated in proposed projects. This may rise 50 percent in the case of projects requiring heavy outlays for insecticides and hired workers to meet seasonal labor demands.

. Medium-term credit, i.e., loans for periods generally longer than 1 crop year but less than 3 years. Credit of this type may be required to finance the acquisition of breeding stock, minor improvements required to enable the individual farmer to participate in the proposed project, and inexpensive equipment with a relatively short life.

. Long-term credit necessary to acquire major machines with a life expectancy of several to many years, or to carry out major improvements of farm lands and buildings. The success of a project can be measurably accelerated with this kind of credit. The amount needed will vary with the project. If water is to be applied by sprinkler and if farming is to be mechanized, the needs will be higher than if more extensive farming practices are to be followed. Farmers on new projects are rarely able on their own to invest in land treatment, farm buildings, and farm machines having a life expectancy of 5 years or more.

The effective use of the credit intended for the introduction of new methods and the upgrading of technology depends upon the farmers' receiving proper guidance. Credit agencies may provide technical information as a part of a supervised credit program. Such supervision, and particularly servicing, of small individual loans is very expensive per unit of money loaned, and may call for more qualified supervisors than are available. This is one reason why credit institutions are biased in favor of medium- and large-sized loans and farms, and why the small farmer is often neglected.

The credit cooperative which assumes responsibility for individual member loans is one device for reducing costs of credit program administration, particularly for the small farmer. The cooperatives may also bring farmers together so that technical specialists from the extension service or the credit agency can work with them efficiently on group basis. The CPA needs to address squarely the issue of whether credits, particularly for small farms, can be effectively used and serviced. The conclusion may be that only subsidized credits can serve the farmer's needs; if so, the cost of such subsidy must be expressly included in the NNRR (General Guidelines, chapter VIII).

Price supports. Frequently the attainment of national objectives can be facilitated by the establishment of price supports to encourage production of a crop or crop group in short supply, or where such production would be advantageous from the viewpoint of its impact on foreign exchange payments. Agencies of government capable of providing and administering price support programs should be available. This applies equally to livestock projects.

The view is sometimes encountered that farmers are strong traditionalists, not very responsive to price incentives. Such ideas, however, have been shown to be erroneous in country after country. The farmer must of course have access to the means of responding to the price incentives.

It should be recognized that any announcement of a price support must be backed by the ability to make it effective. This is likely to involve purchases, storage, and sales of the commodity by a public agency or its designated agent. Reliable information on supply and demand conditions is necessary to estimate costs of supporting prices at relevant specified levels. The costs of constructing the necessary physical facilities to store the crop and of administering the program are costs to be included in the calculation of the NWRR.

Tariff protection. The CPA must identify the tariff protection available, or the subsidies to be paid on exports. If, for example, farm machinery and fertilizers have to come from foreign sources, their use can be encouraged or discouraged by the amount of tariff added to the cost of these items. If imports are significant, tariffs can be an important factor and should be reviewed and adjusted from time to time as circumstances warrant. This is particularly true when new farming or stock-raising programs are being started or emphasized. Tariffs and subsidies will affect the business enterprise rate of return, but they are excluded in calculating the national rate of return (see General Guidelines, chapters III and VIII).

Establishment of favorable policy on land tenure. The task for the analyst is to judge whether the proposed project will be facilitated or hindered by the effects of government policies with respect to the size of farms and land tenure.

- Land reform and tenure. Programs in this area can create problems of economic farm size. Excessive subdivision results in uneconomic holdings. The project analyst will need to identify whether government actions on land policy could have this effect on the project under appraisal.

- Land reform requires a careful inventory of physical and other resources, i.e., the land, water supply, fertility, management problems, and the crop or crops planned. The planner can then divide the resource base into economically viable blocks. The size of holdings can be critical. Units that are too small can make the project uneconomic. Larger holdings will generally permit more effective management, efficient machinery and more favorable lines of credit and marketing. Cooperatives in machinery, marketing, puchasing, and related cooperatives, can permit the advantages of small and family-size farm holdings to be realized whil retaining the economies permitted by larger holdings. The analyst may find that land reform along with other changes are necessary for the success of the project.

. Farm shape. The analyst must judge how the project will be affected by farm shape as well as size. In some sections of the world, the practice of dividing farmland among the heirs of an estate leads to the fragmentation of farms into sizes and shapes which preclude economic operation. What is more, success may be impeded by the local practice of surrounding each field with tree crop plantings or adobe walls, thus making it difficult and costly to change agricultural practices. All farms should have ready access for machines.

Provision and support of requisite agricultural project facilities or services. Does the project adequately identify the nonproject (external) facilities and services that are needed? Among these are:

. Roads and highways -- Farm supplies must be moved to the farm and farm produce must be carried to the marketplace. The availability and quality of roads and highways exercise a tremendous influence on crops that can be profitably grown and on the combination of enterprises that can be followed. Perishable commodities cannot be produced if they have to be moved to market over rough roads and trails. Even if the project area is ideally adapted to high-quality, high-value production, poor roads and inadequate transportation and marketing facilities and services may force the farmer to forego the production of high-value crops in favor of less profitable -- but less perishable -- crops. The farm road explicitly created to make a project possible becomes a charge to the project in calculating the NWRR. The benefits to other sectors created by the road should also enter into the NWRR.

. Markets -- Agriculture products require ready markets that are equipped and financed to absorb production at fair prices or the project will either fail or be slow to succeed. Can the farmers be made to be market oriented? Is there reasonable assurance that they will plant for the market, produce for the market, and offer the products of farm and ranch in acceptable quantity and quality for a given market? If they do, will the market take up their products and at a remunerative price?

Is the proper information about prices, needs, and qualities likely to reach the farmer to guide his decisions?

Markets must provide specialized services such as receiving the many small lots of agricultural produce to be combined and moved in economic quantity to major consumption centers. A second service is to accept agricultural products of previously announced quality and hold them for later disposition to the ultimate consumer. This function is particularly important in the case of nonperishable crops such as wheat, rice, corn and other grains, alfalfa and cured hay, and semiperishable crops such as potatoes.

Where canneries or freezing plants are contemplated as the "market," the availability of large quantities of uniformly high-quality produce must be assured. Canneries cannot be made profitable on the basis of occasional offerings of fruits or vegetables of uncertain quality. All of these considerations should be made a part of the market analysis.

. Communications -- The importance of communications increases in proportion to the perishability and specialization of agricultural output. When specialty crops are ripe, they must be moved rapidly to the marketplace and there be equally rapidly absorbed. Moreover, once these crops are committed to any market, the decision becomes almost irrevocable. The analyst must determine whether the producer will know where perishables are needed and where market prices are favorable. All this indicates the need for reliable postal, telephone and telegraph services.

. Market information service -- Prices and profits can be greatly affected by market information on where products can be sold and at what prices. The analyst must determine whether government agencies or private organizations exist to perform this service.

<u>Legislation and control agencies</u>. A project's success may depend importantly upon rules and regulations laid down by the government, e.g., the allocation of water resources or grazing rights. Are the laws and regulations sufficient, and is enforcement effective? Several matters may be essential to the project; the analyst has to decide which are so.

. A water code together with an organization to administer it. The water code should establish broad priorities of use and spell out how the right to use water is acquired (or lost), should detail the process of water allocation, and should treat with both surface and subsurface water supplies and how each is to be developed and used. Whatever the present code, we may now be witnessing development of a totally new series of water law concepts governing industrial and agricultural uses, and use of water for recreation, fish, wildlife, and esthetic uses. Society's right to clean water will undoubtedly force additional changes in water law. The project analyst must judge whether a project will be affected by such changes.

There must be an organization capable of administering the code. Does it exist? Does it do the job? Should the creation of such an agency be considered essential to the project?

. A range code together with an organization to administer it. Where open range exists, rules governing use and use rights may be essential to the project. Several satisfactory range codes are available, e.g., the Taylor Grazing Act of the United States, together with the rules and regulations promulgated by the Bureau of Land Management, the F.A.O. draft (Allred, 1966) prepared for Saudi Arabia. Is there an effective agency for administering the code? Is the need for one important to the project?

. Does the project's success hang on the existence of a land-use code and an administering agency? Is there a government service equipped to work with farmers and ranchers in the prevention of soil or fertility loss through erosion, seeping, chemical deterioration, overgrazing of pastures and like hazards and to assure the availability of the land resource from generation to generation? (Example: The U.S. Soil Conservation Service and the Turkish soil conservation program.) The use of a resource should carry with it the obligation to perpetuate the resource in usable form.

Social infrastructure. Farmers will not stay at their farms and ranches indefinitely unless they are provided at least a few of the basic amenities of a modern society. The list of desired services will probably include schools; medical, dental and hospital care; a potable water supply and associated sanitation facilities for domestic needs; and postal, telephone, radio, and -- increasingly -- television services. Does the project's success hang on improvements in these services? Are they likely? At what cost? Where?

Investments made in the social infrastructure that are additional to what would be made in the absence of the project must be considered as part of the project investment and should be included as costs of the project. For example, land development schemes to open new areas to settlement and agricultural production will require a broad range of social infrastructure investments if settlers are to be attracted to the area (e.g., schools, medical facilities, and facilities for worship). To the extent that such investments could be avoided if the land development scheme (and movement of population into the area) is not undertaken, the required infrastructure investment should be considered as both financial and real economic costs of the project.

The Farmer

The farm or ranch operator's qualifications should be judged in the CPA. Native ability may be adequate in the case of range livestock operations but may not suffice when the proposed project anticipates the conversion of herdsmen to irrigation farmers. Moreover, the ability of the farmer to accept new methods and to change his operations to meet changing and developing market conditions stresses the need for literacy. Projects that call for drastic change in the traditional patterns of farming or ranching require careful attention to educational and training programs.

Agriculture is strongly influenced by tradition and custom. Particular consideration must be given to those customs that are significant in attaining project success. Tradition may decree that a farmer's wealth is in his camels, horses, cattle, goats, sheep or other livestock, and he plows any surplus income he may derive into increasing the size of his herds or flocks. To attain reasonable success he must be trained to become market oriented -- to sell his surplus crops and livestock and to measure his wealth in terms of his holdings of productive assets, including bank deposits. Whenever custom impedes or tends to impede project success, the factor should be identified for appropriate consideration. Project evaluation is not complete unless these factors have been identified and the possibility, probability and cost of remedial measures evaluated in rough orders of magnitude.

International Considerations

Certain projects are particularly sensitive to international marketing arrangements. For example, the success of a project for the growth and export of coffee, cocoa, and sugar will hinge in great measure on whether international commodity agreements control trade in these products. If so, do such agreements allow room for the increased exports? Trade in coffee and sugar is today controlled by international quotas; cocoa is a perennial candidate for an international commodity agreement.

Other kinds of international considerations will affect a project. For example, an irrigation project may depend importantly upon water originating in a neighboring country. Is there any threat to the continued flow of water posed either by political considerations, or by plans in the neighboring country for water diversion of usage for its own purposes? A livestock industry may require seasonal movements of herds into neighboring countries. Is there a threat of border closure? Agricultural exports may have to travel on the transport system of a neighboring country. Is there any danger of interference with that transport?

The task for the analyst is to identify the international actions likely to affect the project. In the sensitivity analysis conducted for the project (see General Guidelines, chapter VII) due weight can be given to such considerations.

IV. STEPS IN THE CAPITAL PROJECT APPRAISAL

Project preparation and appraisal consist of the following:

1. Identification of need for project and potential outputs, in relation to overall economic conditions and sector plans and projections

2. Formulation of physical resource flow plan for the project

3. Pricing the project: valuation of inputs and outputs

4. Examination of the most promising alternatives

5. Computation of rates of return

6. Sensitivity analysis of rates of return

7. Evaluation summary

While the above steps can be discussed as discrete steps that will occur in the stated order, it should be recognized that in the course of carrying out these steps there will be considerable interaction. For example, in carrying out step 4, the analyst may find that other alternatives suggest themselves, so that he may find it necessary to go back to step 2.

Market Demands and Price Considerations

Considerations discussed previously, and Phase I and Phase II of the checklist in appendix B, suggest the range of potential outputs for proposed projects. In the agricultural sector for each potential output item there must be an estimate of the demand because output produced without regard to demand can be disastrous. Here one must distinguish between two types of market situations.

The first kind of market situation is one in which the volume of output of the project is sufficiently small in relation to the total sold that one can disregard effects of the output on price. Conditions favorable to such insulation from the effects of project supply are small projects, staple products, large markets, nonperishable products, and use by processing plants. The prices of products sold in the world market would often be insensitive to the project supply.

The other type of market situation is one in which the supply generated by the project is likely to exert a major effect on the price. Conditions that are commonly associated with the latter type of market are large projects, local and/or small markets, seasonal markets and perishable products.

The variables affecting the market are subject to change by design. An example is a small project that specializes in tomato production for a small local market. It is possible for such perishables to flood the market seasonally and to cause a sharp drop in price. Measures that will reduce or eliminate the price drop are diversification, access to larger markets (capital city, neighboring country), or the establishment of a processing plant.

Because one can expect changes in demand-supply conditions of particular farm products over time, wherever possible the product mix of the planned project should be flexible. Projects that involve the production of one or two main crops are especially risky.

The projection of price and quantity of potential outputs provide a basis for estimating the economic merits of the project. Particularly for nonstaples, the data available will be quite scanty. Projection methods outlined in the General Guidelines will be used with particular regard to the effects of project supply on price. Where projections are highly uncertain, it is desirable that provision be made for initial diversification and, if possible, potential shifts in output.

Formulation of Alternative Physical Resource Flow Plans

A consideration of the potential outputs, related to the projected demand for such outputs, will facilitate the assessment of physical resource flow plans to meet the need.

The elementary unit of farm activity is the production of a particular crop or particular type of livestock, etc. Based on a technology which is available or could be made available as part of the project, consideration is given to what are economically promising activities. As a first approximation, one would calculate the profitability of a potential activity in conventional accounting (or farm budgeting terms) as is illustated in table 1. Such calculations would be in terms of market prices. Projections such as that shown in table 1 would be prepared for the various potential products.

Taking into account the size of farms in the project, one would project for major types of farm units covered by the project a suitable mix of elementary activities, with due regard to their individual profitability, complementarity and compatibility. Factors to be taken into account in combining elementary activities in individual farm units are peak labor requirements, beneficial crop rotations, use of byproducts (such as manure) and diversification needs. Because the potential combinations are extremely large in number, it is important that the analyst exercise judgment as to what combinations are promising.

By providing projections for major types of farm units and aggregating these for the farms of the project, it is possible to arrive at physical resource flow plans for the farms. In addition, the physical inputs and outputs for activities outside the individual farm units have to be formulated. Activities such as technical assistance, credit, farm-to-market roads -- all the physical inputs that are required to realize the project's output -- must be specified as part of a physical flow plan for the project.

Alternatives may differ with respect to farm size, tenure status, seed and fertilizer distribution and other inputs, crops and cropping patterns, processing plants, and the availability of credit and extension services for both landlords and tenants. For example, in irrigation, the analyst must consider tubewells as alternatives to a dam. If a dam is determined to be the most promising, alternatives will still exist in phasing and methods of construction, in the size and type of dam, and in how the water is used on farms. In designing an irrigation project there may be options to achieve additional benefits such as flood control, navigation, urban water supply, recreation or power generation.

In land reclamation, the complementary activities necessary for realizing benefits inherent in any agricultural project and the size of the project are all options that must be considered.

Because rural unemployment and underemployment are common problems in developing countries, activities that require relatively large amounts of labor during the whole year will be especially attractive. Although one would pay special attention to such activities, the technology assumed would be based on minimizing the cost of producing the product, given the prices faced by the farmer. Thus, there might be a special interest in the growing of tobacco because, in addition to having a generally favorable market, it makes use of a large amount of labor.

Table 1. Cotton Growing Enterprise, Approximate Net Return to Farmer Per Hectare

Item	Unit	Proposed project			Without proje	
		Price or cost/unit	Number of units	Value or cost	Number of units	Val or
Gross Receipts						
Cotton lint..................	cwt	$27.50	3.40	$ 93.50	1.70	$46
Cotton seed..................	ton	45.00	.26	11.70	.13	5
TOTAL.....................				105.20		52
Cash Expenses						
Seed.........................	lb	.09	60.00	5.40	50.00	4
Machine use..................	hrs.	1.00	4.00	4.00	--	
Insecticide..................	acre	1.50	2.00	3.00	--	
Hoeing.......................	hrs	.30	24.00	7.20	24.00	7
Fertilizer...................	cwt	3.75	4.00	15.00	--	
Dessication..................	acre	3.00	2.00	6.00	2.00	6
Custom Stripping.............	cwt sc	.50	14.16	7.08	14.16	7
Ginning......................	cwt sc	.60	14.16	8.50	7.08	4
TOTAL.....................				56.18		29
Returns over Cash Expenses..................	dol			49.02		23
Other Expenses						
Interest on operating capital..................	dol	0.06	44.50	2.67	35.00	2
Depreciation on machinery and equipment.............	dol	.27	13-14	2.67	2.00	
Labor........................	hrs	.30	20.00	6.00	30.00	9
TOTAL.....................				11.34		11
Returns Over Specified Expenses..................	dol			37.68		11

In many situations important social co[illegible]
have a bearing on the project. For example, it may be considered desirable for the project to settle more families. Such an alternative would have its own set of physical flows.

Pricing the Project

The physical flow plans of the project will reflect intuitive and rough judgments of what constitute promising sets of farm activities, and of the nonfarm inputs that are required to facilitate such activities.[1] The suggested physical flow plans would then be priced in two parts: farm costs and income and nonfarm costs and income.

Farm Costs and Income

Farm income in its simplest form includes receipts from the:

- Sale of crops, animals or animal products
- Sale of crop residues and pasture
- Price support or benefit payments.

In real terms, farm income also includes the value of farm products consumed by the farm family, i.e., income in kind.

As will be discussed in a subsequent section, in the computation of the net national rate of return, the shadow price for output will be the import price plus local handling charges, allowing for the shadow price of foreign exchange.

The expense side in its simplest form includes:

- Cost of land preparation
- Cost of feed, seed, fertilizers and production supplies

1/ Calculations such as those shown in table 1 would be used as a check on what are considered promising elementary activities of the farm unit.

- Cultivation costs
- Harvesting and marketing costs
- Transport and storage costs
- Other services purchased by the farmer
- Land taxes and interest on borrowed money
- Amortization of capital development costs such as sprinkler systems, assigned project costs and other obligations that are paid back over a period of years.

Many of the costs incurred in agricultural projects will consist of labor input supplied by the farmer and family members. Even though such inputs require no explicit money payment, they should be included in the investment and operating costs of the project at an appropriate accounting wage. On the other hand, some of the explicit outlays and receipts, such as interest, taxes and debt repayment on the cost side and subsidies on the receipts side, are excluded from the inputs and outputs in computing the NIRR or other measures based on real benefits to the economy.

When each of the major cost terms is broken into all of its parts, the list will be long and complex. For the PPA, the analyst can concentrate on getting approximate data for a limited list of key expenses, and can cover the remainder with a global estimate which experience in the country or elsewhere suggests to be reasonably accurate.

<u>Nonfarm Costs</u>

In addition to farm costs, an agricultural project may include investments and expenditures that are public in nature. As was discussed in the earlier section on infrastructure requirements for projects, it is important to include all investment costs that are made specifically for the project in computing the net national value flow.

Selection of the Most Promising Alternatives

In considering the various possible physical arrangements the analyst will have compared alternatives that appear promising. In this process, attention is narrowed to relatively few projects. By applying the techniques of comparing alternatives and choosing the least-cost alternative as described in chapter V of the General Guidelines, the analyst will point up one or possibly two alternatives that are most promising.

In comparing alternatives, one often becomes conscious of variations that one did not consider previously. For example, the great importance of reaching full production at an early date may suggest special measures to be undertaken.

The analyst may find it worthwhile to reformulate or modify the project in order to improve it in some important respect.

Size and Phasing

The size and phasing-in of agricultural projects can have a marked influence on both costs and returns. The size of large irrigation projects should be determined, in part, by the ability of the market to absorb the increased agricultural production. Most probably the hay, grain, and other nonperishable forage crops produced on a new 10,000-acre irrigated block could be absorbed by the market. It might possibly be able to handle a considerable volume of semiperishables such as apples or potatoes. But it is not likely that it could handle the added production if the entire block were planted in perishables such as tomatoes, peas or peaches.

The means of determining the optimum size of the project are described in the General Guidelines (see chapter VI).

Computation of Rates of Return

Judgment on the financial and economic feasibility of the project must rest on the analyst's quantified judgments on each of the important factors affecting both the costs and the benefits of the project. That is to say, all that he has estimated up to this point is intended to permit him to place values on the cost of the inputs required for the project's execution and on the outputs likely to be produced by the project. As explained in chapter III and illustrated in chapter VIII of the General Guidelines, these costs and benefits must then be expressed in relevant terms: from the national viewpoint, in the net national rate of return (NNRR); from the farmer's viewpoint, in the business enterprise rate of return or, alternatively, in the increase in the farmer's income.

In computing the net national rate of return, the import price plus handling cost of the product should be used as the unit value of the output. Therefore, if wheat can be imported at a cost of $2.00 a bushel, that price should be used in calculating the value for purposes of the NNRR, even though wheat may sell domestically at a higher price. However, if the official rate of foreign exchange overvalues the domestic currency, the lower import price must be adjusted accordingly. In the example given, if the real value of a unit of foreign exchange is 35 percent higher than the official rate, the alternative of importing wheat at $2.00 a bushel is equivalent to a cost of $2.70 for national measures such as the net national rate of return. To estimate the opportunity cost of the product, short-term dumping prices should not be used when such prices will not be available on a long-term basis.

If the proposed project does not yield a net national rate of return equal to or above the marginal opportunity cost of capital, and equal to or above the rate on any alternative form of the project that would meet the need, it should be dropped or modified. Modification to improve the rate of return might require a different phasing of investments and returns, a change in size of farm unit or in technology used, or different credit arrangements.

If the proposed project is attractive from the national point of view (i.e., the NNRR meets the standards noted above) but is not attractive from the farmer's point of view, measures to provide incentives would be in order. These might be in the form of price supports, tariffs, outright subsidies, or tax exemptions or credits.

It should be noted that the farmer's interest is analogous to that of the business enterprise discussed in the General Guidelines. It is useful to obtain the total flows of all the farmers affected by the project. But in addition one should construct the flows of representative farmers to determine the attractiveness of the project to the individual farmers and to examine the relationships of cost of inputs to outputs. For example, if the cost of fertilizer is high (because of protection) and the price of output is low (because of price control), then assumptions about the use of fertilizer (and yields) may be wide of the mark. To induce change, it is important that price relationships between inputs and outputs are sufficiently attractive.

Tariff policies for agricultural inputs and outputs as well as price support policies must be coordinated to provide adequate incentives for farmers to produce at projected levels. This is especially true if the project assumes a changed pattern of production.

Sensitivity Analysis

As explained in chapter VII of the General Guidelines, a CPA should include the effects of divergence of values from the best estimates. Rates of return on agricultural projects are particularly sensitive to:

- Yields
- Prices of outputs (because the NNRR evaluation for outputs is based on world prices, the prices for which sensitivity estimates are relevant are c.i.f. prices)
- Length of gestation period and time needed to reach full production
- Prices of major inputs.

Evaluation Summary

An evaluation summary of the findings should be prepared. An outline for such a summary is presented in Appendix C of the General Guidelines.

APPENDIX A. RANGE REGULATIONS

An example of the essentiality of sound policy on range matters is provided by the case of the Great Nafud Sedimentary Basin in Saudi Arabia. The government has enunciated a policy favoring agricultural development which as yet has not been fully implemented. In the case of the range resources of the Great Nafud Basin, drastic conservation measures will be required if the resource is to be preserved even in its present deteriorated condition, with a still greater effort required if it is to be improved. When dealing with nomadic herdsmen who move at will across the range following clouds, rumors, and an inborn sense of being able to find graze to maintain their livestock, it would be of no avail to implement a policy of range restoration without at the same time initiating a system of strict use permits and a drastic and compulsory reduction of stocking to the capacity of the range. Even then, if conservation measures were to be initiated which resulted in increased production of forage, it would simply create a magnet that would draw Bedouin herders and their livestock to the Basin from all over the Arab world. This would quickly produce havoc on the restored range. For a range project to succeed under conditions prevailing in Saudi Arabia it would be necessary:

1. For the government to enter into agreements with its friendly neighbors to establish strict rules governing the movement of livestock across international lines.

2. To organize a system of range permits which would limit livestock numbers to the supporting capacity of the range.

3. To utilize the tremendous volume of forage produced by annual plants. To do this, Bedouins would have to be settled in open feed base. There they could produce cut hay that could be fed when, because of the vagaries of desert rainfall, the annual crop failed.

4. To abolish the present practice of grubbing up range shrubs for firewood.

5. To provide for the acquisition of improved sites, and to provide advice on how to breed up the quality and productivity of the livestock.

6. To provide a collector system that could accumulate for resale, in economic lots at the larger central markets, small lots of hides, pelts, fleeces, and livestock.

A simple decision to restore the range is not enough. These same general rules would apply almost anywhere in the Middle East. Attacking only a single segment of the problem should be discouraged or be reason enough to eliminate a livestock proposal from consideration. With it all is the requirement for a trained cadre of specialists who can lead the way.

Prior to initiating projects, governmental policy should be clearly enunciated and institutions either strengthened or created to implement policy. The government holds the key to both farmer and project success. Needed services generally cannot be provided by a farmer himself or by several farmers acting as a group.

APPENDIX B. RECAPITULATION AND CHECKLISTS OF KEY CONSIDERATIONS

A CPA for agriculture should seek to:

1. Assess the physical feasibility of the proposed project;

2. Establish that overall economic strategy and policies, particularly in agriculture, will provide support for the proposal;

3. Demonstrate adequate institutional support for the project;

4. Judge the project in the light of relevant international considerations;

5. Estimate the availability of farmers or ranchers with sufficient training and experience to man and to operate the project;

6. Establish all the costs and receipts of the project including those costs both internal and external to the project;

7. Finally, quantify the return of the project using at least the concepts of net national rate of return and the business enterprise rate of return, and such other measures as seem pertinent (such as the benefit-cost ratio).

The checklist appearing on the following pages can help to assure the comprehensive coverage of the important considerations for each phase of work. These checklists will require adjustment to fit the various kinds of agricultural sector projects that might be proposed and will vary also from country to country. They are provided here only as guides to the kinds of things that can influence the soundness of agricultural sector project proposals.

Phase I - Physical Feasibility

This phase covers an appraisal of the physical feasibility of the proposed agricultural sector project. It is concerned with broad judgments on the soil to be tilled, the quality and quantity of the water supply, the climate, management problems, best crops and best combinations of enterprise, and also the proposed project works. Basically needed is a finding that in the area being considered the physical realities of soil, topography, climate (including frost and rainfall), and water supply give promise of being able to sustain the project. Also needed is a finding that the works proposed are soundly conceived and probably can be constructed within the price estimates provided.

From the review of physical data, the basic engineering, management, and physical problems emerge and are picked up as cost factors in the economic analyses.

The checklist for Phase I must be adapted to each project. However, the following general checklist does indicate the kinds of information needed.

Phase II - Institutional Consideration

The facts brought out in response to the checklist should be supplemented by sufficient narrative to explain strong points or weak points in these major areas and to outline suggested remedial programs.

Projects could be turned down on the basis of the second phase analyses. If a project is clearly a "no-starter" based on Phase II findings, there is no purpose in moving on to Phase III. If the Phase II review uncovers a major deficiency, remedying it should clearly become a "condition precedent" to the making of a development loan or the commitment of public or private funds to the project.

As a byproduct, Phase II appraisals can assist AID or other lending institutions in structuring a development lending program for the agricultural sector. For example, the appraisal of institutional factors may establish a lack of private lending sources to supply production credit. The development of lending institutions would then appear to be a ripe candidate for development assistance. For instance, if agricultural research is not being carried out or is deemed inadequate, a development loan might then be considered to establish an agricultural research program and an extension program to carry research results from this and other sources to the country's farmers and ranchers.

Phase III - Economic Feasibility

In this phase, the analyst must demonstate that the project is compatible with national goals and strategy. Often it is difficult to ascertain just what these are, but the analyst should nevertheless seek to identify them. The project must be seen as conforming (or not) to the national purposes.

In this phase there must also be a means to bring together costs and expenses so as to calculate net project benefits as developed in the General Guidelines. Emphasis must always be on calculating the net national rate of return, which can be compared with the business enterprise rate of return.

A Three-Phase Appraisal of Agricultural Sector Project Feasibility

Phase I Appraisal of the Physical Characteristics of Projects	Phase II Policy, Institutional, Farmer and International Considerations	Phase III Feasibility Appraisal of Projects
Concerned with the adequacy of the soil, water supply, the engineering works, if any, that are proposed, the size of farm or ranch proposed. In short with all aspects of the physical plant or with physical feasibility.	Concerned with: 1. The impact of established policy on agricultural project. 2. The adequacy of established institutions and services. 3. The availability of farmers and ranchers with sufficient training and experience to man the project and operate its facilities. 4. The direct problems to project success posed by international considerations. Note: From this step can come a list of "conditions precedent" and a preliminary outline of a developmental lending philosophy and program.	Concerned with the economic feasibility of the proposed project. It seeks to convert the various costs and benefits associated with the project into measures permitting a preliminary decision on the feasibility of the project. As a minimum, should include computation of business enterprise and net national rates of return.

Phase I Checklist -- Physical Feasibility

Name of project ____________________

Location of project ____________________

Type of project, i.e., irrigation, drainage, etc. __________

A. General (in acres, hectares, or ________)

1. Total area embraced by project __________
2. Total cultivable __________
3. Planned average size of farm __________

	Yes	No
B. The Soil		
1. Has area been covered by land classification survey?	☐	☐
2. If yes, at what standard: Detailed __, Semidetailed __, Reconaissance __		
3. What system used ____________________		
4. Are major management or fertility problems present? (If yes, discuss on attached sheet)	☐	☐
C. The Topography		
1. Is project covered by topographic survey?	☐	☐
2. Scale of maps __________. Are maps available?	☐	☐
3. Does topography present management problems? (If yes, discuss on attached sheet)	☐	☐
D. The Climate		
1. Frost-free days in growing season ______. Are early or late frosts a problem?	☐	☐
2. Average annual rainfall __________ Average during growing season __________ Standard deviation of average annual rainfall __________		
3. If irrigation project, what is source of water? ____________________		

4. Is supply adequate for present or projected use? (If no, discuss on separate sheet) Yes ☐

5. If irrigation water is to come from international stream, is it covered by treaty? (If no, discuss on separate sheet) ☐

E. Location, Crops and Enterprises

1. Is isolation a problem in management or marketing programs? (If yes, discuss on separate sheet) ☐

2. Adapted crops and enterprises

a. Considering all physical factors list:

Four best crops and yields		Next four best crops and yie	
Crop	Expected yield	Crop	Expected
1.			
2.			
3.			
4.			

b. Considering all physical factors indicate best combinations of enterprise.

1. ______________
2. ______________
3. ______________
4. ______________

F. Land Tenure -- Farm size and shape (Yes / N)

1. Will farms be of economic size? Discuss. ☐ ☐

2. Does farm size or shape pose major problems? (If yes, discuss on attached sheet) ☐ ☐

Yes

3. Will farms be owner operated? If landlord-tenant arrangements are contemplated, describe terms.

G. Vegetative Cover

1. Will removal of native vegetation create cost problems?

Erosion problems?
Discuss.

Phase II Checklist

Considerations of Institutions, Government Policies, Farmers' Capabilities and International Implications

1. As far as the place of agriculture in the economy is concerned, is governmental policy regarded as:

   A. Extremely favorable ☐

   B. Favorable ☐

   C. Indefinite or unexpressed ☐

   D. Negative or opposed ☐

2. Are the following programs (1) adequate, (2) present but in need of strengthening, (3) inadequate, or, (4) being developed?

	1	2	3	4
A. Training programs:				
(1) Farm or ranch operation and management including use of modern farming techniques	___	___	___	___
(2) Project operation and maintenance	___	___	___	___
B. Agricultural experiment stations and demonstration farms	___	___	___	___
C. State of relevant technological development				
(1) Hybrid corn	___	___	___	___
(a) Continuing capability of ongoing research	___	___	___	___
(2) Hybrid rice	___	___	___	___
(a) Continuing capability of ongoing research	___	___	___	___
(3) Tobacco growing	___	___	___	___
(a) Continuing capability of ongoing research	___	___	___	___
D. State of relevant markets				
(1) Corn	___	___	___	___
(2) Rice	___	___	___	___
(3) Tobacco	___	___	___	___
(4) Oranges	___	___	___	___
E. State of inputs				
______________________________	___	___	___	___
______________________________	___	___	___	___

	1	2	3	4
F. Financial assistance				
(1) Agricultural credit	___	___	___	___
(2) Price supports	___	___	___	___
(3) Tariff protection	___	___	___	___
G. Characteristics of land tenure	___	___	___	___
H. Infrastructure				
(1) Roads	___	___	___	___
(2) Markets, processing plants, etc.	___	___	___	___
(3) Transport				
(a) Highway	___	___	___	___
(b) Rail	___	___	___	___
(c) Air	___	___	___	___
I. Codes and administering agencies				
(1) Water	___	___	___	___
(2) Range	___	___	___	___
(3) Land use	___	___	___	___
(4) Wildlife	___	___	___	___
(5) Parks and shrines -- recreation	___	___	___	___
J. Active sponsorship of projects	___	___	___	___

3. The farmer	Yes	No
A. Are project farmers trained in types of farming proposed?	☐	☐
B. Are project ranchers trained in the types of stockraising proposed?	☐	☐
C. Are special skills required in the operation and maintenance of the project and the complicated machines of modern farming possessed by those who will man the project and its farms?	☐	☐
D. Tradition and superstition:		
(1) Do traditions, customs and superstitions tend to inhibit success?	☐	☐
(2) Are special remedial programs indicated?	☐	☐

	Yes	No
4. International considerations		
A. If water for an irrigation project is to be taken from an international stream, are its waters covered by treaty?	☐	☐
B. Are grazing operations involving crossing of international lines covered by treaty?	☐	☐
C. Are international problems present in either procurement of essential supplies or in marketing farm or ranch products?	☐	☐
D. If "C" answer is yes, are problems of sufficient magnitude to require treaty resolution prior to initiating project? Discuss.		

Note: For clarity, reference each point discussed to the appropriate topic on the checklist. For example, if the current situation regarding point 2H(3)(a) is totally inadequate, but a series of road and highway proposals now out for finance would rectify this situation, suitable explanation should be given.

Phase III Checklist -- Price/Cost Factors

Use before project (grazing, irrigate crop land, etc.) ____________________

Income before Project:

Land Rentals ____________

Expenses before Project:

Land Taxes ____________________

Use after project (grazing, irrigate crop land, etc.) ____________________

Income:

_____bu. cereal grain at _____per bu._____

_____T. hay at ______per T._______

_____T. vegetables at_____per T._______

_____T. crop residues at_____per T._____

_____ha. pasture at_______per ha._______

Total _______

Less income before _______

Net project income _______

Expenses:

Land taxes_______ha. at________=_________

Fertilizer________T. at________=_________

Seed _________

Custom land preparation and harvest cost _________

Storage cost

Project operation and maintenance cost _________

Amortization of project cost (if applicable) _________

Amortization of private debt _________

DRAFT CIRCULATED FOR COMMENT

APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II - WATER SUPPLY AND SEWERAGE

Agency for International Development
September 1971

CONTENTS

FOREWARD

The project analyst using these guidelines should first read Part I, General Guidelines. It discusses key considerations for capital project appraisals (CPA's) in all sectors, with a detailed discussion of the methodology for calculating the internal rates of return, the benefit-cost ratios, and other relevant measures of the worth of a project.

These guidelines deal expressly with those matters relevant to water supply and sewerage. They tell the analyst how to think about a water project; what to look for; and how to assure consideration of all elements essential to a project. They suggest institutional, cultural, political, and other factors which can weigh heavily on a project. They encourage concentration on big issues in broad orders of magnitude, leaving details and matters of lesser importance to be explored later in a subsequent study.

The CPA is most efficiently undertaken by multi-disciplinary teams, e.g., social scientists (economists, financial analysts, political scientists, etc.) and technical specialists (engineers, agriculturists, etc.). The structure of the individual multi-disciplinary team can only be detailed within a specific analytical and project context. The term project analyst or analyst, used herein, refers to a member of a team engaged in a CPA.

I. INTRODUCTION

Purpose and Scope

Water supply projects, broadly defined, comprise facilities to provide water for (1) agricultural purposes, (2) exclusively industrial uses which may or may not require fully treated water, and (3) general use by private households, industrial and commercial establishments, and public and private institutions. These guidelines are concerned primarily with the third type of facility, and with sewerage systems for general use by the community as a whole. Special facilities used exclusively for treatment of industrial effluents are excluded from the scope of these guidelines.

These guidelines provide ground rules for selecting and analyzing engineering and economic data for CPA's in the field of water supply and sewerage. They should help the analyst to evaluate the need for a proposed project and to make a preliminary judgment as to the technical, economic, financial and institutional soundness of the proposed project. The need for subsequent study, and suggested scope of work if one is required, should be determined by the CPA.

Chapter I of the General Guidelines describes the objectives of a CPA. The General Guidelines also establish the overall methodology and principles for treating the technical economic and other facets of a project. Methodological matters are, therefore, not repeated here. Rather, attention is focused on developing the concepts and facts particularly relevant to water supply and sewerage. The analyst is given guidelines to aid his search for alternative approaches to projects and also to help insure that all essential information for a correct analysis is considered. The analyst should refer to the General Guidelines, particularly chapters III and VIII, for guidance on how to utilize the facts he has gathered to arrive at a conclusion on a project's worth.

These guidelines cover principal elements of water supply and sewerage systems, including investment in outside and inside physical plant, operations and maintenance, management and technical personnel, operating procedures, financial analysis, and systems planning. A general description of the physical components of water supply and sewerage systems, treatment processes, and the environmental aspects of these facilities is presented in appendix A of these guidelines.

The General Guidelines emphasize the net national rate of return for a project as the preferred measure of its worth. How does this rate of return compare with the opportunity cost of capital and return in other projects? To arrive at that return is a rather complex operation: all costs and revenues must be measured; clearly identifiable benefits which do not yield revenues must be assessed and, if possible, assigned values, shadow prices must be applied as appropriate; and best estimates must be qualified with sensitivity analyses. These tasks are particularly complex for water and sewerage projects because there is no conventional commercial market price for these services; they may freely be provided or may enjoy partial subsidies. These matters are discussed later.

General Characteristics of Water Supply and Sewerage Projects

Water projects often are among the "felt needs" of rural areas. Particulary for towns and villages, but also for cities, potable water has great appeal, and public demands for subsidized water projects are extremely strong.

Sewerage projects cater primarily to urban areas. They are the counterpart to the indoor supply of water. Users are generally expected to pay the full costs of such projects.

Both types of projects, but particularly water supply projects, are sensitive to maintenance practices. Many countries have invested enough in water supply projects to obtain good water, yet still do not enjoy a reliable supply of wholesome water because of inadequate maintenance.

Both types of projects pose questions of tradeoffs involving economies of scale, varying operational costs, foreign exchange, and total investment. In making rational choices among alternatives, the analyst will find the least-cost procedures described in chapter V of the General Guidelines fully applicable and straightforward.

II. RELATIONSHIP OF MACROECONOMIC FACTORS AND SECTOR STUDIES TO WATER SUPPLY AND SEWERAGE PROJECTS

Macroeconomic Factors

To a considerable degree, the capital investments required to supply water and sewerage services are set by macroeconomic objectives and strategies. A few examples follow:

- The rate of population growth will affect the need for water. Acceleration of urban population growth and rising living standards intensify the demand for potable water supplies and for sewage disposal.

- There may be a rapid increase in output in water-using industries, arising from water needed both for manufacturing and the disposal of waste. If the economic development plan encourages such industries, the plan will also have to provide water.

- The country's balance of payments position will affect the quantity and possibly the type of capital equipment available from foreign sources of supply.

- The country's price stabilization policy -- particularly as it affects wage rates and the cost of capital -- will affect the cost, timing, and scope of water projects.

- The country's policies regarding the generation of public capital for investment will substantially influence the funds available for water and sewerage projects.

- Water supply projects may be used by national planners to help implement certain overall economic objectives, including regional growth, income redistribution, land development, and increased employment and income.

Other macroeconomic factors will affect projects in the sector. The analyst must judge which of these are likely to exert significant impacts on his project, and must express this judgment in his assessment of the project's feasibility.

Relationship to Sector Study

An adequate water sector study can provide very valuable background data for the analyst (see appendix B for checklist). It will provide such information and insights as:

- Stream flow and other hydrologic characteristics for the purposes of surface water supply and sewerage planning

- Geological characteristics and success or failure rates of well-drilling programs for the purpose of ground-water supply planning

- An inventory of existing water supply and sewage treatment facilities, including their design capacities and current throughputs

- Present and projected population by size of community

- Projected per capita water requirements by community size, with a comparison of existing capacities and future requirements

- Recent investment costs and current operation and maintenance costs by type of supply, by system capacity, by region in million gallons per day (m.g.d.) and on a per-capita-served basis

- Rate schedules and current revenues by class of consumer (domestic, commercial, industrial, institutional, and governmental)

- Government subsidies (if any), with reasons for their existence

- Current maintenance practices and problems

- Personnel availabilities, with recommendations for overcoming any existing shortages and for providing a future supply of the specialized skills required in the sector

- Organizational deficiencies

- Levels and kinds of water pollution in waterways and along coastlines

- Types and geographic incidence of waterborne diseases

- Review of national policies, legislated or not, covering the spectrum of water resources management.

If such data are not available from a sector study, the analyst must decide what information is absolutely essential to a preliminary appraisal of the project, and must formulate plans to obtain it. He must gain access to information on alternative water sources and on water requirements which are realistic for the proposed service area. These are absolutely required, even for a CPA.

The General Guidelines discuss useful sources of macroeconomic and sectoral economic data. For the particular needs of water, obvious sources of information are public health statistics on morbidity and mortality rates for waterborne diseases, meteorological and hydrological data; collecting networks; ground water studies; and geological and topographic mapping.

III. STEPS IN THE CAPITAL PROJECT APPRAISAL

Project preparation and appraisal consist of the following:

1. Identification of need for project and category of project
2. Formulation of physical input and outputs for project
3. Pricing the project, including inputs (costs) and benefits.
4. Computation of rates of return on the project
5. Examination of the most promising alternatives
6. Sensitivity analysis of rates of return
7. Evaluation summary.

While the above steps can be discussed as discrete steps that will occur in the stated order, it should be recognized that in the course of carrying out these steps there will be considerable interaction. For example, in carrying out step 5, the analyst may find that other alternatives suggest themselves, so that he may find it necessary to go back to step 2.

Identification of Need for Project and the Category of Project

The value of safe and dependable domestic water supplies is widely recognized in relation to public health and economic development. Nevertheless, the vast majority of the rural -- and even substantial portions of the urban -- population in LDC's do not have access to safe and dependable supplies of water.

Local projects may germinate in any number of ways, and the bases for the proposals will vary in their quality. The project analyst should attempt a priori to determine the extent of need and what kind of project is appropriate to meet it. Sector studies, if available, may provide specific informatio on needs. If they are not available, the analyst will normally prepare the essential projections on the basis of data available from other sources.

In general, water supply projects can be classified into two categories: original installations and plant additions.

Original Installations

The provision of new water supply systems is usually limited to the smaller towns in a country and to villages in rural areas. The project analyst evaluates a program to provide potable water which consists of small but possibly numerous projects. In preparing a CPA, the analyst must discuss and offer analysis on (1) the geographic alternatives, based on existing sources of supplies, population, potential benefits, costs, etc.; and (2) the possible alternative sources of supply: surface, ground, or the extension of a municipal system. Technical factors, hence costs, vary considerably among alternative means of supplying the same need, and technically feasible alternatives must be evaluated through rate-of-return calculations.

Plant Additions

Every proposal for plant additions must be compatible with the existing system. Within this constraint the analyst should assure that additions reflect continuing advances in the state-of-the-art.

Plant additions are brought about by requirements for additional capacity or service extension into presently unserved areas. In the planning of the original installation, consideration may have been given to future requirements, and quite possibly the proposed plant additions will fit into this planning scheme. In the case of unexpected additional requirements, new or enlarged facilities may be required that were not part of the original planning. For example, an area at high elevation may have been considered unlikely for development. If that area is developed, the supplying of water will require distribution facilities and a source of supply. A pumping station and a large supply line to the station may be required. This new requirement is a unit unto itself, and its cost should be gauged against the anticipated revenue. Some cities make an additional charge for water that must be repumped.

Projected Requirements

CPA's of water supply and sewerage systems require estimates of future demands on the systems. The usual method for arriving at projected water requirements is to multiply a population forecast for some future time period by some selected daily requirement expressed on a per capita basis. (For obvious reasons, available data on per capita consumption in developed countries cannot be used for developing countries.) A water requirements schedule should be developed for the particular country through the use of available incountry sources. Data can be obtained from actual observation of withdrawals from public standpipes or hand pumps, and from existing water departments' water production records.

It is very convenient for planning purposes and future CPA's to classify requirements by size of community. Projected requirements can be estimated on a higher basis (if historical growth rates are not available) that reflects higher per capita consumption in larger urban areas by virtue of more widespread use of plumbing facilities and water-using appliances.

An example of a requirements schedule developed by a study group for an African country is given in table 1.

Table 1. Estimated Per Capita Water Requirements by Community Size

Community size	Estimated per capita water requirements[a/]			
	1970	1980	1990	2000
Less than 1,000.....	5	5	5	5
1,000-2,000.........	5	5	5	6
2,000-5,000.........	7	8	9	10
5,000-10,000........	8	10	11	12
10,000-20,000.......	8	12	14	16
20,000-50,000.......	14	16	18	20
50,000-100,000......	18	22	26	30
100,000-500,000.....	24	28	32	36
More than 500,000...	30	35	40	45

a/ Figures are in imperial gallons per day. A 25-percent increase was allowed for system leakages.

The figures in the schedules may be taken as averages. Normally there will be variations among communities in the number of water-using institutions (hospitals, schools, etc.) and industrial firms that choose to purchase rather than self-supply their water requirements. Projections should take into account the policies to be applied with respect to metering, and also the proposed user charges. The latter may be an important determinant of the quantities required from public systems for industrial purposes. At some rate level industrial users will provide their own sources.

With respect to industry, heavy water users generally self-supply their own requirements and therefore locate near dependable sources of supply. Most industrial water returns to the water course for reuse downstream by other industries or municipalities. However, industries are the largest and most serious polluters of water, and their waste-water discharges compound the problem of adequate sewage treatment and disposal. Thus, pollutant-prone industries are an important determinant of the demand for sewerage systems. In some cases such industries may be required to provide their own facilities for treatment of industrial effluents. This possibility should be considered in CPA's for sewerage facilities. If treatment of industrial wastes is to be included in the proposed public system, the analyst should be particularly sensitive to the kinds of industrial connections there will be in the service area and the chemical, thermal, etc., characteristics of the discharges.

The other requirements placed on a proposed sewerage system include those from domestic, commercial, and institutional (schools, hospitals, etc.) users. These classes of users seldom impose special problems on load forecasting, and analysts can follow the simple rule that the volume of water supply that the utility delivers must be collected by the sewerage utility.

Development of Physical Resource Flow Plans

The physical flow plans should relate physical resources to needs. Appendix A outlines some of the principal physical elements that will influence alternatives to be considered in water supply, treatment techniques, transmission methods, distribution, pumping requirements, storage facilities, service connections and site selection.

Basic Physical Factors

Several basic physical factors influence planning of water and sewerage projects.

The most economical source of water is generally underground water because its treatment and transmission are usually less costly than those for surface water. Underground supplies seldom need treatment other than chlorination. The disadvantages of underground water are the danger of exhaustion of supply and the possibility of a heavy mineral content that may require special treatment.

Probable per capita consumption and growth of demand over time will determine design requirements. Distribution storage reduces capacity requirements at peak hours of demand and supplies a safety factor in the event of breakdowns. Me[illegible]ing of consumer services is effective in reducing waste.

Pressure must be designed to provide adequate service without damaging plumbing. Where consumers are located at a great variety of elevations, different pressure zones may be required.

The capacity of a pipeline varies with the square of the diameter. Thus, an increase in diameter will greatly increase the capacity. For example, one 6-inch pipe will carry more than twice as much water as two 4-inch pipes. A major portion of the cost of a pipeline is in the excavation, backfill and paving. It is less expensive to install a 6-inch pipe than to duplicate a 4-inch pipe after a few years. Pumping units and filter capacity can be installed as needed but the connecting piping to a pumping station or filter plant should be of sufficient size to serve the anticipated requirements.

Street sewers normally cost much more than water mains because of the depth of the sewer below the street surface. Pipe is a minor cost; installation is the major cost.

Pricing the Project

Conversion to Value Flows

At this point in the CPA it is important for the analyst to be familiar with the pricing methods described in chapter II and appendix B of the General Guidelines. It is especially important to distinguish between the pricing of inputs and outputs for computation of the net national rate of return (where shadow pricing may be required) and the pricing of inputs and outputs for the computation of the business enterprise rate of return (where shadow pricing is not used).

Use of Costing Modules

For CPA's in the water sector, major input elements to the various kinds of systems should be available in "prepackaged" modules which are "prepriced" in the local currency. Cost estimating modules are required for construction and annual operating elements. These should be based on local labor costs and capabilities. These modules help to establish quickly the approximate cost of a project, given the capacity or size of the proposed service area.

Before examples of costing modules are provided, methods by which they can be put together will be given. One method is to take the original costs of the existing plant and, for each of the capacity categories (50-100 m.g.d., 100-250 m.g.d., etc.), to raise them to present costs using an appropriate construction cost index. Another method is to obtain current quotations from suppliers for capacity-rated elements covering the spectrum of plant sizes suitable throughout the nation. One set should be done for surface water, one for ground water, one for primary sewage treatment, etc. With data in this form, one can express new construction costs on a per gallon or per capita basis. For the latter, one needs, of course, an estimate of daily requirements.

Annual operating, maintenance and administrative cost modules, on the other hand, are obtained from the most recent plant accounting statements of actual incurred expenses and then, for each category of plant size, averaged over all operating plants in that category. This method is only feasible when fairly reliable accounting practices are used in a country.

If expenses are not properly recorded, then estimates need to be made for the various subelements in the module, including the very important category of assumed operating labor requirements.

Although the second of the methods given for both the construction and operating costs is the more difficult and time-consuming one, it avoids the inclusion of past mistakes in the pricing of elements. This is especially true for countries which historically have had poor planning.

Examples of input estimating modules in the water sector are

- Cost per unit volume of buildings
- Cost per mile of underground transmission and distribution pipe
- Purification cost per m.g.d.
- Cost per foot for drilling deep wells by type of local substrata
- Cost of pumping per thousand gallons an hour
- Cost per m.g.d. for primary and secondary treatment levels
- Operation and maintenance cost per m.g.d.
- Operation and maintenance cost per thousand persons served daily

Village Water Supply Costing

A unique consideration often arises in the cost estimation of rural or village water supply projects. This consideration is the willingness of the local people to participate in some type of cost-sharing arrangement with the water development authority. Cost-sharing may take the form of small monetary donations or of voluntary labor where well-digging or earth damming of streams is required. Unfortunately, voluntary labor can play only a minor role in the construction of systems that entail mechanical well-digging, treatment and storage, and pipe-laying (other than trenching operations).

In the costing of such small systems, a project analyst should not place too much emphasis on a cost-offsetting allowance derived from local contributions. This is because a good deal of the total cost of even the most simple well is accounted for by outside technicians who must site the well, line it, and supervise the building of appurtenances and the installation of handpumps, etc. Also, visits by outside technicians are usually required for continued maintenance and periodic testing of the water quality.

Other Costs

There are possible project inputs or costs other than those which arise from construction or operation outlays. These are the economic costs -- tangible and intangible -- which may arise in conjunction with the construction or operation of a project. The damming of a river and the subsequent flooding of land to provide a reservoir for a municipal water supply provides an example. If the inundated land had a value in an alternative use (e.g., agriculture), then this flooding represents a cost to society, and the estimated loss should be included in the calculation of the net national rate of return whether or not the monetary cost is charged to the project.

For municipal water supply and sewerage systems in LDC's, it has been estimated that 60 to 70 percent of the total construction costs are accounted for by foreign-made equipment and foreign technical assistance. Annual operation and maintenance costs include a much smaller proportion (20 to 25 percent) of foreign inputs. These percentages will vary among countries.

Valuation of Output: Water Supply Projects

The valuation of output of water supply projects is rendered difficult by two characteristic conditions:

1. Treated water is frequently distributed on a free basis, or under a schedule of prices designed neither to exact

the full price consumers would be willing to pay nor to recover the full cost of producing the output.

2. Treated water supplies and the sewerage systems associated with piped-in water yield external benefits accruing to a wider group of beneficiaries than those consumers enjoying direct benefits. These indirect benefits accruing to the community at large include reduced incidence of certain types of diseases and improved environmental conditions.

As a result of these preceding characteristics, the market price of water supply and sewerage disposal systems can seldom be used as a measure of the total value of the services.

Where water is supplied for either a metered or flat-rate charge, and consumers have a free choice to utilize the service or not, the value of the direct benefits of the output can be viewed as being at least equal to the revenues received. If the demand for such services is greater than can be met from existing capacity at the prevailing schedule of charges, this is an indication that consumers attach a higher value to the service than the prices charged. It is also a strong indication that expanded capacity is justified on purely economic grounds if the schedule of rates produces revenues adequate to cover the total costs of providing the service, including a return on investment equal to or higher than the marginal opportunity cost of capital. Where this set of conditions is satisfied, the schedule of prices provides some guidance in the valuation of output of water and sewerage systems -- at least insofar as the direct benefits are concerned. As noted above, the total value of benefits will be greater than the value of the direct benefits for which a price can be imposed as a condition for receiving the service.

In the case of large-scale industrial and commercial users, the cost of self-supplying their requirements (by the least costly means) may be a useful measure of the value of the output consumed by these users. At some level of charges, these users would choose to supply their own requirements as an alternative to purchase; if this level can be ascertained, it is probably a better measure of the value of the direct benefits of the output than the water actually charged.

As an alternative approach to the valuation of output of water supply and sewerage projects, rates may be set at levels adequate to cover costs and to yield an internal rate of return equal to or higher than the marginal opportunity cost of capital. Then, by an estimation of the quantities demanded at the predetermined schedule of rates, the predetermined schedule of prices can be tested against consumers' (subjective) valuations, as evidenced by their willingness to pay. In this estimation it is important to note that projected population growth and increases in per capita consumption are taken into account. If this estimation indicates a relatively high rate of utilization of the capacity of the proposed installation, the rate schedules used may be considered to reflect the minimum value users place on the direct benefits provided.

Because the indirect benefits provided by water and sewerage projects are large (and difficult to value) and also because government may decide to subsidize users of water and sewerage services to obtain the maximum of indirect benefits (and also to minimize costs to low-income groups), the valuation of all benefits may not be practical. Therefore, computation of rates of return based on these valuations will not be possible. In these circumstances, economic and financial feasibility tests will be necessary for the determination of the least-cost alternative form of the project capable of meeting the identified need.

Given the least-cost alternative, decision-makers will have to judge whether the direct and indirect benefits are worth the costs. In arriving at this decision, consideration should be focused on:

- Estimated value of reductions in waterborne diseases, mortality and morbidity rates, and loss of working time

- The convenience to users of the services supplied

- Improved fire protection

- The comparative benefits from other projects that must be foregone if the proposed water supply project is undertaken.

- Protection and improvement of the environment.

Some but not all of these can be quantified; fewer can be expressed in meaningful values suitable for rate of return (NWRR and BERR) computations.

Some approaches to quantification and valuation are suggested below.

Health improvement may sometimes be quantified as a direct benefit resulting from an increase in the number of man-days of productive labor (including life expectancy) and also from the reduction of medical costs associated with such water-related diseases as bilharziasis, dysentery, and typhoid. Furthermore, a water supply system may considerably reduce the probability of certain types of epidemics, particularly in cities.

To quantify the health benefits of water supply the following formula can be applied for endemic diseases:

Health benefits = [(total pop. affected)(proportion in labor force)(proportion of labor force employed)(disease incidence)(average working days sick)] X (daily wage)

This formula provides an estimate of the annual value of economic benefits.

In estimating the value of benefits from the reduction of disease, caution is in order, because it is easy to err on the high side. The temptation is strong to assume that large proportions of the population will become diseased and lose working days, whereas in reality the incidence of the disease may be quite low and the unemployment levels high in the particular water supply area under consideration. Therefore, recourse should be made whenever possible to those records of the public health authorities concerned with the types and prevalence of waterborne diseases.

Although it should be possible to make rough estimates of the effect of clean water on the incidence of diseases and the effects on earnings, such economic effects should be regarded as partial and incomplete. The economic effects of health measures (such as water supply and sewerage) are quite complex and require consideration of interactions with mortality, birth rates, productivity and resulting per capita income effects over time. Tracing such interactions is beyond the scope of a CPA.

Greater Convenience in Obtaining Water

There are situations where substantial time is required for families to obtain water. Where this is the case and the project reduces this time, one might wish to quantify it as follows:

Annual hours saved = number of families X time saved per day X 365

It is unlikely that the savings in time has substantial economic value, because water is generally carried by women and children whose opportunities for gainful employment is quite limited.

Fire Protection

If fire protection capacity is built into the water system (such capacity normally requires pipe diameters of 6 inches or more), the additional cost entailed may be offset by a reduction in fire insurance rates over the life of the project. However, rate reduction is also dependent on other factors, including the type of building materials used in the particular area, the distances between hydrants and buildings, the type and size of the fire department, fire prevention precautions taken by building owners, etc. These factors must be considered before an economic justification is attempted for the incremental costs associated with fire protection capacity.

Valuation of Output: Sewerage Projects

Sewerage systems are almost invariably built with the understanding that they are to be financially self-supporting. Because of cost considerations, they are geographically limited to areas of relatively high population density and of the economic capacity to support such activities. Thus, assessments can readily be levied against urban landowners, commercial enterprises and industrial firms which, in turn, have a relatively large capacity-to-pay for such services. In fact, collecting mains can be installed almost on a "pay as you go" basis for a city block-by-block installation schedule with immediately payable assessments.

Finally, metering is not required, and periodic billings can be made on a real-property-by-real-property basis. Alternatively, the charge may be based on metered charges for water. In the case of large industrial or commercial users, charges may be negotiated, taking into account any special costs incurred in the treatment of industrial effluents. Payments for services can easily be enforced by means of disconnection. In short, the valuation of at least the direct benefits presents no great difficulty in determining net national or business enterprise rates of return to the project.

Very little attention has been paid in the past to the nonrevenue or indirect benefits of sewerage projects. Main drainage systems have been constructed in countless urban and suburban areas for reasons of aesthetics, convenience, and perhaps more significantly, public health maintenance. However, another aspect of waste water -- sewage treatment -- has become an increasingly important matter of concern, especially in the last decade, under the generalized term of water pollution control. Here, economic and aesthetic considerations, in addition to purely financial ones, are beginning to play a role in the calculations of the real costs and benefits of sewerage systems, including mains, storm drains and treatment plants.

The nonrevenue benefits of sewerage and treatment systems consist of the elimination or reduction of certain municipal costs and of a variety of other costs borne by the general population in the absence of systems for handling waste or storm waters.

Benefits accruing through the municipal structure include the elimination or reduction of expenses associated with:

- Night soil collectors engaged in conservancy, transport and disposal

. Public health crews to combat such nuisances as rodents and mosquitoes

. Public roads crews to repair roadways damaged by rainstorms.

The benefits to society in a broader sense may consist of the following:

. Economic cost reductions from the elimination of road traffic bottlenecks by the installation of storm drains. These costs can be estimated from techniques developed for highway analyses, but it should be noted that heavy rainstorms are stochastic phenomena, and the probability of occurrence must be included in the analysis.

. Flooding damage that could be eliminated by sewers or storm drains.

. Elimination of private cesspool maintenance in the areas to be served.

. Recreational enhancement opportunities on local waterways that are afforded by sewerage treatment. Here, benefits should be real rather than merely apparent, and the same calculating precautions hold as in the case of water supply systems.

. Aesthetic improvement of the community by the introduction of underground sewers. It is hardly necessary to mention the quantification problem faced here by project analysts. However, anyone accustomed to underground mains who moves to a city with open trenches realizes that substantial aesthetic benefits do indeed exist.

. Human health improvement and the resulting economic gains from higher labor productivity and reduced mortality and morbidity.

This last-mentioned benefit is usually considered the one providing the most justification (other than revenues) for a sewerage system. However, it is difficult to document, and, as discussed previously, can be done only partially and incompletely in a preliminary appraisal.

External Costs

Sewage treatment plants may depress the value of adjacent real estate, at least to the extent that residential use is precluded on zoning or aesthetic grounds. The cost can be quantified by discounting the acreage-value differential between average residential land values and those for the particular type of nonresidential zoning in the area adjacent to the plant. The simplifying assumption can be made that the two types of acreage values will appreciate at the same average annual rate in the future. The discounting period should be the expected life of the project.

Selection of the Most Promising Alternative

In considering the various possible physical arrangements, the analyst will have formulated alternatives that appear promising. By applying the techniques of comparing alternatives and choosing the least-cost alternative as described in chapter VI of the General Guidelines, that analyst will point up one or possibly two alternatives that are most promising. In some cases alternatives may offer both different levels of service and cost that merit consideration by the decision-maker.

Alternatives can take on various forms: technical alternatives, alternatives regarding the postponement of the project, alternatives involving a with-or-without evaluation, and alternatives as to the scale and timing of the project.

With respect to technical alternatives at the level of a CPA, considerations affecting the least-cost alternative include the following

- For a new water project, a comparison of surface versus ground water sources should be made. Ground water sources often involve smaller investments and lower cost of treatment, but may be adequate sources for a limited time period.

- For extensions to existing systems, the same comparison should be made, especially if proposed extensions are far from the main transmission lines.

. For increasing the capacity of an existing system, a comparison should be made of a new source and treatment site versus expansion of the old waterworks.

. For rural programs, a comparison should be made of mechanical versus manual digging of wells in terms of the long-range effectiveness of this type of water source.

. For a new sewerage system, a comparison should be made between service only to the high-volume commercial and industrial areas of the city and service to include high- and low-density residential areas as well (in the first stage).

. For new sewage treatment plants, a comparison should be made of primary versus secondary treatment in the light of antipollution policies (water quality standards).

More detailed technical considerations of alternatives should be left to a feasibility study or a final engineering study.

Scale and Timing of Facilities

Variations in the scale and timing of proposed facilities are two important aspects of alternatives. These two factors are interrelated; in addition, they influence the requirements for financing the project. Inasmuch as water supply systems historically have had steadily increasing demands, they are faced with the need for increasing capacities to meet ever-larger demands.

The choice of the scale and timing of water and sewerage system installations are influenced by the following factors:

1. Costs per unit of supplied water or treated sewage tend to be lower for larger installations. These economies of scale arise from both capital and operating costs, particularly in the case of surface water systems.

2. For the installation of facilities of a given type, size and location, the total construction cost will generally be lower if the entire facility is built at one time rather than in phases over a period of several years.

3. Capital invested in providing capacity that will not be used for several years involves waste equal to the net output that the capital could have produced had it been invested in some other project.

4. The rate of increase in demand for the services to be provided together with the marginal opportunity cost of capital will set the limits to the amount of excess capacity that can be built into a project.

The factors noted in 1 and 2 above are favorable to construction of facilities on a scale to meet more distant prospective demand, i.e., on a scale that will provide excess capacity over a considerable span of years. On the other hand, the opportunity-cost-of-capital consideration imposes a constraint on the scale-time decision, and the rate of growth in demand operates as the decisive factor in the choice of scale and timing.

This choice, involving tradeoffs between 1 and 2 on one hand and 3 on the other, can best be made by computation of the present value of various alternatives differing in scale, phasing, and timing of installation. The methods are explained and illustrated in chapter V of the General Guidelines. In general, the lower the opportunity cost of capital and the faster the rate of growth in demand, the larger the scale and the earlier the timing that will be indicated by these computations.

Water and sewerage costs are very much affected by density of population and the time it takes to reach the ultimate density. This suggests that orderly and full settlement, as compared to sparse and irregular settlement, of new neighborhoods can reduce costs of water and sewerage substantially.

Computation of Rates of Return

One proposed project or more than one alternative may be indicated by the preliminary appraisal. The choice of the specific alternative may depend on the gathering of more information on the level of service that is preferred by the decision-maker. (It may be desirable to leave options open for the decision-maker.)

The business enterprise rate of return and the net national rate of return should be computed for each alternative (which has been reduced to its least-cost form). The BERR will be based insofar as possible on market prices; the NNRR, on shadow prices (see chapters III and VIII of the General Guidelines).

Sensitivity Analysis of Rates of Return

As described in chapter VII of the General Guidelines, the sensitivity of rates of return to various factors should be determined.

Evaluation Summary

In accordance with the General Guidelines (Appendix C) an evaluation summary should be prepared in which the major findings are presented for consideration.

APPENDIX A. PRINCIPAL ENGINEERING ELEMENTS IN WATER SUPPLY AND SEWERAGE SYSTEMS

Principal elements in water supply and sewerage systems are described below, including their more important technical features.

Sources of Water Supply

Lakes and Rivers

Natural lakes and rivers are sources of much of the world's major water supplies. Lakes are usually fed by streams and springs, and the inflow to the lake may vary with the seasons; this results in variations in the elevation of the water surface. In most cases lakes have an outlet through which water flows away from the lake. The amount of the outflow will be governed by the elevation of the lake's water surface unless the outflow is intentionally regulated by man-made control works.

The flow of rivers may vary widely with the seasons or may be regulated by such control works as dams. The flooding of land adjacent to rivers is a factor to be considered in planning a water supply project. Some rivers dry up during parts of the year or may be reduced to a very small flow. These factors should also be considered in planning a water supply project. If stream flow or water level data are not available, an effort should be made to obtain general information from residents along the river or from observations of high water marks from previous floods.

The chemical and sanitary quality of water in lakes and rivers is important. Many lakes and streams are subject to pollution from runoff, sanitary sewage, or industrial waste. The type and degree of pollution will govern the degree of treatment necessary to render the water suitable for its intended use: domestic, industrial, irrigational or recreational. The quality of the water may also vary with the seasons and may be adversely or beneficially affected by storms. Records of water quality should be obtained at an early stage in the planning of a water supply project. If such records are not available, samples of the water should be obtained and sent to a qualified laboratory for analysis. A complete cycle of sanitary analyses will require a full year or perhaps several years of testing, but the preliminary appraisal of a project need not be delayed while this information is being obtained. Sampling and testing should proceed during the planning and financing stages of a project unless good records are already available.

Impounded Streams

To maintain constant flow, natural streams require regulation by the construction of dams that will store water during periods of high stream flow and release it during periods of low natural flow. The lake or reservoir formed by the construction of a dam may be utilized as the source of supply for a water supply project; in fact, this is usually the reason for construction of the dam. The elevation of the water surface behind the dam may vary widely, and the intake works for the water project must be designed to function at the limits of contemplated water elevation. The amount of water that may be withdrawn from an impounded supply is governed by the net safe yield of the drainage area above the dam.

The quality of the water in the reservoir will be affected by the degree of pollution in the inflow, subject to the beneficial effect of storage. When water is stored for periods of time (days, weeks, or months), natural sedimentation will remove some suspended matter and will improve the sanitary quality. The degree of treatment should be governed by the worst condition anticipated in the quality of the stored water at the point of intake to the water supply project. Obviously an accurate determination of this factor cannot be obtained until the dam has been constructed and the reservoir has been in operation for at least 1 full year. The design of the treatment works should not be delayed until this factor is determined, but fair estimates of water quality can be obtained from similar experience at other locations augmented by the application of mathematical formulas.

Underground Water Sources

A major source of water supply is underground water. This water is the most economical source in most cases, because the water is at or near the point of use and no collecting works or long transmission lines are necessary. In many cases the quantity of underground water that may be obtained is limited, and this source must be supplemented by water from other sources. If water withdrawn from underground exceeds its replenishment, the water table will fall and wells will need to be deepened.

As the water table declines, the amount of water obtainable lessens, because most underground basins are bowl-shaped and less water is retained in the deeper strata. If fresh-water basins along the seacoasts are overdrawn to the point that the water level falls below sea level, there is danger of salt water intrusion. This can permanently ruin an underground source of supply.

Water from underground sources is usually safe for human consumption because the water is protected against bacteriological contamination, but it may contain a high concentration of minerals such as calcium or iron. Hard water may be softened and the iron may be removed from solution, but the treatment process is relatively expensive. Chlorine is usually applied to underground supplies as a precaution against disease-bearing organisms. The treatment of the supply must be tailored to the chemical and bacteriological quality of the water.

Reclaimed Water

Waste water from communities or industry may be treated to produce water that is satisfactory for most uses, including human consumption. Sewage may be given full secondary treatment, and then may be filtered and disinfected to produce safe water supplies. Much of the water withdrawn from natural streams is contaminated with waste products, but it is treated by modern water purification plants to constitute a satisfactory, safe source of water supply. In areas of the world where water is scarce, the use of reclaimed water is gaining in favor and in some communities constitutes the major source of supply. However, treatment must be thorough and complete, and this may make reclaimed water more expensive than alternatives.

Desalination

The removal of minerals, especially chloride, from water may be accomplished by any of several methods, among which are distillation, reverse osmosis, chemical precipitation, and electrodialysis. All of these methods are expensive and, except in rare instances, water which needs such treatment should not be considered as the source of a community water supply. No further mention of this source will be made herein.

Treatment Techniques

Sedimentation

Water carrying a great deal of suspended sediment will deposit most of that sediment when the water's velocity of movement is reduced. Colloidal particles carried in suspension will settle out very slowly without the help of coagulating chemicals. Whether or not chemical coagulants are used, sedimentation is the first step in water treatment. With the use of chemical coagulants and proper mixing, a detention period of 2 hours or more should be provided to clarify the water. Care must be exercised to avoid disturbance of the water during the sedimentation period. Provision should be made to mechanically remove the settled matter from the bottom of the sedimentation basin. Settled water should be removed from the basins by being skimmed from the top and then passed into the filters without any disturbance that would break up the floc formed in the basin. The release of small air bubbles below the water's surface around the perimeter of the basin will assist in preventing ice formation in cold climates.

Filtration

The filters are the heart of the water treatment process. They remove the finely divided suspended particles and much of the bacteria from the water. Filters consist of beds of fine sand supported on gravel through which the water is passed. Filtration rates of 2 to 5 gallons per square foot per minute are customary. Back washing of the sand in place cleans the filters; filters must be washed when the head loss through the filter approaches the depth of the filter basin.

Disinfection

Disinfection is usually accomplished by adding chlorine, a powerful oxidizing agent that is very destructive to bacteria, to the water. Chlorine contact of 30 minutes or more is desirable with an effective chlorine residual. Measurement of chlorine residual is easy and accurate with simple equipment. Although there are other disinfecting agents besides chlorine, they are expensive and less effective.

Softening

Hard water may be softened by any of several processes. The usual methods are the lime-soda chemical process or the zeolite ionic-exchange method. Softening the entire water supply for a community is expensive and has certain disadvantages. Careful consideration should be given to a proposal for softening a water supply.

Transmission Methods

Pipes

The transmission of water from its source to its point of use is an important factor to be considered in appraising a water supply project. Pipelines are usually employed for transmission of water. Several materials are used for pipelines, including concrete, steel, cast iron and asbestos cement. Large-diameter pipelines are usually constructed of concrete or steel. Cast iron pipes are expensive and are not made in many countries, especially in large sizes. Asbestos cement pipes have certain limitations in diameters over 24 inches. Major feeder lines in distribution systems are frequently considered transmission lines and should not be used for direct consumer service.

Canals

In some instances open canals are utilized to transmit water over long distances. Open canals should be lined with impervious materials, usually concrete. Canals are less expensive than pipelines and are suitable where the terrain is relatively level or slightly sloped in the direction of the desired flow. Canals should be fenced on both sides to prevent the entrance of unauthorized persons or animals. The growth of algae or moss frequently occurs in open canals and reduces the capacity of the canal. Growths can be controlled by chemical means.

Natural streams which cross the route of the canal should be diverted over or under the canal to prevent the entrance of undesirable water.

Natural Streams

In some cases a natural stream may be used to transmit water. The stream should be relatively free from contamination and should be of sufficient capacity to handle the total flow without flooding.

Conduits

The term "conduit" is usually applied to a composite of all the elements in a transmission system. It may be a combination of tunnel, canal, pipeline and natural stream. In some cases pumping is necessary at one or more points along a conduit. The hydraulics of a conduit should be carefully calculated to ensure that the proposed conduit will transmit the desired quantity of water and will deliver it at the proper elevation. Treatment is usually applied after the water has been passed through the conduit.

Distribution

Trunk Mains

A distribution system is a series of pipelines that distribute water throughout the service area. Trunk mains are large-diameter principal feeders that supply water to the grid system of street mains at several points in the service area. Direct consumer service from trunk mains should be avoided as much as possible. Trunk mains should be valved at frequent intervals to avoid the necessity of shutting down large sections of the distribution system when repairs are needed.

Street Mains

The water mains located in the streets constitute the grid system that supplies customer service. Street mains should be installed in every street in which consumers' premises are located. The mains should be valved at frequent intervals to minimize the number of consumers deprived of water when shutdowns are necessary. Street mains should be interconnected frequently and dead ends should be avoided. The design of a distribution system, including the trunk mains, should be checked by the Hardy Cross method before the design is finalized.

Pressure Zones

When the terrain of a community includes areas of extensive difference in elevation, it may be necessary to separate the distribution system into zones designed to supply water at the proper pressure for each zone. (If the entire distribution system is operated at sufficient pressure to supply the higher elevations, the pressure at the lower elevations may be excessive. Damage to plumbing fixtures and abnormal leakage may result.) A saving in pumping costs may also be effected. Although entirely separate piping systems are desirable, separation may be effected by closing valves along the zone lines. A closed valve on a continuous pipeline creates two dead ends; there is also the danger that a valve may be opened by mistake, which would subject the lower zone to excessive pressure. The use of pressure-reducing valves should be kept to a minimum because such valves are delicate and frequently get out of order. In some cases, however, their use cannot be avoided without high expense.

Fire Protection

One of the purposes of a community water system is to provide water in sufficient quantities for fire fighting. The addition of fire hydrants will add little to the overall cost of a water system, and the additional cost will more than be compensated for by lower insurance rates. Fire hydrants should be placed along pipelines that are 6 inches or more in diameter. Pipelines that are 4 inches or less in diameter provide little protection for fire-fighting purposes. Fire hydrants should be of an approved design and should be standardized for an entire community.

Pumping Requirements

Transmission

Pumping is frequently necessary at the source of supply or along the transmission line. All pumping stations should be equipped to serve the maximum demand when the largest unit is out of service. Pumps may be centrifugal or reciprocating, vertical or horizontal shaft, and powered by electric motors or internal-combustion engines. The type of pump and driver must be selected to meet the specific conditions encountered. Centrifugal, horizontal shaft, electric-motor-driven pumps are commonly used and are relatively trouble free. They may be manually operated, remotely controlled, or automatic. Very high-speed pumps should be avoided. pumps that operate at more than 1,750 r.p.m. wear out quickly and are subject to high maintenance costs. Although high-speed pumps are usually cheaper to purchase, this saving is more than offset by maintenance and replacement costs. Salesmen will frequently try to sell high-speed pumps solely on the basis of first purchase cost.

Pumping stations at the intake from a lake or stream should be located at as low an elevation as possible to reduce the suction lift. The station must be protected against flooding by walls or embankments. Access for repair and maintenance must be provided, and stations containing large units should be equipped with an overhead crane. Pumping stations along a transmission line may get their suction directly from the pipeline, by pumping around a closed valve; or they may get suction from a receiving reservoir or tank. Pump discharge piping should be equipped with a check valve and a control or shut-off valve. Available suction pressure should be utilized if possible.

Distribution Pumping

If water systems are separated into pressure zones, repumping to reach the higher elevations is frequently necessary. In some instances, pumping in the distribution system is necessary to maintain pressure within a zone. Pumping stations should be insulated to protect the neighbors from noise. If more than one pumping station supplies a zone or a single area, there must be coordination between stations by adequate communication.

Ground-Water Pumping

Wells are pumped by multistage deep-well turbine pumps, which are usually driven from the surface of the ground by a drive shaft that extends the depth of the well to the pump.

Drive may be provided by directly connected electric motor or by internal-combustion engine through an angle drive unit Many wells are pumped directly into the distribution system, allowing no time for contact with chlorine if the well water is to be disinfected. This may result in a chlorinous taste close to the well and inadequate disinfection. The use of a receiving tank requires repumping unless the tank is high enough to supply distribution pressure. All the factors should be studied in connection with the design.

Storage Facilities

Reservoirs

Impounding reservoirs behind dams are major sources of supply for many water systems. These reservoirs are usually of large capacity and are intended to assure a supply of water during dry seasons. Areas to be flooded with water should be cleared of all growth before water is impounded. The outlet works by which water is withdrawn from the reservoir should be designed with outlets at various levels so that water can be drawn at depths suitable to the condition of the water. Algae growths occur at times on exposed water surfaces, and provision must be made to treat these growths with chemicals as needed.

Distribution reservoirs are located in the distribution area at suitable elevations so stored water can be fed into the distribution system to maintain pressure. Such reservoirs are usually earth embankments or concrete constructions and may be covered or open. The use of reservoirs will enable the system to meet fluctuating water demands without increasing the supply from the source. They will also provide water supply during temporary periods of outage at the source.

Tanks

Storage tanks for water systems are usually made of steel or reinforced concrete, and may be located at ground level or be elevated. Their purpose is to provide water storage in the distribution system to meet peak demands and to equalize pumping rates. They may also provide contact time for chlorine. Tanks are usually covered to avoid the algae problem and to protect the water from airborne contamination. They are usually of much smaller capacity than reservoirs. In some cases, if system demands are high, several tanks may be located at the same place. Several small- or medium-sized tanks are more economical to build than one very large tank.

Basins

Basins are in effect shallow reservoirs. They are seldom used because of their limited capacity, and because the shallow water promotes the growth of bottom organisms. Although under certain conditions they may be useful, they are inferior to reservoirs or tanks.

Service Connections

Service Pipes

Connections between the street main and consumers' premises are made with small-diameter pipes. Service pipes should be copper, plastic, or other corrosion-resistant material. The connection to the main is made with a corporation cock that includes a shut-off valve. In some systems the property owner installs the entire service line; in other systems the utility installs the service pipe from the main to the curb line or the edge of the street, and the owner installs the remainder. The corporation cock in the street main should be installed by the utility, because skill and special equipment are required to make this connection when the street main is under pressure.

Water Meters

The metering of service connections is highly desirable. Without meters consumers will waste water; they will stop waste when they have to pay for all the water that goes through the meter. Studies have shown that unmetered cities use twice as much water per capita as do metered cities. It costs money to procure, treat, and distribute water, and consumers should pay for the water they use.

Positive displacement meters are superior to turbine-type meters. Small flows are accurately measured with positive displacement meters, but much of the water passing through a turbine meter at low flow rates goes unmeasured. People will soon learn that the loss of revenue to a utility by this practice can be very important. Compound meters should be used for large services (over 3 inches).

Typical Sewerage System Elements

Service Connections

House Connections

Service connections for sewerage are usually provided by the property owner from the building to the street. The connection into the street sewer should be made by the utility. The connecting pipe should be not less than 4 inches in diameter and should be of noncorrosive material. Vitrified tile or cast iron are the usual materials. The connecting pipe must slope downward toward the street sewer at all points. An opening for cleaning must be provided, usually on the consumer's property.

Industrial Monitoring and Special Connections

Large sewer connections for industrial plants or institutions must be designed for the particular need. In some cases metering of the sewage from industrial plants is required, which calls for special meters. In some cases monitoring of industrial processes is used instead of metering the sewage flow. The water entering the plant is metered and a percentage determined of the part of the water flow that enters the sewer system. In some cases, such as in a bottling plant, part of the water goes out in the product.

Street Sewers

All sewers, except pump discharge lines, must be laid on a grade or slope. The slope is determined by a formula based on the size of the sewer. The flow velocity of the sewage should be at least 2 feet per second to prevent deposition of solids in the sewers. Access manholes for cleaning and maintenance must be provided at frequent intervals and should always be placed at a change of grade or alignment. Sewers should be of corrosion-resistant material or provided with a corrosion-resistant lining. Bare cement products do not make satisfactory sewers because hydrogen sulfide gas will attack the cement. The size of the sewer must be determined by the anticipated flow requirements. Street sewers should be placed in all streets where occupied premises are located.

Collectors and Interceptors

Street sewers feed into collecting sewers of relatively large diameter, and collectors feed into still larger sewers frequently called interceptors. Sufficient grades must be maintained so that flow rates will be at least 2 feet per second. Collectors should be built of corrosion-resistant material or of concrete with corrosion-resistant lining. Collectors or interceptors are used to convey the sewage to the treatment plant or the outfall. Design must be based on the anticipated flow rates.

Pumping Requirements

Because sewers must be laid on a slope or grade, they soon reach uneconomical depths below ground surface in areas of flat terrain. For example, a 12-inch sewer should slope about 2 feet per thousand feet of length. At 10,000 feet of length the sewer will be 25 feet deep, which means that the sewage must be pumped approximately every 2 miles to maintain reasonable construction depth. A sewage pump is usually of the open impeller type because of the solids contained in the sewage. Bar screening of the sewage ahead of the pump is sometimes necessary to remove large objects which would clog the pump. Sewage in collectors and interceptors must sometimes be pumped, and sewage must frequently be pumped into the treatment plant. Collecting chambers are sometimes installed ahead of the pumps, especially when screening is necessary.

Treatment Techniques

Primary Treatment

Primary treatment consists of screening and sedimentation, with or without aeration and with or without chemical additives.

Sedimentation takes place in large tanks or lagoons and produces a fairly clear effluent plus raw sludge. In plain sedimentation, surface loadings of 900 to 1,200 gallons per day per square foot of surface with tank depths of 8 to 10 feet are common. Sludge may be removed mechanically, or the tanks may be periodically drained and cleaned.

Secondary Treatment

Secondary treatment of sewage follows the primary treatment described above. This type of treatment involves biological action and produces a much better quality of effluent and sludge. The activated sludge process is the most common form of secondary treatment. It consists of extensive aeration of the sewage in the presence of activated return sludge, trickling filtration and sludge digestion. The technicalities of the activated sludge process will not be covered herein.

Tertiary Treatment

Tertiary treatment of sewage is used only when a high-grade effluent is required for special purposes or when treated sewage is to be reused for domestic consumption. The process involves extensive chemical treatment, removal of phosphate and nitrogen, and usually carbon filtration. It is not likely that tertiary treatment will be used on projects in developing countries.

Disposal Requirements

Treated Effluent

The quality of the final effluent from a sewage treatment plant is usually governed by the requirements of an official agency. The BOD (biological oxygen demand) content and the concentration of certain chemicals are the measuring factors. In the absence of governing regulations, the quality of the effluent should be such as not to adversely affect the ecology of the area. If the effluent is to be used for agricultural, industrial, or domestic purposes, the higher the degree of treatment, the higher the cost will be. All the factors must be studied in determining the type of treatment to be used, keeping in mind the economics of the situation.

Sludge Disposal

Any degree of sewage treatment produces sludge that requires disposal. The sludge may be in liquid or solid form and may or may not be obnoxious, depending on the degree of treatment. The disposal of sludge is frequently a complex problem. Sludge makes good fertilizer, but chemical fertilizers are usually less costly to obtain and apply. Sludge must be disposed of in the most economical method possible without damaging the ecology of the area. Some common methods of disposal are incineration, burying, hauling to a place remote from habitation, composting with selected solid wastes, using for fertilizer, or disposing at sea.

Storm Drains

Combined Systems

Many of the older cities of the world utilize combined systems for storm drainage and sanitary sewers. This type of system is less costly than separate systems. In recent years drainage systems have been separated in some cities, but most such cities still have a combination of both systems. If economically possible, separate systems should be favored for future construction. When a combined system overflows, sewage may stand in the streets and contribute to health hazards. During and following storms, treatment plants must frequently be bypassed which results in the discharge of untreated sewage into streams, lakes, or the ocean.

Separate Systems

Separate storm drainage systems are designed to take run off and convey it to the point of discharge keeping it separate from sanitary sewerage. This system eliminates the hazards mentioned above. Surface channels are frequently utilized for storm drainage, a less costly means than buried pipe lines. Storm and runoff records are utilized in designing a storm drainage system. It is seldom economical to design storm drainage systems to handle maximum floods but the system should have sufficient capacity to take care of normal storms.

Site Selection of New Facilities

The selection of a new sewage treatment facility should take into consideration the following factors:

1. Sufficient area for facility and future expansion.
2. Adequate discharge facilities for effluent and/or storage of fluids and solids for reuse (irrigation and fertilizer).
3. Where possible, favorable elevation to allow gravity feed or to minimize pumping.
4. Favorable subsurface conditions to preclude contamination of potable water aquifers.
5. Where possible, favorable location in relation to prevailing winds.
6. Out of the path of future civic expansion.
7. Reasonable distance from community and industry.

Each community has its own individual problems and seldom, if ever, can all of these prerequisites be met.

Adverse Environmental Effects

Failure to meet several of these factors can produce adverse ecological effects, particularly when the system being installed is not up to "big city" standards. Such systems, with inadequate digestion capacity, will create air pollution problems in the vicinity of the plant and the "downwind" community.

Further, water pollution problems will result from the inadequately treated effluent, which may effect the local ground water supply, rivers and beaches.

To a lesser degree, the adverse effect on surrounding property values is another factor to be considered, particularly in the more developed communities.

Solution

To forestall such adverse conditions, there are but few solutions:

1. Locate facility sufficiently distant to minimize or eliminate the problem.

2. "Upgrade" the system to improve the quality of the effluent and design the surroundings to disguise the facility. (Surrounding park areas, tree rows, fences, etc.)

Each of the above will, of course, increase the cost of the overall facility.

Where budgeting considerations do not permit the additional expenditures, few, if any, actions can be taken, such as:

Enacting zoning restrictions to restrict residential encroachment in the vicinity of the facility.

In any case the adverse environmental effects of the facility will have to be weighted against the increased cost of moving or upgrading the facility. A thorough understanding of the problem which will evolve will help in the decision on which action to take.

Existing Facilities

In cases where expansion of an existing facility is contemplated, it will be necessary to weigh the cost of adequate treatment against the cost of moving the plant site to a more remote area.

Another important factor to consider is the problem of flies, mosquitoes, and other insects which may adversely effect the health of the local residents. The added expense of medical precautions to prevent plagues, malaria, etc., should be considered.

In smaller villages and towns a series of septic tanks may be the solution, providing the potable water aquifer is not affected.

APPENDIX B. CHECKLIST FOR STUDYING EXISTING WATER SUPPLY AND SEWERAGE SYSTEMS

A thorough study of existing systems entails the following:

I. Water

A. Area served
B. Population served
C. Per capita consumption of water, industrial usage
D. Leakage or unaccounted-for water
E. Adequacy and dependability of facilities
F. Distribution pressure and continuity
G. Source of supply, adequacy, dependability, quality
H. Treatment, water quality
I. Pumping, storage
J. Operating procedure and supervision
K. Maintenance schedule and adequacy
L. Meter reading, billing, collecting
M. Management and administration
N. Financial status, indebtedness

II. Sewerage

A. Area served
B. Population served
C. Per capita production of sewage and industrial wastes
D. Infiltration
E. Adequacy and dependability of facilities, overloading
F. Collection system, street sewers
G. Interceptors and trunk sewers
H. Pumping
I. Operating procedures and supervision
J. Sewer cleaning and maintenance schedule, adequacy
K. Method of payment for sewer service
L. Degree of treatment, disposal of treated effluent and sludge
M. Effect of disposal on surrounding area
N. Management and administration
O. Financial status, indebtedness

III. Health and Ecology

A. Endemic diseases, waterborne, vector-borne, contagious
B. Typhoid, cholera, dysentery index

C. Birth rate
D. Death rate, infant mortality
E. Medical facilities, hospitals
F. Climatological factors
G. History of disease in area, endemic graph, epidemics

IV. Storm Drainage

A. Rainfall and runoff records
B. Topography and usage of drainage area
C. Records of previous floods including flooded areas
D. Combined sewer and storm drain systems
E. Separate sewer and storm drain systems

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APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II - MANUFACTURING

Agency for International Development

September 1971

CONTENTS

FOREWORD

The project analyst using these guidelines should first read Part I, General Guidelines. It discusses key considerations for capital project appraisals (CPA's) in all sectors, with a detailed discussion of the methodology for calculating the internal rates of return, the cost-benefit ratios, and other relevant measures of the worth of a project.

These guidelines deal expressly with those matters relevant to manufacturing. They tell the analyst how to think about a manufacturing project; what to look for; and how to assure consideration of all elements essential to a project. They suggest institutional, cultural, political, and other factors which can weigh heavily on the outcome of a project. They encourage concentration on big issues in broad orders of magnitude, leaving details and matters of lesser importance to be explored in a subsequent study.

The CPA is most efficiently undertaken by multi-disciplinary teams, e.g., social scientists (economists, financial analysts, political scientists, etc.) and technical specialists (engineers, agriculturists, etc.). The structure of the individual multi-disciplinary team can only be detailed within a specific analytical and project context. The term project analyst or analyst, used herein, refers to a member of a team engaged in a CPA.

I. INTRODUCTION

Few developing countries can achieve rising standards of living without some expansion in manufacturing. Certain manufacturing industries are vital to low-cost inputs for agriculture; other manufacturing industries are needed to meet basic consumption requirements that would be excessively costly if filled by imports. Moreover, those countries which have achieved the most rapid rates of growth in the 1960's have looked to the export of manufactured goods to provide the impetus for development.

Easily accessible, price-competitive natural resources and infrastructure facilities aid industrial growth. So do populations of a size large enough to provide markets for efficiently sized factories. However, these are only aids to projects in manufacturing. Such projects have their own exacting technical and commercial requirements. Their success hinges very heavily on national economic policies, and their fortunes are tied to developments in other sectors of the economy and in world markets.

The task of these guidelines is to determine the requirements for a successful project. The analyst must judge whether they can be met.

Why Manufacturing Is More Exacting

Manufacturing is perhaps the most demanding field of activity for developing countries. The success of projects in the manufacturing sector will depend on several critical factors, of which the following merit special comment.

. World competition. The manufacturing sector is subject to worldwide competition. In this competition, appeal to consumer taste, changing technology, comparative advantage, credit and the ability to maintain standards of quality play important roles. The manufactured goods of developing countries are in competition with the products of experienced, talented, and well-endowed producers of the world, unless these goods are shielded in the domestic market. The shielding process, however, is costly to the economy.

. Entrepreneurship. Along with the ability to meet competition, manufacturing projects require a high order of entrepreneurial ability, particularly in the early stages of the enterprise. The starting of new manufacturing enterprises requires persons who will be bold and innovative and who will take responsibility for results. While every society has such individuals, special inducements may be necessary to get them engaged in manufacturing enterprises.

Management and the use of labor. Experience in managing manufacturing activities is limited in most LDC's, and yet success depends greatly on the quality of management. Also, the labor force is unlikely to be familiar with manufacturing activities; in some countries it tends to resist the discipline required by industrial employment. Typically, productivity is considerably lower in developing countries than in industrially more mature countries. Although wages are also lower, labor costs per unit of product are not necessarily lower.

. Demand and returns to scale. The demand for most manufactured goods is sensitive to that part of income which is above subsistence requirements. In proportion to population, therefore, the demand for manufactured products is low in developing countries because such a high percentage of income is absorbed by expenditures for unprocessed -- or lightly processed -- foods and other subsistence goods. At the same time, costs of manufactured products tend to be high because of the small volume of production. Particularly for the smaller countries, the domestic market is often too small to adequately support manufacturing activities at levels of efficiency comparable to those in countries with larger markets. Thus, the country may be faced with the choices of (1) abstaining from the development of manufacturing, (2) starting uneconomical production for a limited domestic market, or (3) establishing manufacturing activities geared to foreign markets.

. Preference for imported goods. Prejudice against locally manufactured goods is a common obstacle faced by domestic manufacturers in many LDC's. In part this reflects snobbishness on the part of consumers, because possession of scarce imported items is a status symbol. Sometimes, however, the prejudice is well founded in experience.

To overcome its initial disadvantages in manufacturing, a developing country has to devise a suitable strategy for the sector. This will be discussed in a later section.

Some Characteristics of Manufacturing

While manufacturing has distinctive characteristics as compared to other sectors, within itself it is an extremely diverse activity. Each plant has its distinct technology. Projects can vary considerably with respect to the following characteristics:

- Availability of technology - some technology is readily available, others are closely held.
- Training requirement - manufacturing requires complex skills, and also a wide diversity of skills. The latter characteristic complicates the training function.
- Returns to scale - the gains from size vary considerably among potential projects.
- Risk - changes in consumer tastes and changes in technology make some lines of manufacturing more risky than others.
- Sensitivity to management - this is closely related to consumer tastes and changes in technology, and also to the complexity of the production processes.
- Sensitivity to international competition - some lines of manufacturing are very sensitive to competition from abroad (high rates of value to bulk, sensitivity to quality).
- Importance of fixed costs - some lines of endeavor have very high fixed costs, making them vulnerable to underutilization of capacity.
- Dependence on other activities - industries vary in their dependence on other manufacturing, other sectors, and policies of government.
- Employment per unit of investment - industries differ with respect to employment generated per unit of investment.
- External economies - some industries generate and benefit from complementary activities.
- External diseconomies - such as pollution, noise.

. Market orientation - industries differ in their requirement for close proximity to the market, or at least for a close liaison with the market.

. Raw material orientation - some industries require close proximity to the raw material.

Importance of an Industrial Strategy

Manufacturing is extremely sensitive to the form, size and circumstances under which incentives are made available to it. The incentives themselves will be very much influenced by whether an inward-looking or outward-looking strategy is adopted for manufacturing.

The inward strategy for industry undertakes to make the domestic market for manufactured goods attractive to indigenous industry by the use of credit, subsidies, customs exemptions for raw material, and protection of the domestic market from foreign competition. An inward strategy tends to create many industries covering a large variety of needs -- largely substitutes for imports.

The outward strategy for industry undertakes to make export of industrial products attractive to indigenous and foreign-owned industry by selective use of credit, subsidies, rebates, technical assistance and other means. An outward strategy tends to create fewer number of industries, but those created are more likely to be competitive.

It is possible for a country to use both strategies simultaneously, but to do so requires special care. The danger that has to be avoided is that the output of a protected industry will be overpriced and will saddle other domestic industries with high cost inputs. Thus, industries geared to the world market find themselves with costs so high that exports are unprofitable. The project analyst must take existing strategies as given but should point out their consequences.

Certain strategies come about for ad hoc and programmatic reasons. A country may choose certain industries to develop because of the desirability of giving employment to a large number of persons, of building up a prosperous industry on the basis of a natural advantage, of saving foreign exchange, or because it is determined to create a given type of industry that will over time have a comparative advantage. Such decisions can take a variety of forms. A country with petroleum or natural gas could decide to create a petrochemical complex. Or a country may decide to provide services and incentives that will attract light industry requiring relatively large amounts of employment.

A strategy may designate certain types of industries as promising for providing employment or achieving national defense or regional development goals; still, the project analyst seeks to ascertain whether a project has a favorable net national rate of return. Industrial projects that do not achieve high national rates of return contribute little to economic growth and can represent serious obstacles to future growth, even if they are consistent with declared strategies. The CPA performs a critical function in making explicit the real cost, in terms of foregone opportunities.

Each country must decide which industries, if any, will be owned or operated by the government or by government entities, and which will be privately operated or owned. Government enterprises may enjoy certain competitive advantages over private firms. Hence, private investments will be inhibited unless clear ground rules establish a fair basis of competition between the two enterprises. A CPA should treat this subject explicitly.

II. PERSPECTIVE FOR THE PROJECT: ITS RELATION TO MACROECONOMIC, POLITICAL, AND CULTURAL FACTORS AND TO SECTOR SURVEYS

Macroeconomic Factors

The General Guidelines emphasize -- and indeed cannot overemphasize -- the influence that macroeconomic objectives, plans, and strategies have on a project's feasibility. The analyst's task is to judge which matters are of paramount importance and to see them reflected in the calculations made later concerning the project's worth. Of like importance, they will reinforce his qualitative judgments about the project. The following illustrative list delineates a few of the many macroeconomic variables that affect a manufacturing project.

- The growth of the economy in terms of total and per capita income, population, and exports

- The development strategy of the country, with particular regard to policies on incentives for import substitution and export of manufactured goods

- The amount of capital available for investment in industry

- The status of and investments to be made in health, transport, education, power, forestry, fisheries, and agriculture that may affect a project in manufacturing by affecting the demand for its outputs, competition for its inputs, the infrastructure available to it and its efficiency in general

- The foreign exchange and exchange rate policies that will affect import costs and the development of export markets

- Tax and price policies that will affect sales and profits and that will favor or discriminate against products of the manufacturing sector

- Credit policies, costs, and availabilities that will affect the funds available for investments in manufacturing

- Tariff policies that will affect competition from imports and the costs of imported inputs

- Emphasis in the national plan on regional development -- both within the country and with neighbors -- and decisions to enter into complementary agreements in which designated facilities are developed along lines that will maximize inter-industry linkages.

The project analyst must identify these, as well as many other, macroeconomic factors and give them their due weight in the CPA.

The Importance of the Sector Study

An industrial sector study may provide valuable background for the project appraisal. It will provide such data and insights as:

- Measures of aggregate income and other variables closely related to the demand for manufactured goods, i.e., price and income elasticities of demand for the output of manufactured goods

- A survey of capital markets and credit institutions and the availability and terms of funds to finance projects in the manufacturing sector

- An inventory of manufacturing facilities, potential sites, potentially useful domestic raw materials, and markets that are or can be made accessible

- Availability of skills, levels of education, work habits, absenteeism, and other factors relating to the efficiency of the work force

- Information on costs of production within the country, within the sector, and possibly for like projects; and comparisons with costs of imports

- Incentives available for both import substitution and export projects, and the circumstances under which projects qualify

- Difficulties and assistance that can be expected from governmental and other agencies and institutions that must be dealt with

- Taxation and credit policies affecting industrial enterprises

. Policies on conditions under which foreign investors can operate in industry

. Experience in the country for like or related projects, which will offer a valuable perspective for the project under consideration.

Useful sources of background macroeconomic and sectoral economic data have been cited in the General Guidelines. For the needs of manufacturing, use should be made of industrial censuses or of sample studies made in conjunction with these censuses. If vital information is lacking, the analyst may make direct inquiries, especially among suppliers and customers. Such inquiries can be quite informative because there typically are few significant manufacturing firms, importers, and exporters in an industry in the smaller developing countries. However, in keeping with the objectives of a PPA, the collection of primary data should be restricted to that which is absolutely essential to the appraisal.

Perspective for the Project Appraisal

The analyst may not be an expert in the industry concerned. To remedy his lack of insight and information, he must turn to readily available and obvious sources such as:

. Input-output tables establishing interindustry relationships in the country concerned or elsewhere

. Identical or similar projects undertaken in the same country or in other countries

. Different projects which draw upon the same kinds of materials, labor, and other factors, thus revealing information on quality and costs of inputs

. Business censuses, trade reports, technical manuals, and import data, which may provide pertinent information

. Information from engineering, management, and business journals and catalogues that sheds light on businesses and projects of various kinds

. Population censuses from which information may be gathered on the size and composition of the labor force by age, sex, skills, occupations, formal education and location

- Intelligence gathered from banks, businessmen, trade associations, importers, and exporters involved in the industry concerned or generally familiar with industrial conditions in the country

- Other sources, including government, that can provide information on actual or potential markets.

The Problem of Delineation

The factors to be considered in the CPA are only those elements essential to a project, including its direct linkages to other sectors. It is essential, therefore, to establish the limits of a project -- to distinguish between the internal and external elements of a project to assure that the computation of costs and outputs is all embracing.

- Those infrastructure services used exclusively by the project are clearly internal and chargeable to it: a power source, an access road, a water supply facility.

- If the infrastructure is to be otherwise provided (e.g., state-constructed road or publicly financed electric utility), the CPA need not include as inputs the capital costs thereof if the project is being appraised from the enterprise point of view. The cost of the purchased service (e.g., power) would be included as an input in the project.

- When the net national rate of return (NNRR) is calculated, the project must be charged with the entire cost of the infrastructure, even if it is paid for by others, <u>if</u> the project itself is the cause for its construction. If the project is one for several users, then the cost must be allocated. The analyst can then note that the NNRR would be higher if the project were credited with side-benefits that the specially created facility would bring to, say, industries served by a newly created port or a specially built road.

- The BERR should not be charged with the cost of training workers, of subsidized (low-cost) capital, or of other benefits conferred on it by the state. The NNRR must be charged with these costs.

. A manufacturing project may be a link in a chain of activities that is in the nature of a complex (e.g., a metalworking complex). It should not be presumed that each link must be included within the project. There may be a more economical option to import.

. In defining the extent of capital requirements for a project, the inseparability of certain aspects of it must be considered. Thus, in the case of a metalworking complex where a foundry supplies castings to two other projects, it may be necessary to treat the two projects plus the foundry as a single project, if the justification for the foundry depends on the success of the two other projects. Where separability is possible, the so-called test of differences provides a guide as to the arrangement -- combination or separation -- that is best. (See General Guidelines, chapter V.)

The project analyst must ultimately decide the limits of the project. There are no inelastic rules governing the right coverage. How far does the project's influence extend and, therefore, what costs and benefits must be considered? The analyst must make clear how far he has gone. However, the analyst can be fairly certain that the coverage for the NNRR is wider than for the BERR.

Sociocultural Environment

Attitudes, habits, and behavior patterns in the community must be considered. Questions must be answered as to the social structure, outlook of the population regarding industrialization, working habits, and cultural taboos.

Development of a sociocultural environment profile will permit judgments on the managerial and labor requirements and will suggest suitable recruitment, training and personnel programs. It will serve as a guide in predicting the success of the proposed project in the particular locality and will identify needs for an educational program to gain project acceptance.

International Considerations

The CPA must discuss the hazards or benefits to a project that will arise from its international orientation.

Some manufacturing projects will be extremely sensitive to international considerations. The prices and availability of some commodities will be affected by supply conditions (e.g., for copper and nickel -- items frequently in short supply). Exports will be affected by tariffs and quotas, which can have serious effects on marketing possibilities. Sanitary regulations and other constraints must be kept in mind. Regional trade agreements, which are relatively new developments, may create possibilities and constraints that have not existed before. Is the project heavily dependent on imports or exports? Are the necessary assurances present or is the project open to risks from abroad? On the whole, projects heavily dependent on exports, imports, or foreign capital are more hazardous than those that are domestically centered.

National Policies Toward Industry: Tariffs, Taxes, Development Assistance

Most developing countries provide favorable conditions for development of manufacturing industries. The form which the government's aid will take will depend on the government's views on these matters:

- Has it reserved certain industries for state enterprise? If so, which?
- What rules has it laid down for foreign investment and other forms of foreign participation?
- Is it oriented towards import substitution? If so, what are the economic and noneconomic criteria employed?
- Is it oriented towards export of manufactured goods?
- Are special inducements offered to manufacturing enterprises utilizing domestic raw materials or domestically produced intermediate goods?
- Has it expressed a preference for certain types of industries? Labor intensive? Capital goods? Consumer goods?
- Is it seeking industrial development in certain regions of the country?

The analyst should try to examine whether government policies will be helpful or harmful to a project in these respects:

- Tariff protection and tariff exemptions for inputs. Will the government grant tariff protection to the project's product? This generally permits the project to receive a higher price for its output than would otherwise be possible.

- Conditions affecting the ease of importing and the availability of transportation.

- Tax exemptions.

- Guarantees, as for credits required for foreign loans.

There is a large number of ways in which the actions of government can influence the project. The analyst's task is to judge the matters of greatest significance and to seek to convert them into measures of impact on the costs and revenues of the project. Precedents for other projects in the country will provide important insights. The standing and influence of the person organizing the project will also have an important bearing on the matter.

Environmental Considerations

The effect on the environment must be treated as an important factor in the CPA. Beyond a certain point individuals cannot adapt fast enough to environmental changes. Typically, disruption to the ecological balance is caused by pollution -- by solids, liquids, gases, noise or thermal output. Relevant effects can be on air, water, land, buildings, monuments, people, plant life, or fish or animal life.

It is necessary to identify and estimate the kinds and amounts of pollution, their duration, and their probable effects. At the same time, corrective actions to eliminate or minimize the potential damage must be identified. Additionally, the potential environmental damage must be estimated along with the probable cost of alternative actions. Such costs, if available, would be incorporated as an input in computing the NNRR; they may also be an input to the BERR if the project (enterprise) requires preventive or remedial measures.

In some cases, the actual damage to the environment may be tolerable from a single establishment, but cumulative pollution effects caused by a series of manufacturing plants may be alarming. Anticipation of future difficulty in this regard may influence the design of the plant.

A CPA may merely identify the dimensions of the problem and suggest further study, particularly where damage and remedial costs could be important and estimates have a wide range of uncertainty.

III. STEPS IN THE CAPITAL PROJECT APPRAISAL

Project preparation and appraisal consist of the following:

1. Identification of the need of the project, particularly the demand

2. Formulation of promising physical resource flow plans

3. Pricing the project

4. Selection of the most promising alternatives

5. Computation of rates of return

6. Sensitivity analysis of rates of return

7. Evaluation summary

While the above steps can be discussed as discrete steps that will occur in the stated order, it should be recognized that in the course of carrying out these steps, there will be considerable interaction. For example, in carrying out step 4, the analyst may find that other alternatives suggest themselves, so that he may find it necessary to return to step 2.

Determining the Demand for Output

The General Guidelines (Chapter II) discuss how one would go about estimating the demand for products.

Since the sales forecast is critical for the project, how soundly based is it? Factors that will help to determine the size of the market of manufactured products are:

. Macroeconomic factors. These have already been discussed.

. Size of market. As a benchmark, has the size of the present apparent domestic market been determined (imports plus local production less exports)? Are special surveys necessary to sample local consumption?

. Division of market. Has the market been discretely divided among classes of customers by income, age, location, etc? If the project is to produce an intermediate good, has the market been identified by the sources of demand?

. Guaranteed market. To what extent is there a guaranteed market (captive user, replacement of imports because of new import restrictions, firm sales contracts with, say, a factory requiring the part or raw material to be produced)?

. Competitive tests. What competitive tests have been made and who are the competitors? Has a comparison been made of the price for the product with prices of imported products, after allowing for transportation and handling charges to different destinations in the country? Brand preference?

. Price-demand schedules. Have these been calculated? How sound is the basis for such calculations?

. Preference for imported goods. Consumers of a developing country often show a strong preference for imported goods. Has the matter of domestic preference been competently addressed in the project?

. Product design. What is the basis for judging the acceptability of the appearance, quality, and technical specifications of the product? Replica of existing product? Produced to customers' specifications? Survey of customers' wishes?

. Stability of market. Are there assured outlets for a given product, or will it require frequent shifts in volume and kinds of output to meet competition?

. Market experience in other countries (particularly those with similar income and population characteristics). What has been the experience there?

. Sales outlets and distribution methods (particularly for export markets). Is a qualified sales force likely to be available, and can agency or other outlets be readily established? Particularly for the export of manufactured consumer goods, effective ties in foreign markets are extremely important.

A large number of factors will determine sales. The project proposal, particularly if it is in preliminary form, is likely to have covered only a few of such matters. The analyst must determine whether the most indicative factors have been considered adequately. Allowing for miscalculation, he must also determine:

- What margins of safety have been allowed in the calculations

- What alternatives are available if sales should fall below (or rise above) the projected level.

Formulation of Promising Physical Resource Flow Plans

To compare promising alternatives in manufacturing, physical flows must be considered. Ideas for alternative flows will arise from engineering considerations bearing on how the demand for the product(s) can be met. The aspects related to engineering are discussed in appendix A. Ultimately, decisions on alternatives must be based on determining the alternative with the least-cost and/or the most attractive rates of return, using the procedures described in the General Guidelines (see chapter V).

A common difficulty with manufacturing projects in developing countries is that for a variety of reasons a given investment gives rise to a relatively small output, making the burden of fixed costs excessive in relation to output. Project design can influence this in a number of important ways.

- The scale of the project should be appropriate for the market. Planning for multishift operation is extremely important for heavy investments.

- Where demand for a product is limited, it may be possible to plan for a number of products to be manufactured, using the same plant.

By planning an export program, it is possible to overcome the demand limitations of the domestic market.

In manufacturing, consideration must be given to promi alternatives involving different raw materials, sizes and sco of project, technology, provision for expansion, phasing of gestation, and location. Because of the very large number of possibilities, the analyst must exercise judgment as to which alternatives are worth pursuing.

Pricing the Project

The business enterprise will calculate its rate of return (BERR) based on market prices for both inputs and outputs.

To obtain the NNRR, inputs and outputs may require the use of accounting or shadow prices if actual market prices do not provide accurate measures of real costs and benefits. This commonly applies to foreign exchange earned or expended, capital employed, and unskilled labor and skilled personnel. The value of output sometimes presents some problems. The opportunity cost of the output is the expected c.i.f. price plus handling charges. Where the output is not a standard product, there may be some difficulty in establishing an equivalence in value. However, an even greater difficulty is the difference in prices, depending on the exporting coun.. the supplier and the marketing conditions. In general, one should not assume c.i.f. prices that are temporarily depress because of dumping or other short-term developments. Neither should one assume prices that are high because of unusual circumstances. As a practical matter one may have to resort to averaging of some kind.

Construction of the BERR flow as described in the General Guidelines will yield approximate cash requirements to be supplied by all sources of finance, equity and loan and the potential amounts available for payment of interest and repayment of loan. Normally, the relative importance of different forms of finance will be open-ended at the PPA stage.

More detailed timing of required funds would be undertaken in later project studies when the relative roles of the different forms of financing were more definite. This would take the form of cash flow projections on a quarterly or monthly basis, detailed by major items, taking into account the specific forms of finance employed.

Selection of the Most Promising Alternatives

While many of the physical alternatives that are possible (see appendix A) can be rejected on the basis of engineering considerations, many of the choices will require a comparison of cost. Where alternatives involve only current domestic costs (for example, raw materials or labor utilization), relatively simple comparisons are sufficient for the analyst to reach a decision. However, where one or more alternatives involve a greater or lesser investment with varying costs over the life of the project, the comparison of their respective value flow is called for, as described in the General Guidelines (see chapter V).

Computation of Rates of Return

A detailed example for a manufacturing project is given in the General Guidelines (chapter VIII). The illustrated tables indicate how one goes about calculating the business enterprise rate of return and the net national rate of return.

The differences between the business enterprise and the net national rates of return can be quite large in manufacturing projects.

The business enterprise rate of return reflects the return on assets employed by the project and is of interest to the owner of the business and to the lender.

Actions to improve a project with an unattractive BERR should be considered if the NNRR is favorable. Changes can be made in training allowances, import privileges, tariff protection and various other types of assistance.

Sensitivity Analysis of Rates of Return

How likely is it that the estimated rates of return will be realized? Are there controllable factors that can have large effects on such rates? What are the effects of the factors that cannot be controlled?

An important tool for determining sensitivity of rates of return of manufacturing projects is the so-called break-even point analysis. By categorizing costs into those that are fixed and those that are variable, it is possible to project profits (or losses) under a variety of conditions. Figure 1 presents a graphic break-even analysis. One can readily trace the effect of changes in price, volume, and variable expense on a yearly basis and convert it into terms of rates of return. For example, if production is scheduled to reach 90 percent capacity by the end of the second year and actual production only reaches 60 percent, in many types of manufacture the effect on profit is very large. One can also test the sensitivity of rates of return to the size of investment and the length of gestation period. These in turn may suggest desirable modifications in implementation or production techniques.

High fixed costs are associated with automatic equipment, and this will tend to be reflected in the need for a large volume of sales. On the other hand, products requiring a high labor input tend to be associated with lower fixed costs; this in turn usually will result in the need for a lower volume of sales to achieve a break-even point. Specific analysis, however, must be performed for given cases; generalizations will not suffice. All factors must be considered, such as the expected volume of sales, the amount and cost of labor, the need for overtime to meet demand, equipment requirements and the like.

Where variables having a large impact can be affected by policies or further study, sensitivity results can indicate the desirability of further study or reconsideration of policies.

Evaluation Summary

In accordance with the General Guidelines (Appendix C) an evaluation summary incorporating the major findings of the study is suggested.

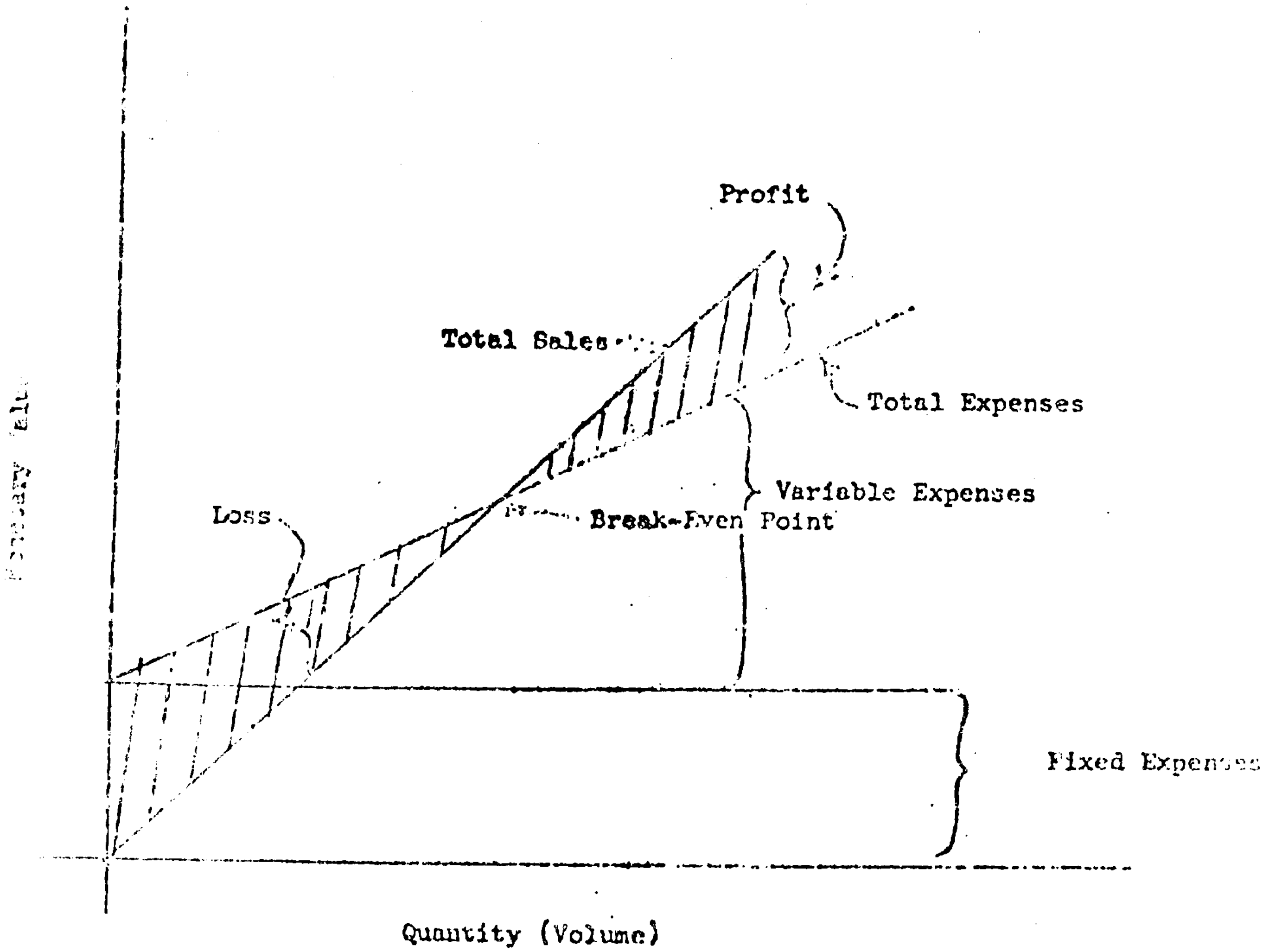

Figure 1. Break-Even Analysis

APPENDIX A. ENGINEERING ASPECTS OF A MANUFACTURING PROJECT

The aspects of engineering variables involved in planning a manufacturing project have to be settled in terms of least-cost alternatives rather than on the basis of absolute engineering standards.

Product Definition and Design

Definition of the product must be clearly specified. First the characteristics of the final product must be determined on the basis of the nature of the market. Second, decisions are required on which materials and parts should be bought and which should be manufactured in the plant.

The plant may be conceived primarily as an assembly plant and all components may be purchased. It may be a deliberate policy of the government to require a certain amount of subcontracting. On the other hand, it may be that some of the components cannot be produced on the outside because qualified vendors are not available; the company may wish to retain and maintain control over the production processes; vendors may not be willing to produce the product due to inadequate profit margin or lack of available open shop time.

Specific factors affecting make-or-buy decisions are the available technology and equipment within the plant, available qualified sources for procurement of needed items on a competitive basis, desire to maintain or develop skills within the plant, company or government policies for developing outside procurement sources, available plant capacity, opportunity costs of rejecting an available alternative, and differences in the foreign exchange burden implied by the decision.

What is the basis of the decision to make or buy? Are the decisions irreversible? Whenever possible, the analyst should seek comparative costs.

The cost of parts to be purchased domestically is likely to be surrounded by great uncertainty, and the preliminary appraisal will have to work with a range of costs. For this reason, it is desirable to consider imports as alternatives, even if on a contingent basis.

It is frequently necessary to modify the product for it to be compatible with available manufacturing equipment. Sometimes the product is modified for production by high-speed specialized production equipment. The converse is also true; that is, a product may be designed for production by general purpose equipment. Thus, it may be necessary to modify the designs to meet available local production equipment. Consequently, in most manufacturing plants, some product design functions are performed.

Definition of Production Methods

The elements that contribute to the efficient production of goods are production equipment, plant layout and assembly operations. The selection of equipment, establishment of assembly operations and the choice of plant layout is governed primarily by the volume of output of a given product. However, where quantities of a product are small, more efficient equipment can be justified if the plant is designed for more than one product.

Plant layout is characterized by the following three basic types:

1. Production line -- where a production line is established to produce a single product. Material flows progressively through consecutive work stations of equipment or assembly operations arranged according to the sequence of operations, such as is characteristic for automotive plants. The advantages of this method are reduced handling of material, reduced material in process, effective use of labor, more effective production control.

2. Process layout -- also known as batch layout or job shop, where all operations are grouped together. That is, all similar equipment will be in one area of the shop. For example, lathes may comprise one area, milling machines another, and welding equipment still another. Similarly, assembly operations will be grouped by like processes in the same area. Advantages of a process-type layout are improved machine utilization, the variety of products that can be produced by lot sizes, and allowance for frequent product changes.

3. Fixed position layout -- where the material or major component remains in a fixed place. Equipment, labor and materials are brought to one location. An example of this kind of layout is the refitting or build-up of a shop in a drydock. Advantages of this type of layout are (a) handling of a large item is reduced or eliminated, (b) changes in product design can be readily incorporated, (c) skilled operators can complete their work at one point, and (d) less total space is required.

A summary of the various types of plant layout is given below:

Type of layout	Characteristics
Production	High volume, single product
Process	Low volume, many products, intermittent demand
Fixed	Large item, prototype, one-of-a-kind product, small working space

Determination of specific equipment to be used is facilitated by outlining the operations and equipment to be used in a manufacturing process planning sheet, such as is shown in table A-1.

Table A-1. Illustration of Manufacturing Process Planning Sheet

Operation Summary Sheet
Part Name: Gear
Part Number: XXXXXXXXXXX

Operation number	Operation description	Equipment	Pieces per hour
10	Receive and inspect blanks	Bench and Brinnell hardness tester	120
20	Rough turn and cut-off	Monarch engine lathe	20
30	Roll stamp heat code	#25 Schmidt marker	120
40	Break sharp corners, wash and oil parts	Speed lathe, dip tank	50

The type of machines required must be determined and priced. Information on standard machinery is readily obtainable from manufacturers who are listed in the Thomas Register of Manufacturers for the United States or in like references for other countries. The analyst will do well to obtain catalogues from various manufacturers to compare processes and prices. Installation costs can be obtained from engineers or from equipment manufacturers. Through inquiry or by drawing on experience in similar projects and using cost indexes, it should be possible to arrive at approximate costs of installation and equipment, and at the lead time required for ordering.

Production Area

Design of a production area is dependent upon the specific types of product methods incorporated into the overall production plan. The basic point to stress in the design of production areas is the concept of visible production control. This concept is applicable to all methods of production as it emphasizes adoption of work-in-process storage, aisle space, correct material handling and proper flow of goods without backtracking and the like.

To achieve visible production control even in a process-type layout, much can be accomplished to obtain a reasonable straight-line flow of materials. An analysis of the operations will reveal that the various production areas such as lathes, milling machines, drill presses, and other equipment can be arranged with the objective of minimizing backtracking of material through the shop. Also the aisles for moving materials should be wide enough without work-in-process materials stored on the aisles. Likewise, the production equipment work areas can be arranged in proper geometric configurations that will encourage neatness. In an orderly shop, foremen and higher echelons of supervision will be able to walk through the shop and observe that neat, orderly work stations are producing goods without interruptions. On the other hand, work stations with material accumulating by them will provide a signal of potential problem areas, because either the equipment is not performing properly or the operator cannot handle the work to be processed on time.

Supporting Production Departments

In the design of a manufacturing plant, consideration must be given to the proper location and space allocation of the functions that are either directly or indirectly required in support of production. Typically such supporting functions are maintenance, incoming materials storage, tool rooms and cribs, finished goods storage, shipping, cafeteria service and power plant. Some of these functions, such as the power plant, maintenance shop, or cafeteria, may be located outside the plant. Size of the plant, size of the supporting function, relative importance of the function to the production area, and other related factors contribute to the location and space allocation of supporting functions.

Physical Plant

The physical plant is comprised of: production equipment and the structure containing the equipment, administrative offices, warehouses, maintenance shops, power plants and the like. The size, type and complexity of the physical plant depends upon:

- Scale of operations
- Nature of operations
- Geographical location

Thus, a small manufacturing plant may not require a power plant or may require only a small diesel engine to satisfy its needs. On the other hand, an extremely large automotive assembly plant may require its own power plant if the outside power sources cannot supply power in sufficient quantities.

The nature of operations will contribute to the needs of particular facilities. Even a light electronics assembly plant will normally demand an air-conditioned environment for the manufacturing area.

Geographical location, of course, requires different structural considerations. A warm, humid climate may impose the necessity of an air-conditioned environment to assure an alert, efficient working force. This, in turn, will impose specific building construction to meet these needs.

Supply Logistics

Materials for the production lines, spare parts for maintenance of equipment, water for plant operations, and other supplies must be provided at the right time and in correct quantities. Initial supplies must be made availabl to start the manufacturing plant, and plans must be made to assure continuous flow of supplies to support production.

Thus, it is necessary during the planning phase to identify the following:

- Items to be supplied
- Quantities to be supplied
- Preliminary candidate suppliers, e.g., wholesalers, manufacturers, utilities, jobbers
- Method of payment for supplies
- Cost of supplies and their shipment
- Method of shipping the supplies, e.g., air, water, rail, truck
- Method of inventory control over supplies (quantities to be purchased and stored)
- Unusual constraints in terms of tariffs, money exchange and the like.

A total logistic plan in rough form must be developed to identify the method for acquiring goods to sustain productic in an orderly manner. A logistic plan is to be considered an important part of manufacturing planning.

Distribution Needs

Consideration of the adequacy of planning for distribution is essential in overall project appraisal. The analysis of product distribution requirements will reveal basic factors relevant to plant location decisions -- transportation requirements, handling requirements for shipping, warehousing needs -- and will also force clear identification of expected marketing locations. The project should contain a description of:

- Quantity of product to be shipped in a given time interval: day, week, month or year

- Method for shipping the product, such as unit loads, containers, type of packaging, or bulk (as in mining products)

- Available transportation modes, and selection of proper transportation modes

- Kinds of warehousing or storage requirements

- Destinations to which the products will be shipped

- Taxes or duties that must be paid.

Again, the analyst must judge whether these matters have been explored; if so, he must also judge the quality of the supporting data. He will need current information on distribution methods, particularly for analogous facilities in the country and elsewhere.

Plant Location

Analysis of the marketing areas, distribution requirements, and supply logistics will assist in the decision-making for plant locations. Obviously, the ideal is to be close to the raw material and the markets; however, such an ideal condition is not always possible. Many factors will influence a plant location. Some of these factors are:

- Political climate or requirements
- Social demands
- Location of raw materials
- Location of the markets
- Taxation
- Labor costs or labor availability
- Transportation costs (raw material and market)
- Market demand
- pecial concessions.

A CPA hould quantify the national rate of return flows and the business enterprise flows corresponding to the most promising locations along with other quantifiable and nonquantifiable considerations. This task is made simpler by the fact that the requirements of the facility often narrow the choice considerably (close to port, pool of skilled personnel, etc.). The procedure of finding the least-cost alternatives can be used for choosing among contending alternatives, providing sufficient consideration is given to their quantifiable and nonquantifiable considerations.

Proper plant location analysis must identify all the relevant factors that were considered in locating the plant in a specific locality. This will permit proper evaluation of the merits of the proposed project.

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APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II - PUBLIC HEALTH

Agency for International Development

September 1971

CONTENTS

FOREWORD

The proper use of these guidelines presupposes that the analyst has a working knowledge of Part I, General Guidelines. The basic concepts applicable to preliminary appraisals of projects in all sectors, detailed discussions and illustrations of the methods to be employed in valuation of project inputs and outputs, the computation of internal rates of return, benefit-cost ratios and other pertinent measures of the worth of a project are presented in the General Guidelines.

These guidelines deal specifically with capital project appraisals (CPA's) in the field of public health, including family planning, with the emphasis on the unique features of projects in this field. They tell the analyst how to think about a public health project; what to look for; and how to assure that the critical elements essential to a project are considered in the appraisal. They encourage concentration on major issues in relatively broad orders of magnitude, leaving details and matters of lesser importance to be explored later, possibly in a subsequent study.

The guidelines are designed to assist the analyst in recognizing and assessing the significance of institutional, cultural and political -- as well as medical, economic and financial -- factors that will determine the feasibility of a project. The analyst confronted with the task of appraising a public health project will recognize early in the process that such projects do not fit easily into the analytical framework presented in the General Guidelines.

Widespread health care demands that the project analyst seek the least-cost alternative consistent with the quality standards of health obtainable and the resources available to the health sector. Medical capital projects have to be fitted to a medical delivery system -- a set of arrangements for meeting the total health needs of a designated population as distinguished from meeting the needs of persons who merely contact a medical facility.

The CPA is most efficiently undertaken by multi-disciplinary teams, e.g., social scientists (economists, financial analysts, political scientists, etc.) and technical specialists (engineers, agriculturists, etc.). The structure of the individual multi-disciplinary team can only be detailed within a specific analytical and project context. The term project analyst or analyst, used herein, refers to a member of a team engaged in a CPA.

I. DISTINGUISHING CHARACTERISTICS OF PUBLIC HEALTH PROJECTS

Role of Government

Public health projects may be distinguished from most commercial and industrial projects, first of all, in terms of the degree of governmental participation. In most countries, including the LDC's, some medical services are provided by private practitioners -- medical doctors, dentists, laboratory technicians, hospitals, clinics, etc. Charges are made for such services where privately supplied. Governments frequently participate, in varying degrees, in the provision of such services by providing buildings, equipment and medical supplies. This participation may be in the form of explicit subsidy payments, tax and customs exemptions, or government provision of land and other physical facilities. While medical services of this type have an influence on the general state of health of the public, these services are generally not included in the scope of public health projects.

In most developing countries private expenditures meet a small part of the total health needs. This is true even where a significant portion of health expenditures are made on a private basis.

Public health projects -- the type for which these guidelines are applicable -- are generally financed by government, with only nominal charges, if any, being made to individuals deriving direct benefits from the service. There are several reasons for the "free" principle:

1. Many, if not most, public health project benefits accrue indiscriminately to the population as a whole, e.g., a mosquito eradication program, an immunization project, or a health education project. There is no practical way in which a payment from individuals can be exacted as a <u>quid pro quo</u> for benefits received.

2. Benefits external to the person receiving care are often very important results of health activities. Medical care and public health measures aimed at preventing or reducing the incidence of infectious diseases provide a classic example of external benefits. The rapid spread and consequences of most infectious diseases (scarlet fever, polio, diptheria, smallpox) and parasitical diseases give the whole society a strong incentive for preventive medicine.

3. The benefits of a project may depend on cooperative action by the community as a whole, thus requiring educational programs and/or some form of authority to ensure conformity to the pattern of behavior required to realize the benefits.

4. In LDC's the low level of individual incomes and the marked inequality in income distribution means that health services would not be available to most of the population if left to private suppliers. Yet the per capit. resources available to LDC's for health services are likely to be severely limited in the foreseeable future.[1/]

The Health Sector and Economic Development

The health sector is intertwined with economic development in complex and almost limitless ways.

. Health activities can reduce the incidence and severity of diseases, reduce mortality and raise the general level of the health and vitality of the population, thus contributing to higher productivity.

. Primary school education is seriously handicapped by poor health of infants and preschool children. The diarrhea-pneumonia complex is responsible for a large proportion of ill health as well as mortality of children.

. Parasitism and such diseases as malaria sap the energies of the work force.

. The ill health of skilled personnel is particularly damaging to economic development because skilled personnel are scarce and costly to train, and their absence due to illness disrupts production. Although skilled personnel can be protected against diseases such as tuberculosis, in the long run it becomes more practical to halt the transmission of diseases throughout the community.

. In some situations, a health program makes it possible to bring otherwise uncultivated lands into production.

1/ For projections see John Bryant, Health and the Developing World (Ithaca: Cornell University Press, 1969), pp. 48-51.

. People can be given a sense of control of their fate and environment, helping prepare a climate favorable to economic development.

. Economic development will by itself, and certainly in combination with well-conceived health projects, reduce mortality. The reduction of mortality is, of course, a goal that must be taken for granted. Rapid population increases in some developing countries have acted to minimize increases in per capita income and welfare. This problem can be remedied by the incorporation of birth control programs in public health projects.

Factors Affecting Health Programs in Developing Countries

Limitations of Medical Programs

Medical programs have limited value in the face of poor nutrition and unhygienic and unsanitary living conditions. Some of the major diseases of infants and young children are caused by malnutrition and are generally responsible for about half of infant and child mortality. The effective prevention of these diseases requires improved nutrition, potable water and more hygienic living conditions.

High Cost of Trained Personnel

The cost of training health personnel varies widely depending on the type and length of training. The physician is the most costly to train, followed by the nurse and then by other less trained personnel. The comparative costs of educating health personnel (given in table 1 for three regions) are generally paralleled by the salary costs of such personnel. Therefore, the more health cases that less trained personnel can assume, the more feasible does it become for a poor country to meet important medical needs. The guidelines on Education Projects should be consulted in regard to training aspects of public health projects.

Proximity to Target Population

Medical facilities must be relatively close to the target population. The use of medical facilities falls off sharply as the distance from the target population increases. In most countries requirements can be met economically only by the use of small local facilities that are manned by auxiliary personnel and are only occasionally attended by a physician or other professional personnel.

Table 1. Comparative Costs of Educating Health Personnel, Three Regions

Health personnel	Cost to produce one graduate (U.S.$)
Thailand	
Physician..............	6,600
Nurse..................	1,200
Auxiliary sanitarian....	350
East Africa	
Physician[a/].............	26,000
Nurse[b/]................	9,800
Auxiliary nurse[b/].......	840
Medical assistant[b/].....	1,260
Auxiliary sanitarian[b/]..	1,680
Colombia	
Physician[c/].............	24,600
Nurse..................	3,000
Auxiliary nurse[d/].......	1,000

a/ Makerere University College Hospital.
b/ Malawi. The cost of educating nurses includes the salaries of nurses added to the staff both for teaching and to improve the quality of patient care. This makes the cost per graduate unusually high, but it represents what Malawi invested in the nursing educational program.
c/ Universidad del Valle, Cali, Colombia.
d/ Cost per graduate in 1968. In the two preceding years in this development program the cost was $115 and $561.

Source: Costs from ministries of health or university authorities. John Bryant, Health and The Developing World, (Ithaca: Cornell University Press), 1969, p. 123.

Need for Greater Use of Less Trained Medical Personnel and Inexpensive Facilities

Generally rural areas get substantially less medical attention than urban areas. However, even in urban areas whole segments of population have relatively little contact with medical facilities. Given the small amount of resources available and the pressing medical needs, it is therefore necessary to make substantial use of less trained personnel.

Coincident with the need to make the maximum possible use of less skilled personnel is the need to make use of less expensive forms of care. The great disparity in cost among different types of care in an African country is illustrated in table 2.

Table 2. Index of Medical Cost Per Case, by Health Facility

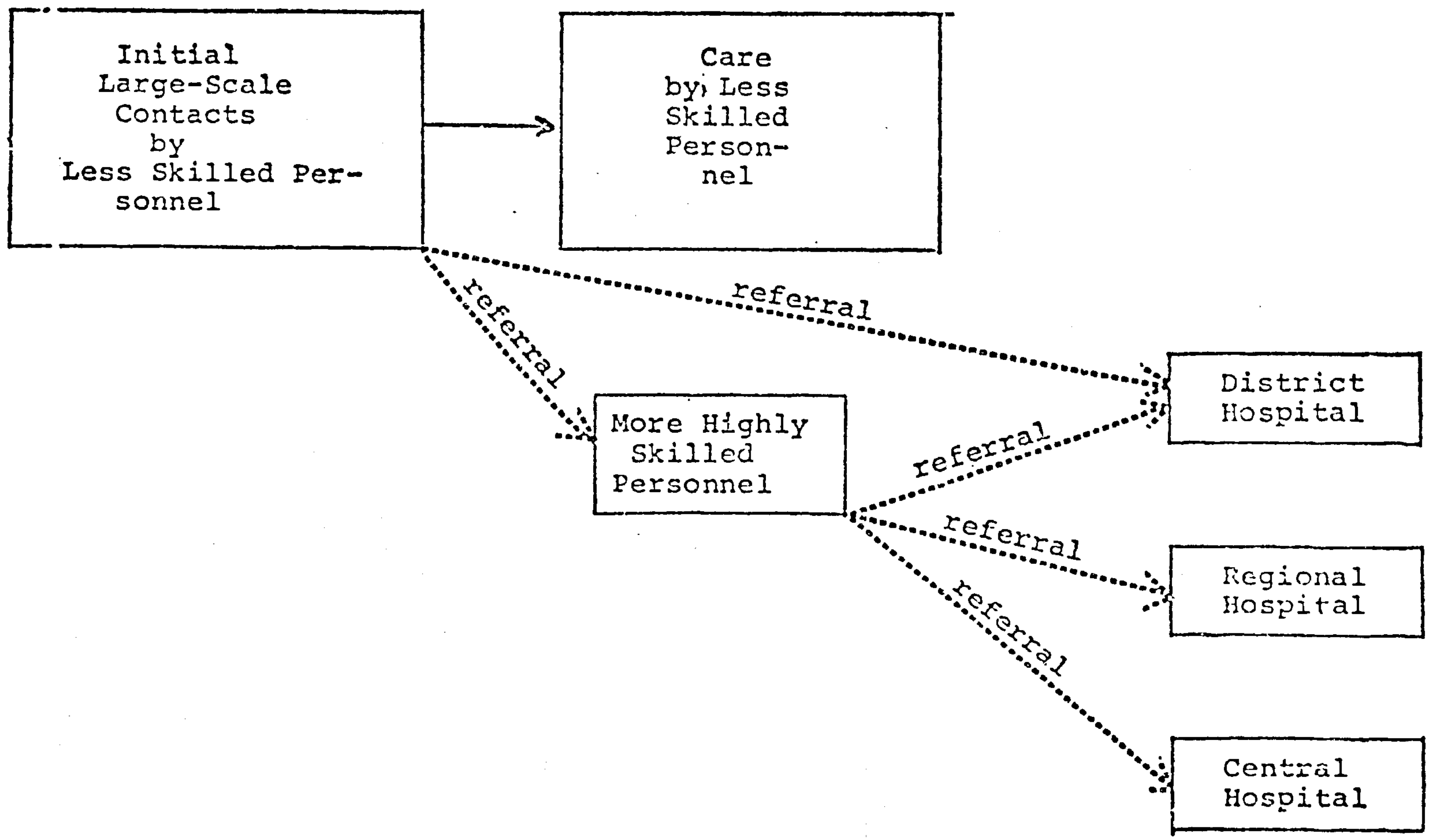
(Dispensary cost = 100)

Health facility	Index of medical cost per case
Dispensary.............	100
Health center..........	243
District hospital......	5,130
Regional hospital......	10,435
Central hospital.......	22,609

The basic strategy must be to shift the preponderance of treatment to less skilled hands and to resort to the more expensive forms of treatment (physicians, hospitals) on a highly selective basis. The potential economies in so doing are indicated in table 2. A schematic diagram of patient referral under this plan is shown in chart 1. Because of substantial differences in availability of resources and other considerations among countries, the mix of types of care will differ from country to country. One would expect greater emphasis on the more expensive forms in a country that spends $10.00 per capita per year than in one that spends $1.00.1/

1/ It is noteworthy that an affluent country like the United States is moving toward greater use of less skilled personnel to meet sharply rising demands for medical care.

Chart 1. Pattern for Low-Cost Public Health Programs



Need for Health Teams

Quality care requires that less trained personnel be supervised, instructed and led by the more highly trained professionals. This can be achieved only when the persons participating in health care are organized as teams led by physicians. Auxiliary personnel, working alone, can ultimately provide the first steps of care for all problems and act as a filter, referring only a small proportion of cases to professionals -- those problems that require the skill and knowledge of professionals.

Role of Management

The explosive demand for health care poses serious management problems, forcing a reorientation of health organization and attitudes. Workable patterns of health care require detailed determination of case patterns, communication to the various working levels of the health system and correction both in planning and implementation, all within the context of a preponderantly decentralized system of delivery of services. Many of the basic management decisions and actions have complex medical aspects which require deep involvement and leadership by physicians and nurses. However, the task of management is too deeply seated to be the exclusive prerogative of medical professionals. Participation in management must extend to the auxiliary in a local clinic as well as to the physician who visits the clinic once a month.

Educational Implications of Low-Cost Health Programs

The achievement of effective care at low cost requires teams heavily weighted with paraprofessionals or auxiliaries. This requires that the physician be oriented, trained and motivated toward leading and managing a team rather than merely caring for patients in a hospital, clinic or office setting. Medical curricula for the LDC's might be designed to this end.

Curricula should embrace the education of all members of the team, treated as an integral whole, and should involve medical assistants, technicians and auxiliaries as well as doctors and nurses. In addition to internship in hospitals, there is a need for supervised internship in decentralized clinics in preparation for coping with the more typical situation faced by medical teams.

II. STEPS IN THE CAPITAL PROJECT APPRAISAL

As outlined in the General Guidelines, project preparation and appraisal consist of the following:

1. Identification of need for the project
2. Formulation of alternative physical resource flow plans
3. Pricing the project
4. Examination of alternatives
5. Computation of rates of return
6. Sensitivity analysis
7. Evaluation summary

While the above steps can be discussed as discrete steps that will occur in that numerical order, it should be recognized that in the course of carrying out those steps there will be considerable interaction. For example, in carrying out step 4, the analyst may find that other alternatives suggest themselves, so that he may find it necessary to go back to step 2.

Identification of Need for Project

The staggering health needs and severely limited resources of less developed countries make it urgent to have a systematic way of determining how to deploy very limited resources.

Definition of Target Population

In many developing countries there is a tendency to concentrate health activities in large urban centers, with very uneven coverage of health needs in both urban and rural areas, especially the latter. It is desirable that there be an explicit definition of the target population.

Because major portions of health facilities must be local, target populations must be estimated for localities that correspond to local facilities such as dispensaries. Population estimates from the last census must be updated and adjusted for estimated future population growth.

Determination of Caseloads from Major Health Problems

It is necessary to define the estimated frequency of various cases per thousand persons, including those cases not presently reached that are proposed to be reached, classified by type (severity, age, class, and other significant variables). Projections would be in the form of a table listing the various health cases such as tuberculosis, diarrhea, pregnancies, pneumonia, smallpox, diptheria and malaria, with annual frequencies of specific types under each major case.

Since statistics on estimated frequencies are poor or nonexistent, considerable reliance must be placed on the judgment of knowledgeable medical practitioners of the country for such frequency rates. Such estimates would have to allow for local conditions.

Definition of Preferred Feasible Ways for Handling Specific Health Problems

It is necessary to define the proposed method for handling each major type of problem case, trading off "effectiveness" against cost and bearing in mind the need to make relatively little use of the more expensive forms of care -- professional personnel, hospital beds, elaborate equipment.

Implied Aggregate Workload Units

The estimated target populations, the frequency of cases and the preferred ways of handling specific health problems have an implied total workload to be accommodated by medical projects, existing and future.

Typical workload units might be:

- First visits by patients
- Number of pregnancies
- Doses of drug X
- Doses of vaccine Y
- Referrals to district hospitals, etc.
- District hospital bed days.

Because major portions of facilities must be local, estimates of workloads should be for localities that correspond to local facilities such as dispensaries. The workload requirements that correspond to larger facilities would be aggregated for the groups of localities served.

Formulation of Alternative Physical Resource Flow Plans

Decisions on the treatment for particular cases are really a first level formulation of activities, forming a basis for aggregating total workloads or needs. Taking the aggregated workload units that have been phased over time, the analyst can consider the projects (type, size, phasing) that can meet the stated workloads. A first step is to consider existing facilities and personnel and determine how, after deploying them in the best possible manner, one can meet the projected workloads. This may require expansion of existing facilities; new facilities; rearrangement of personnel and functions; and additional personnel, obtained by recruiting and/or training. The construction project in health thus grows out of the need to provide physical facilities to meet the workload requirements and has meaning only as an integral part of all operations, capital and current, over the life of the project.

Health resources used without regard to a coordinated health plan are likely to be devoted to uses that are of lesser importance, having the effect of depriving many persons of urgently needed health services. Because of its fixed nature, capital health projects that are not an integrated part of a coordinated health plan can be particularly damaging. In addition to the investment cost, the operating cost of a facility that is out of balance with resources and needs can burden health efforts for many years.

Local Dispensaries

The size of local facilities will depend on the density of the area's population. Areas of sparse population may have a dispensary staffed by a single medical auxiliary or two. In general, the physical structure and equipment of local dispensaries can be relatively simple.

Medical Education

As previously discussed, medical education should be oriented toward the health needs of the country. This means that such education should be concerned with the training of personnel as related to the projected conditions of health care in the country. The numbers of different types of trainees, the quality and the approximate costs (both investment and operating) of training are derived from a coordinated plan, as discussed above.

In view of the general reluctance to serve outside the capital city and other major urban centers, serious consideration should be given to ways of overcoming such reluctanc. Possible measures are location of the educational facility outside the capital city, a strong effort to recruit students whose upbringing is rural, and provision of incentives for personnel to serve in rural areas.

While costs vary considerably among medical schools, in all cases investment costs and current expenditures are significant. There are substantial opportunities for both the reduction of costs and the improvement of quality.

Since a considerable part of the costs of a medical school consists of overhead, the investment cost per student will decrease as enrollment increases. This fact suggests that careful attention should be given to the start and phasing of medical schools. Over a period of a decade or so, a country might profit from starting one medical school and bringing it up to full capacity before starting another, rather than starting two simultaneously. Similar considerations might make joint planning by neighboring countries mutually attractive.

In considering whether to set up a medical school, a small country might consider such alternatives as joint participation in a school with neighboring countries or the sending of its students abroad. The latter has the advantage that the major costs are often borne by the country of study.

The investment cost of a medical school will be sensitive to the design, the method of construction, and the standard of luxury or modesty of residences and dining halls.

Associated hospital facilities are an integral part of a medical school. However, when hospital beds are a part of a teaching hospital, they are considerably more expensive to maintain. Also, a larger bed capacity places an increased load of patient care on the clinical faculty. At the same time, if the physician and other team members are to be attuned to relevant health activities, there must be greater emphasis on internship in clinics and district facilities. Thus more appropriate training and cost reduction both point to lower ratios of teaching-associated hospital beds than are customary in the more developed countries.

Similar opportunities for improving the quality of graduates and reducing cost can be realized by changing the style of teaching. Greater emphasis on self-learning can foster the very qualities and attitudes that will be needed in the field -- initiative, self-reliance, and the capacity for independent study. Styles of learning that place greater reliance on students permit lower faculty ratios.

There is a need for critical appraisal of individual parts of the curriculum, e.g., are 800 hours of instruction in anatomy required for a physician? Questions can be raised about elements that are costly and that at the same time detract from the quality of graduates. The equal emphasis on memorization of important and trivial details has the effect of diluting the retention of the important details.

The value of many time-consuming and expensive laboratory exercises can be questioned in terms of their contribution to a physician's skill, their heavy faculty cost, and their preemption of student initiative and attention.

Hospital Projects

Hospital projects are costly in terms of investment and operating costs. The preliminary appraisal regards the workload as given. The physical resource flow plan specifies the construction, equipment and staffing by specialty that are required over the life of the facility. These workloads can be met by additions to existing facilities, different-sized facilities, and differences in construction and equipment. In addition, even with stated workloads, alternative staffing patterns may be worth considering. The latter may involve qualitative changes that compromise stipulated workloads to some extent. If so, this should be specified.

Planners of health projects start out with health needs to be satisfied. Within the severe resource constraints that are characteristic of developing countries, alternative ways to meet these needs must be formulated. Quality of care considerations will loom large in the formulation and evaluation of alternatives. Difficult choices will be required. Alternatives that are inferior qualitatively may have to be chosen because they are the only ones that can be afforded. However, there is ample opportunity to formulate alternatives that are medically effective and inexpensive. Many of the inexpensive alternatives will have short gestation periods and modest investment, so that discounting will have a small impact on the decision process.

In planning health projects one must overcome a strong tendency to automatically associate greater cost with higher quality. Inventive and ingenious planners will find ways of formulating equal or even better medical solutions that are within the means of a poor country.

Examination of the Most Promising Alternatives

In considering the various possible physical arrangements and flows to meet stipulated workloads, the analyst narrows his attention to a relatively small number of promising projects. By applying the techniques of comparing alternatives and choosing the least-cost alternatives as described in chapter V of the General Guidelines, the analyst will point up one or possibly two alternatives that are most promising. In some cases alternatives may offer both different levels of service and cost that merit consideration by the decision-maker.

The demands of health care tend to outstrip resources, so that it is common for resources required by initially proposed projects to be excessive in relation to what can be budgeted, thus necessitating a reconstructed workload and project.

Pricing the Project

Conversion to Value Flows

At this point in the CPA it is important for the analyst to be familiar with pricing methods described in chapter II and appendix B of the General Guidelines. It is especially important to distinguish between the pricing of inputs and outputs from the national point of view (where shadow pricing may be required) and the pricing of inputs and outputs at market prices (where shadow pricing is not used).

Use of Costing Modules

The use of standardized dispensaries and the maintenance of cost records can facilitate the costing of local facilities and their upkeep.

District hospitals will be few in number, but will lend themselves to module pricing if one divides investment and operating cost into fixed and variable categories. Certain costs are best expressed on a per-patient basis; others are best expressed on a lump-sum basis.

Computation of Rates of Return

Alternatives involving differing investments should be evaluated by the use of the opportunity cost of capital and other shadow prices, as described in chapter V of the General Guidelines.

Most health programs will be designed to meet specific health goals and will be justified in terms of the stated goals and budgeted funds. Economic rates of return justification seldom, if ever, are utilized to justify health programs.

Health projects covering personnel engaged in highly productive activities could provide an attractive rate of return from the national point of view. For example, a program for improving the health of employees of a steel plant could increase productivity and reduce absenteeism, with substantial economic gains. An economic evaluation would be done on the basis of the situation with and without the health project.

Although it is possible to trace the direct economic effect of health projects, complex long-term relationships involving the effects of health projects, mortality, birth rates, productivity, employment opportunities and per capita income make results based on direct effects alone open to serious challenge. Because of the complexity of interactions and data problems, the computation of economic rates of return from health projects is usually not recommended for preliminary appraisals.

It is recommended that wherever direct economic effects can be estimated, such estimates should be given but recognized as partial and incomplete.

Estimation of direct economic effects with and without the project would take the following forms:

Cost of time lost = [(total population covered) (proportion in labor force)(proportion of labor force employed)(annual disease incidence)(average number of working days lost per case)(daily wage)]

Cost of medical care = [(total population covered) (annual disease incidence)(average days sick per year) (medical cost per day)]

Rather than the medical cost per day, for some types of diseases one would use a cost per case multiplied by the estimated number of cases.

Sensitivity Analysis

Major uncertainties surrounding the appraisals of health capital projects are the amount and availability of current funds to operate the facility in later years; the value of the benefits of the projects; and the availability of the required personnel, particularly outside major urban centers. It is useful to explore the probable limits of such factors and their implications for the project.

One should also explore the probable limits of capital investment and the implications of such limits.

Evaluation Summary

In accordance with the General Guidelines (Appendix C) an evaluation summary should be prepared in which major findings are presented for consideration.

The alternatives chosen will probably be based on a choice of the least-cost alternative.

The cost of the project will be given in terms of market prices (of budgetary interest) and also in terms of shadow prices. If more than one alternative merits further consideration, the characteristics and cost of each should be given.

It is important that the relevant effects of the project be described regardless of whether they can be expressed in money terms.

DRAFT CIRCULATED FOR COMMENT

APPRAISAL GUIDELINES FOR DEVELOPMENT

~~GUIDELINES FOR CAPITAL PROJECT APPRAISAL~~

PART II - EDUCATION

Agency for International Development

September 1971

CONTENTS

FOREWORD

The project analyst using these guidelines should first read Part I, General Guidelines. It provides insights into key considerations for capital project appraisals (CPA's) in all sectors, with a detailed discussion of the methodology for calculating the internal rates of return and other relevant measures of the worth of a project.

These guidelines deal expressly with those matters relevant to education. They tell the analyst how to think about a project in education; what to look for; and how to assure consideration of all elements essential to a project. They suggest institutional, cultural, political, and other factors which can weigh heavily on a project. They encourage concentration on big issues in broad orders of magnitude, leaving details and matters of lesser importance to be explored later, possibly in a subsequent study.

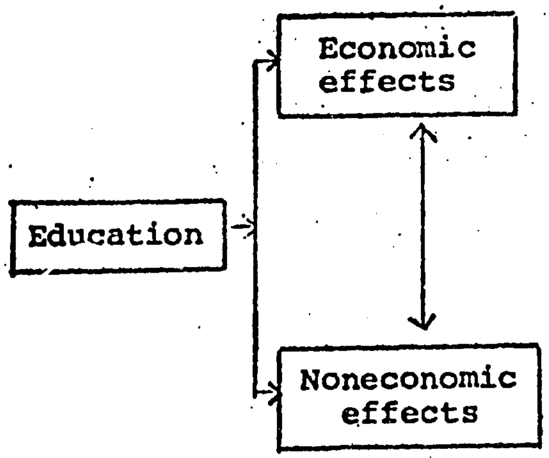
The CPA is most efficiently undertaken by multi-disciplinary teams, e.g., social scientists (economists, financial analysts, political scientists, etc.), and technical specialists (engineers, agriculturists, etc.). The structure of the individual multi-disciplinary team can only be detailed within a specific analytical and project context. The term project analyst or analyst, used herein, refers to a member of a team engaged in a CPA.

I. INTRODUCTION

The objective of these guidelines is to provide a basis for appraisals of projects in education.

The main consideration is that education fit the future nature and purposes of society. Educational projects can be valuable simply because they produce educated persons. They can also help to create more economic wealth. The CPA seeks to measure whether they will do so.

Economic and noneconomic matters interact with each other. The goal of adult literacy may be desired because it is seen as desirable in itself, because it is a way of achieving greater national unity, or because it will have economic effects. This relationship is sketched below:



If the CPA succeeds in calculating the rates of return on investments in education, returns can then be compared with returns from investments in other sectors or returns in other forms of human capital.

The analyst might well feel that there is something artificial in the division between economic and noneconomic benefits in education; indeed, he would be right. However, some choices must be made between one project and another; they cannot all be financed. Consequently, insofar as one can put even a tentative measure of worth on the value of an educational project, it is important to do so. One can still allow faith in noneconomic, nonmeasurable benefits to push a project with a lesser or uncertain return ahead of a project with a higher one.

It is not too difficult to measure the costs of providing educational services. Costs are incurred by parents, by students, and (typically) by governments. For parents, costs include such elements as additional expenditures for clothing, food eaten outside the home, transportation, and books and supplies necessitated by school attendance. For the student, the principal cost is the earnings he might receive if he were not attending school. The government supplies teachers, administrators, supplies, physical plant and equipment, heat, electricity, etc. In private schools, a much larger portion of the costs will be borne by parents, students and sponsors. As noted in a later section, insofar as the private rate of return from educational projects is concerned, parents and students can assess these costs against the value they place on the private benefits.

All of these costs must be included in the appraisal of a particular project -- regardless of who pays the costs -- if the project is to be evaluated from a net national rate of return viewpoint. Fortunately, most of the costs (inputs) can be valued in a straightforward manner, as they involve market transactions at prices that can be determined. When necessary, prices can be adjusted to obtain more accurate measures of real costs. The one cost that cannot easily be figured by quoting the market price is that for the income lost while the student is attending school. This requires an estimate which should be based on the actual reduction in output attributable to the student's absence from the labor force.

The valuation of outputs of educational projects is not so simple; when education is publicly provided on a free basis, the task is especially difficult because the analyst will not have the amount of fee paid (plus other costs borne by parents and students) as a measure of the minimum value to the parent and/or student.

Insofar as education contributes to increased productivity, and insofar as higher earnings measure this additional contribution to output, a basis exists for estimating the economic value of educational output. That there are other, perhaps more significant, values arising from education is not questioned.

A better-educated populace may facilitate the achievement of national unity, produce greater works of art and literature, and contribute in other ways to the enrichment of human life. However, in the appraisal of educational projects these guidelines offer no technique for the quantification and valuation of such benefits.

Nevertheless, the analyst can exercise a useful role even if the total benefits of educational projects elude measurement in terms common to other projects: he should prepare least-cost alternatives to meet the needs of specified educational projects, however it has been determined that such projects are to be undertaken.

Project proposals in education attract support for two basic reasons. The first is the human desire for learning and the political imperative to respond to it. The second is the recognition that economic growth requires an increasingly educated and informed population. The CPA should determine whether the resources to carry on a project in education will be available and whether they can effectively be gathered and administered. It should also determine the relative gains to the national economy from the use of scarce resources in the educational project rather than in alternative investments. And, insofar as quantification and valuation of benefits permit, the potential contributions of alternative educational projects should be assessed.

Project possibilities in education have few limits. Obviously it is not possible in these guidelines to chart the way through a CPA for every possible project. Effort is therefore concentrated on developing a way of thinking about a CPA and on impressing the analyst with the need to identify and test vital matters regardless of whether the project involves bricks and mortar, institutional reforms, or the training of skilled minds and hands. An inquisitive approach is necessary for an effective appraisal.

Since reservations bordering on skepticism may surround a rate-of-return calculation for a project, the CPA might emphasize the least-cost way to achieve a stated objective. Then, if a project moves ahead because decision-makers want it to, regardless of rate of return calculations, at least the project will be done efficiently. The CPA should, therefore, give much attention to the least-cost concept (see General Guidelines, chapter VI).

II. PERSPECTIVE FOR THE PROJECT: ITS RELATION TO MACROECONOMIC, POLITICAL, AND CULTURAL FACTORS AND TO SECTOR AND MANPOWER SURVEYS

Macroeconomic Factors

No project, however small or however difficult the measurement of its benefits, can escape the impact of macroeconomic factors, and this is true even for projects in education. It is a fact that opportunities for educated persons greatly depend on economic growth, for it will substantially determine the demands for educated persons. Moreover, the resources consumed elsewhere determine the resources available for education and for the project. The project should, therefore, try to identify the demographic and macroeconomic factors most likely to affect the project. Among these are:

- Population changes by age, sex, and location
- The growth in gross national product and in per capita income
- Regional development plans within the country requiring basic new facilities in education
- The development strategy of the country
- The development needs in other sectors which will shape the funds available for education
- Demands generated by other sectors for persons of both general and specialized education
- The foreign exchange and exchange rate policies that will affect import costs of items required for alternative educational projects
- Tax and price policies that can affect the availability of total funds and the cost of items required for educational projects
- Credit costs and availabilities

- Imbedded programs in education and in other sectors needing educational aids that require current and future budgetary and resource allocations

- Sectoral emphasis that will emphasize the need for vocational training in certain fields.

The CPA should determine whether the project has adequately considered these and other macroeconomic factors.

Political and Social Goals

Projects in education are uniquely sensitive to cultural mores and values and to the political and social goals of the country. Does the project proposal deal with such matters as:

- Religious customs and goals

- Goals for furthering national unification

- Goals for achieving greater equality of opportunity among various segments of the population

- Identification and development of the full potential of children with outstanding ability and talents

- Role of the tribal leaders, of the matriarch or patriarch

- Regional and tribal differences

- Evidence of the society's adaptability to forces of change and methods for reducing clashes between the old and the new.

Here, again, are factors that will affect the project. Have they been adequately probed? Are there still others to be considered? Were these other factors examined by experts?

The Importance of the Sector Study

Ideally, any project in education should have emerged from a sector analysis because each layer of education makes sense only insofar as it is linked to other layers; e.g., a secondary school project must be related to the primary schools that precede it and to the activities of the students that graduate (college or otherwise). Moreover, a sector analysis should relate the projected outputs of the educational system to the other activities of the society. The sectoral analysis will also have set forth overall objectives and the strategy for meeting them; resources, needed and available; and considered systems, including management and information systems, for controlling costs, improving efficiency, and monitoring progress. If all this has been done, then the CPA will surely have available from the sectoral analysis such useful data as the following:

Past Data

- Data on literacy by age and sex group
- A time series of the number of students in schools of various kinds, capital expenditures, and operating costs (see table 1 for illustrative format for operating cost; a comparable table can be drawn for capital expenditures)
- A description of curricula of the various schools
- Statistics on enrollment attrition in various schools and localities, and the reasons for such (see table 2 for illustrative format)
- Data on repeats in grade
- Data on teacher-student ratios, numbers of teachers, existing training schools
- Expenditures on inputs and outputs (school leavers and graduates) of educational projects
- Data on employment gained by students
- Analysis of major problem areas.

Table 1. Enrollment and Operating Cost of Education

	1966		1967		1968		1969		1970	
	Number	Total cost	Number	Total cost	Number	Total cost	Number	Total cost	Number	Total cost
Primary school										
Basic cycle, secondary										
Other secondary										
Military										
Commercial										
Elem. teacher										
Secretarial										
College prep.										
Higher educ.										
General studies										
Teacher train.										
Social service										
Nursing										
Agriculture										
Economics										
Law										
Denistry										
Pharmacy										
Sciences										
Other										
On the job (by specialty)										
Total										

Table 2. Enrollment in the Educational System, Private and Public, and Attrition from Year to Year, 1966-1969[a]

Classes finishing sixth grade in various years	Year of school							
	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Tota
1969:								
Number of entering students.	95,372	50,994	34,876	23,384	17,791	14,677	7,698[b]	
Rate of attrition...........		.47	.32	.33	.24	.18	.48	
1968:								
Number of entering students.	95,350	48,108	32,458	21,357	16,710	13,923	7,392	
Rate of attrition...........		.50	.33	.34	.22	.17	.47	
1967:								
Number of entering students.	93,287	44,948	28,612	18,655	14,390	12,065	5,635	
Rate of attrition...........		.52	.36	.35	.23	.16	.53	
1966:								
Number of entering students.	68,376[c]	34,869	23,099	15,358	11,880	9,988	4,962	
Rate of attrition...........		.49[c]	.34	.34	.23	.16	.50	
Total........................	352,385	178,919	119,045	78,754	60,771	50,653	25,687	
Cumulative total.............	352,380	531,304	650,349	729,103	789,874	840,527	866,214	
Average rate of attrition....		.49	.33	.34	.23	.17	.49	
Attrition of those starting..		.49	.17	.11	.05	.03	.07	
Cumulative attrition of those starting..................		.49	.66	.77	.82	.85	.92	

a/ Basic figures were taken from a report on the schools in a Central American country.
b/ Based on 1968 rate.
c/ Estimated on basis of average for available years.

Projected Data

A thorough analysis can provide guidance in converting relevant past trends and projections of manpower needs into a statement of educational needs and costs for the future 15 or 20 years:

- Estimates of the number of "graduates" by type and grade required to meet the projected goals of the society

- The time gap that exists between the total required graduates and the estimated numbers of such graduates available from the existing and scheduled supply. This gap would be expressed as a phased requirement for a flow of students and graduates

- Projected structure of the educational system (see table 2 for format)

- Adaptability of various types of graduates for different positions

- Projected policies on tuition, stipends and other measures that affect student selection and retention (student merit, parents' means, etc.)

- Degree of fragmentation of skills that is projected for various activities, with the type of training and numbers that correspond to such fragmentation (e.g., paramedical personnel, engineering associates)

- Regional physical emphasis (rural versus urban)

- Orientation of general curriculum (agricultural, commercial, industrial, general)

- Policies on education for ethnic, linguistic, tribal, religious, or racial groups

- Decisions concerning reliance on national or international training resources

- Deficiencies in the present educational system which are to be corrected
- An inventory of existing teaching facilities.

A sector analysis will have tentatively identified candidates for project assistance -- capital projects, changes in policies, training programs, etc. Indeed, the CPA may be concerned precisely with a project identified in the sector study. Since each project in education is closely linked with the next, it is important that the project proposal clearly establishes what these links are. One of the important values of the sector analysis is that it shows what these linkages are.

Other Important Background Considerations

Before proceeding with a project, the project analyst has an obligation to ask whether the correction of deficiencies in the existing system merits priority over the establishment of a new project. In proceeding with the new project, he should be especially alert to designing the proposed project to remedy inadequacies that are characteristic of existing activities. Too often new schools are built, more textbooks are made available, and more teachers are trained, while the existing plant is underutilized or undermaintained or teachers are unemployed or utilized far below their skill level.

An important factor that will govern projects in education is what might be called "style." Perhaps the chief element in style is the extent to which the student is expected -- and is given opportunities -- to exercise initiative. This in turn affects the need for materials, the adaptability of students as workers, and teacher-student ratios, particularly at higher levels. Aside from the potential savings in cost, a style of teaching which relies on student initiative can improve the potential of the labor force very substantially.

It will be a rare project, indeed, that can be justified solely on the basis of the bricks and mortar or equipment required. What activities elsewhere gave rise to the need for the improved facility? How will the better minds and skills created be utilized? What consumption and capital values depend on better minds and trained hands? For a CPA in education, it is essential that the project's backward and forward ties to other projects in education and to other sectors be described. Particular attention must be given to the relevance of education to the known needs of society. Will the students emerging from schools be trained to handle jobs that are unfilled? Or will the education to be provided alienate students from the types of employment opportunities most likely to be available?

In carrying out a sector manpower study and projecting need in education, there are two extremes to be avoided. The first extreme is to underestimate the educational requirements of occupations, counting on greater learning and adaptation taking place on the job than can reasonably be expected. The other extreme is to overestimate the educational requirement for various projected occupations by counting on schools to provide personnel with ready skills. The latter extreme requires greater expenditure on education than is necessary and may fail to turn out graduates that are adaptable.

In discussing the linkage of schools and training with required skills of occupations, one authority warns against an existing bias toward overestimating the required schooling for specific occupations, such bias being particularly characteristic of experts from developed countries. "Few planners, one suspects, have any realization of how adept employers are in utilizing half-trained men. Gearing plans for schools precisely into estimates of needed skills fosters the very rigidity that would prevent flexible adjustment by workers to changing economic circumstances."1/

Use of Manpower Surveys and Their Relation to the Educational System and the Incentive and Demand-Supply Structure for Graduates

Because sector analyses often do not exist or are incomplete, special manpower studies may have been undertaken that

1/ United Nations, Educational, Scientific, and Cultural Organization, International Institute for Educational Planning, The Social Context of Educational Planning, prepared by C.A. Anderson, 1967, p. 17.

will reveal information vital to a CPA. They seek to relate the output of the educational system -- "graduates" -- to various occupations in the following ways:

- Schooling and training that has been required for various occupations
- Incentives and costs that exist for various occupations, including the cost of education and training and the increase in earnings that may be derived from education
- Shortages and overages of past "graduates" of various kinds in terms of potential occupations and their relation to incentives
- Degree of adaptability of past "graduates," and indications of needed changes in curriculum that will make future "graduates" more adaptable and capable of greater earning power.

These censuses represent limited attempts -- less comprehensive than those in sector surveys -- to relate outside factors to factors that are the responsibility of educational authorities. If a sector survey does not exist, the special manpower survey is a much-needed second best.

The CPA should examine whether the project proposal or the sector or manpower survey unheedingly projects the future from past data. In developing countries many emerging activities, particularly in education, will have to differ substantially in scale and nature from past activities. Changes in economic growth rates, kinds of economic activity, and social systems create new, untested demands for educated and trained persons. Historical relationships may thus be no heralds of the future. However, the past may reveal systematic weaknesses that are relevant for an appraisal of the project.

Lack of Sector or Manpower Survey

If neither a sectoral study nor an educational manpower survey is available to serve as background for assessing an educational project, or if what is available is inadequate, There are a number of ways a preliminary appraisal can be carried out. First, the scope of work that has been given to the analyst may provide specific guidance. Such guidance may assert that a strong and urgently felt need exists. The analyst is therefore called upon for a CPA that concentrates on the least-cost approach to the project, with some leeway granted as to quality. The analyst would formulate and evaluate the various least-cost solutions to meet the stated needs, using the procedures for determining the least-cost alternative described in the General Guidelines.

When the scope of work does not give such specific guidance, the need for a project may still be urgent and manifest in the light of stated government policy. In this case the analyst could proceed on a similar basis, in effect creating his own scope of work with confidence. But in other cases of a priori demand favoring the project, the project analyst will have to determine such key matters as occupational needs to be filled, foreseeable changes in required skills, factors affecting parent or student motivation, and other factors -- particularly those pertinent to the locality where the project is to occur -- that will influence its success.

III. IMPORTANT FACTORS AFFECTING THE PROJECT

Projects in the educational sector cannot be judged feasible or infeasible on the basis of any single simple test, either economic or physical. A number of tests are needed. It is vital to assure that key elements affecting the project are taken into account.

Social and Institutional Factors: National Education Policy

Nothing is more important to education than the government's attitude and actions toward the essential elements of the project. Is the prospective project compatible with the government's expressed or implied educational policies and objectives? The essential elements will vary among projects, but the following elements (and others) are indicative of principal matters that should be considered in appraising the project.

- Institutional arrangements for control of the type of facility and the sources for continued financial support of the activity
- Scale of educational activities that government authorities contemplate and provide for
- Student-selection criteria for domestic institutions and for study abroad
- Goals on language use, particularly where multilingualism is a problem
- Orientation toward continuing research and evaluation of the existing educational system
- Means for involving political, tribal, religious, and other power influences in the shaping and execution of educational programs
- Degree of openness to innovation in teaching techniques, teaching arrangements, and curriculum

- Prestige and influence of senior officials assigned to the educational field
- Assurance of funds to maintain and operate the facility for the life of the project, including necessary supplies; assurance of funds and administrative policies to train and retrain teachers necessary for the project
- Availability of funds to support policies on student selection (tuition grants, stipends, etc.)
- Willingness and ability of government to bring the required infrastructure to the countryside
- Grant of flexibility to educational leaders to modify the curriculum in accordance with changing requirements in the society
- Requirements that projects in all sectors specifically identify training and educational requirements
- Legislation and regulations to assure that those agencies which control funds and have jurisdiction over personnel appointments will work with and not against the project
- A voice in the principal planning councils of government for a representative of the educational sector.

The Parent and Student

Education begins almost completely under the control of the parents and relatives of the child, and remains so for a long time. Have sociologists and anthropologists looked into the attitudes of parents in the community toward the proj[illegible]

- The content and orientation of the curriculum may have to be modified to make the project more acceptable to the parents and students.

Adjustments may be needed to account for local, religious, or ethnic customs on food, clothes, language, or on other aspects of the culture. Do the modifications seem apt and acceptable to the country?

Does the project recognize and respond to parental attitudes towards the apparent economic opportunities that are available as a result of schooling? Does the project seek to prove to parents that their investment in education will pay off? If so, how? Does the project go so far as to seek assured job opportunities for graduates?

Other Key Factors

Many of the factors already described that will shape the project and condition its success are external to it. There are other important matters having a direct bearing on the feasibility of educational projects. These include the factors discussed below.

Student and Teacher Availability

The CPA must assess the degree of assurance that can be attached to the estimated number of suitably qualified students available for attendance. Population density, family and religious considerations that may hold children on the farm, and transportation problems are only a few of the matters that should be considered in assessing likely attendance. Furthermore, there should be some assurance that conditions for learning (nutrition, time availability, health, financial support) will be sufficiently favorable to attract students.

The availability of suitable teachers is sometimes mistakenly assumed. Candidates may not appear because such conditions as pay, location of jobs, hours and working conditions, and competing seasonal demands (particularly in rural areas) are such that potential teachers turn to other employment.

Size and Location of Project

Accessibility to students and teachers may have an important bearing on both the size and location of the project. Economy of a larger sized unit must be weighed against the cost and convenience of transportation and possibly the cost of residence dormitories.

Weather and Other Seasonal Factors

The physical characteristics of the plant should be influenced by climate and other environmental factors. In some climates relatively inexpensive construction can be quite adequate. Weather will influence the need for transportation and may also affect the school calendar. The latter will also be influenced by peak labor requirements in agriculture as well as by holidays.

Health and Nutrition

Does the project give adequate attention to these aspects of student welfare? Are measures necessary to prevent undue absenteeism and the spread of disease through the student body? Is the provision of food a necessary condition for attendance?

IV. STEPS IN THE CAPITAL PROJECT APPRAISAL

Project preparation and appraisal consist of the following:

1. Identification of need for project and category of project
2. Formulation of alternative physical resource flow plans
3. Pricing the project
4. Selection of the most promising alternatives
5. Computation of rates of return
6. Sensitivity analysis of rates of return
7. Evaluation summary.

While the above can be discussed as discrete steps that will occur in the stated order, it should be recognized that in the course of carrying out these steps there will be considerable interaction. For example, in carrying out step 4, the analyst may find that other alternatives suggest themselves, so that he may find it necessary to return to step 2.

Projection of Need

The scope of work for an educational project will generally specify the population to be served and the nature of the education to be provided. A scope of work for a project may be derived from a sector study, a manpower survey or a total educational plan, or it may be an ad hoc solution to a "felt need." If a scope of work is not provided, the project analyst will have to develop one appropriate to the objective. To the extent that data ordinarily available from a sector study or a manpower survey are not available, the project analyst must collect such data on his own. As an absolute minimum, he must determine the extent of the need to be met by the proposed project. In addition, he must also determine the approximate budgetary limit on capital and current expenditures that the project must adhere to.

It is important to specify as precisely as possible the output that is needed, i.e., that capabilities that are desirable for students to acquire. The latter will be very dependent on the employment opportunities expected to be available.

Formulation of Alternative Physical Resource Flow Plans

Based on the needs identified, the project analyst will formulate promising physical resource flow plans. These flow plans must reflect some of the key considerations previously discussed, such as social and institutional factors, desires of parents and students, weather and other seasonal factors, and health and nutritional considerations.

Instructional Methods and Curriculum

Are institutional methods and the curriculum relevant to needs? What is the basis for the judgment? Has adequate scope been given to the use of mixes of teachers, audiovisual aids and other equipment, programmed instruction material, and correspondence course procedures? For example, for secondary schools in sparsely settled areas, expensive busing services and teacher costs might be reduced very substantially by greater reliance on self-study at home or in the resident village. The scope for self-study is probably greater in developing countries than in others because the possible and necessary selectivity of the student body is far greater.

Television is a new but fairly expensive medium for instruction. Experience has shown that the use of TV requires a highly trained, well-paid staff in addition to regular teachers and staff. There is also a cost for equipment, maintenance, and operation. However, with the use of TV cartridges and the availability of prepared courses, the economics of educational TV may change radically.

Intensity of Use of Physical Plant

To reduce the capital costs of education, the multiple use of the educational plant should be examined. Does the project examine the possibilities of double shifts or of a facility so designed that it can accommodate youngsters during the day and adults at other times, with equipment suitable for each?

Search for Alternatives

Does the project specifically address the issue of ways in which the project can be made less costly and can be modified to increase the value of its output? Comparisons among alternative forms of the project are needed, with the rate of return on the difference flow as a criterion for choice. Some alternatives that should be explored are

- Orientation of curriculum
  - -- Rural versus urban
  - -- General versus specific
- Large versus small school
- Schooling versus on-the-job training
- Adult education in addition to child education
- Indigenous college versus college abroad
- Teacher qualification for various levels
- Types of buildings
- Reliance on volunteers or peers
- Methods of selecting students
- Teacher-student ratios.

In the shaping of promising project alternatives, action coordinated with the needs of other sectors is called for (e.g., a change in curriculum consistent with local on-the-job training, the creation of curriculum coverage consistent with skill required in specific fields).

A factor that should be given close attention is that of enrollment attrition and its causes. Such attrition deserves close attention not only because it increases the cost per graduate, but because it can also provide important indications regarding the adequacy of curriculum and the effectiveness of teachers. The attrition rate may also reflect significant external obstacles, e.g., difficulties in access to school attributable to location or inadequate transport, family income constraints, etc.

The possibilities for projects are limitless, and the factors internal to the project will vary greatly. It is simply not possible to list here the many factors internal to a project that will influence its success. The essence of the CPA must be an examination of what is represented as the case for the project; the depth and quality of supporting evidence; the range of factors considered; the extent to which experience in the country and elsewhere has been drawn upon; whether generalized facts and opinions have been used in place of specialized expertise, and whether alternatives to achieve a given purpose have been examined.

Pricing the Project

Conversion to Value Flows

At this point in the CPA it is important for the analyst to be familiar with the pricing procedures described in the General Guidelines. In educational projects the parent-student interest would focus on out-of-pocket costs (at market prices) and foregone opportunities (at market prices). The ministry of education would be interested in market prices for budgetary purposes, but for national evaluation pruposes (NNRR) it would make use of shadow or accounting prices for inputs and outputs.

Delineating the Scope of the Project

It is necessary to determine what is embraced within a project. For a privately owned project (e.g., a shoe factory), the project embraces whatever must be paid for and whatever is received in payment. Looked at from a national point of view, the project coverage may be quite different. The project embraces whatever resources are consumed to make the project possible and whatever benefits are realized, no matter who pays the costs or receives the benefits. Also, because projects in education are almost totally publicly financed, these guidelines require that account be taken of all costs, both those privately and publicly borne, and all benefits as well.

Guidance follows on how to delineate a project in education so that its coverage corresponds to the national viewpoint just described. (See chapter III of the General Guidelines.)

Parents and students pay for some of the costs of education. There will be current costs for tuition, etc., and another cost in the form of earnings foregone by the student while he is attending school. The rate of return on the individual's investment in education can be calculated in the same manner as later described in this document for the nation's investment -- the notable difference being that the individual would calculate his costs and earnings at market prices instead of at the factor prices relevant for the net national rate of return.

Costs

- The project must be charged with all costs internal to it. They should be divided between capital and current costs -- the bricks mortar, laboratory equipment, salaries, current supplies, etc.
- The earnings foregone by students are a cost of the project. However, these earnings should be shadow priced. (See later discussion and General Guidelines, appendix B and chapter III.)
- It must also carry the costs of infrastructure -- roads, power, etc. -- expressly created for the project (perhaps a power plant or a road to some school or laboratory). If the infrastructure was to be created anyway, the capital costs can be ignored, but the charge for purchased services must be included.
- Similar decisions must be made on matters such as school lunches or health activities which may be part of the school program. In general, if these activities provide a kind,

quality, or quantity of good or service which would not otherwise be provided, the cost should be included as part of the educational package. For example, if the society would not feed the child except for his promise of greater productivity when he is provided with education, these ancillary costs would be part of the cost of education.

There may be investments that serve more than one project or purpose; for instance, a printing press that publishes school texts and other material not related to the educational project. If the cost of the press can be justified only insofar as both tasks are served, then all costs associated with the second task must be allocated to the other project.

Establishing the Cost for Project With Noneconomic Benefits

A country may propose an educational project because of noneconomic considerations. For example, society may prize persons with cultural skills or talents (religion, music, dance, poetry). Students can be oriented toward healthier personal hygiene and better nutrition; they can be given a sense of national unity; and they can obtain greater personal confidence and a disciplined attitude toward work (punctuality, responsibility, etc.).

For projects totally or substantially justified by noneconomic benefits, the project should find the least-cost (in net national terms) form of the project and should make clear what the cost is. It will generally be advantageous to determine the cost of such projects at various scales or levels of service and meaningful qualities. The means of so doing are described in the General Guidelines (chapter VI).

For this purpose the opportunity shadow cost of capital must be assumed. What is the basis used in the project for the selection of that rate? Common errors are to assume that it is the price at which the government borrows money or to consider it costless if it is received as a grant. Concessionary interest rates are not the proper basis for setting the opportunity cost. If the same resources required for the project could be employed at a higher rate of return in some other activity, it is that higher rate of return which should be used in the least-cost calculation for the educational project.

Benefits

In a consideration of benefits, natural counterparts to costs appear.

- In measurable economic terms, the increased earnings accruing to educated persons will be considered as benefits. The method of measuring these increased earnings is discussed later.
- Another benefit is the value of the services rendered to other activities benefiting from the infrastructure specifically created for the project, e.g., farmers' use of a rural road leading to and built expressly for a school. The increased output or higher price estimated for the farm product is the relevant benefit.
- Identifiable benefits from improved health and nutritional services and supplies are another benefit.
- The output of a separate but intertwined activity (e.g., printing) should also be considered.

The increase in earnings of educated persons compared to those of persons without education is a reliable indicator of the value of benefits when it is determined by market forces. To the extent that present and prospective educated persons receive payments that result from nonmarket forces, earnings may overstate the benefits of education. This qualification is particularly relevant where earnings are determined by family, racial or political connections or by class status, and where the level of earnings is set by administrative government action.

A subjective description of the noneconomic benefits of a project is properly included in the CPA.

Measuring the Cost of Education

As previously discussed, there are essentially two types of costs that are incurred by a nation in providing education. One obvious set includes expenditures for facilities, materials, and teachers' salaries, among other things. The other and less obvious cost is that of the national production that is foregone while students are in school. Does the project proposal recognize these twin costs? How does it go about measuring the latter in particular?

Production Foregone

While people attend school they may have to forego jobs. If there is not a surplus of labor, some sacrifice of production will result from the withdrawal of workers from the labor force, or their delayed entry into it, because of school attendance. This loss in production is a cost to the nation of providing education, a cost that should be weighed against the increased future productivity of an educated, trained (or more easily and quickly trainable) worker.

However, if students would be unemployed if they were not attending school, or would be replaced by otherwise unemployed workers of equal productivity, there would be no loss of production. If the students would be replaced by workers of somewhat lower productivity, the cost of education would equal the productivity of the students less the productivity of the workers that take their place. Again, this assumes that there is a job available for everyone, but this is very often not the case.

Practically speaking, labor is abundantly available in developing countries, except for specialized skills. Therefore, considering the rough orders of magnitude valid for a CPA, it is generally not necessary for the project to take into account the marginal productivity of labor in the student's age-educational group in order to calculate the production foregone. However, when the educational project deals with persons of special skills, it would be relevant to do this. The value of production foregone in this case has a special element to it. The shadow price for skilled labor may be above the market price for labor, while the wage of the replacement labor may correspond more nearly to its marginal productivity.

Table 3. Earnings[a/] Per Year by Age and Years of Schooling

Age	Years of schooling				
	0	6	10	12	14
6-7..........	30	--	--	--	--
8-9..........	50	--	--	--	--
10-11.........	75	--	--	--	--
12-13.........	90	125	--	--	--
14-15.........	110	200	225	--	--
16-19.........	120	300	400	600	800
20-24.........	130	400	500	700	1,000
25-29.........	180	500	600	800	1,200
30-34.........	180	500	700	900	1,400
35-39.........	200	500	900	1,000	1,600
40-44.........	200	400	900	1,200	1,800
45-49.........	200	350	900	1,400	2,000
50-54.........	150	300	800	1,300	2,200
55-59.........	100	300	700	1,200	2,400
60-65.........	50	275	600	1,100	2,200

a/ Figures are in units of currency and are illustrative.

under consideration and the existing facilities? It would be meaningless to base cost estimates for a technical school on the actual costs of a primary school.

Estimates of costs per student are best made in terms of:

- Capital outlays for buildings, equipment and site preparation
- Recurring expenditures for teachers' salaries and other operating expenses.

The cost per student derived from such general costs should be calculated for the general class of education that includes the project being investigated. Has each cost component been adjusted to take into account differences between the project and the type of educational activities from which the cost components have been computed? Thus, construction cost per student may have to be adjusted to account for the size and location of the project. Equipment cost adjustments would have to reflect differences in teaching methods. Teaching cost per student may be changed to reflect deviations of the project's student-teacher ratio from the average.

Has allowance been made for the cost of teachers' services that are not included in salaries? Generally the training of teachers is subsidized by free or low tuition, and stipends and salaries are set low to recapture some of this public expense. Thus a teacher might have received a subsidy of $2,000 during a 4-year teacher training course, and his salary during his first 5 years of service therefore would be $400 less per year than it would otherwise be. This $400 would be added to the annual salary of the teacher in deriving the cost from the national point of view.

Benefits of Educational Projects

As stated previously, measurable economic benefits from educational projects are the additions to the nation's output -- measured by the increase in earnings of individuals -- attributable to education and training. This difference could appear as shown in table 3. If possible, the project should present an earnings table relevant to the particular profession or skill to be supplied by the project. If, for example, satistical clerks are being trained to become computer operators, by how much can their earnings be expected to rise? The CPA should discuss the adequacy of the data used to establish the prospective earnings schedule. Is it based on different trends in demand for workers among industries?

Selection of the Most Promising Alternatives

Within the scope of work provided or derived by the project analyst, there will generally be alternative projects to meet the specified needs. For alternatives that meet the needs equally well, the procedures for determining least-cost alternatives described in the General Guidelines (chapter V) apply. There is substantial scope for increasing net benefits by trading lower attrition rates for higher out-of-pocket costs per student in attendance.

In addition, alternatives which do not provide levels of service that are as satisfactory may have to be given serious consideration because of budgetary limitations. The project analyst should be alert to these possibilities and should provide the cost of such alternatives to the decision-maker.

Computation of the Net National Rate of Return

In seeking to measure the justification for a project, the analyst should judge the project's worth in terms of the net national rate of return. (See General Guidelines, chapters III and VIII). Relevant worksheets for amassing data on costs and benefits and for deriving the rate of return are shown in tables 4 and 5. The proper setting down of costs and benefits is of great importance.

Direct Costs

Table 4 illustrates how the direct costs of education for primary school students could be shown. Cost data could be drawn from the experience of similar projects (with suitable adjustments). These costs would be expressed in terms of their relevant shadow prices (foreign exchange, unskilled labor,

Table 4. Illustration of Cost Estimates for Direct Educational Costs Based on Prototype Information (Annual Cost Per Student Based on Shadow Prices as Applicable)

Direct educational costs	Age of student					
	6	7	8	9	10	11
Building and equipment investment a/	30					-24
Supplies and books at public expense	2	2	2	2	2	2
Supplies and books at student's expense	1	1	2	2	2	2
Teachers' salaries b/	20	25	30	30	30	30
Miscellaneous	2	2	2	2	2	2
Total current cost	25	30	36	36	35	36

a/ Based on prototype project. Investment is assumed to start the year before entrance to school and the "salvage value" to accrue a year after completion of the sixth year of school. Plant is assumed to have an 80-percent salvage value at the end of the sixth year, reflecting the 18-year life of facility less use (60 percent) per first grades due to the dropout rate (use = 1/3 x .60 = .20).

b/ All payments plus allowance for subsidized training costs.

Table 5. Net National Return on Primary School Graduates for 1,000 Students Entering First Grade

Age	Student retention rate a/ (1)	Number of students b/ (2)	Life survival factor c/ (3)	Total number of graduates d/ (4)	Labor participation rate (5)	Number of employed graduate workers (6)	Current cost per student e/ (7)	Total current cost (8)	Foregone earnings per student f/ (9)	Total foregone earnings (10)	Building and equipment investment g/ (11)	Difference in earnings per worker h/ (12)	Total difference in earnings (13)	Total net return flow (14)	Discount factors 12 pct. (15)
Preschool..															
6..........	.80	1,000			.05		-25	-25,000	-30	-1,500	-30,000			-30,000	1.000
7..........	.80	800			.10		-30	-24,000	-30	-2,400				-26,500	.9454
8..........	.80	640			.10		-36	-23,040	-50	-3,200				-26,400	.8441
9..........	.85	512			.12		-36	-18,432	-50	-3,072				-26,240	.7537
10..........	.90	435			.15		-36	-15,660	-75	-4,894				-21,504	.6729
11..........		392	.9975		.20		-36	-14,112	-75	-5,880				-20,554	.6006
12..........			.9975	391	.27	106								-19,992	.5365
13..........			.9975	390	.33	129					+24,000	+ 35	3,710	27,710	.4790
14..........			.9975	389	.37	144						+ 35	4,515	4,515	.4277
15..........			.9965	388	.40	155						+ 90	12,960	12,960	.3818
16..........			.9945	387	.42	163						+ 90	13,950	13,950	.3409
17..........			.9965	386	.44	170						+180	29,340	29,340	.3044
18..........			.9965	385	.47	181						+180	30,600	30,600	.2718
19..........			.9965	384	.50	192						+180	32,580	32,580	.2427
20..........			.9944	383	.53	203						+180	34,560	34,560	.2167
21..........			.9944	382	.57	217						+270	54,810	54,810	.1935
22..........			.9944	379	.61	231						+270	58,590	58,590	.1727
23..........			.9944	377	.66	249						+270	62,370	62,370	.1542
24..........			.9944	375	.68	255						+270	67,230	67,230	.1377
25..........			.9935	373	.70	261						+270	68,850	68,850	.1229
26..........			.9935	371	.70	260						+320	83,520	83,520	.1098
27..........			.9935	369	.70	258						+320	83,200	83,200	.0980
28..........			.9935	367	.70	257						+320	82,600	82,600	.0875
29..........			.9935	355	.70	256						+320	82,240	82,240	.0781
30..........			.9935	363	.70	254						+320	81,920	81,920	.0698
31..........			.9935	361	.70	253						+320	81,280	81,280	.0623
32..........			.9935	359	.70	251						+320	80,960	80,960	.0556
33..........			.9935	357	.70	250						+320	80,320	80,320	.0497
34..........			.9935	355	.70	249						+320	80,000	80,000	.0443
35..........			.9924	353	.70	247						+320	79,680	79,680	.0396
36..........			.9924	350	.70	245						+300	74,100	74,100	.0353
37..........			.9924	347	.70	243						+300	73,500	73,500	.0316
38..........			.9924	344	.70	241						+300	72,900	72,900	.0282
39..........			.9924	341	.70	239						+300	72,300	72,300	.0252
40..........			.9909	338	.70	237						+300	71,700	71,700	.0225
												+200	47,400	47,400	.0201

Present value: +39,288

a/ Obtained from school records of planning factors.
b/ Column 1 X column 2 of previous year.
c/ Obtained from death rates of country or similar country. Illustrative rates obtained from 1966 UN Demographic Yearbook, table 19, "Death Rates Specific for Age and Sex." Particular survival rates used are derived from male death rates, Colombia, 1951.
d/ For age 12, column 2 X column 3 at age 11.
e/ From table 4.
f/ Earnings for 0 years of schooling from table 3.
g/ From table 4; factor multiplied by 1,000.
h/ Obtained from table 3; difference between 0 and 6 years of schooling.

and capital). See the General Guidelines for suggested ways of estimating and applying coefficients to convert market prices into shadow prices.

Actual Computation of Net National Return

Table 5 illustrates how to calculate the net national rate of return for a project providing children with 6 years of primary school.

For convenience, the computation was carried out for 1,000 students entering first grade. The age of the student is listed on the extreme left so that all variables can be related to it.

Column 1, "Student Retention Rate," is the rate at which students from one class pass on to the next. Thus, in the example, 80 percent of those entering the first grade pass on to the second grade. Such rates and even lower ones are not unusual in developing countries. The main causes of student attrition are socioeconomic reasons, rather than death. Attrition rates of students depend on local conditions.

Column 2, "Number of Students," is the number of students of the previous year multiplied by the student retention rate of the same year. As can be seen from the example, which is not an extreme one, the impact on the number of primary school graduates can be quite substantial.

Column 3, "Life Survival Factor," is determined by the formula: 1 - death rate. The annual death rate, by age group, is given per 1,000 persons for most countries in the United Nations Demographic Yearbook. The death rates used for the example were those for males in Colombia in 1951. For instance, in the 10-14 age group the rate is given as 2.5 (per thousand). The comparable life survival factor for that age group is 1 - .0025, or .9975. Where death rates are high and measures are being taken to reduce them, one might project lower death rates based on the experience of countries that had similar situations some years previously. The United Nations Demographic Yearbook can be very useful in this regard.

Column 4, "Total Number of Graduates," is the estimated number of workers who have graduated from the 6th year of school and have survived to the age given. For age 12 it is the number of 6th-year students multiplied by the life survival factor. For later ages it is the number of workers of the previous year multiplied by the life survival factor.

Column 5, "Labor Participation Rate," is the proportion of persons in the labor force who are employed. In the example it is implicitly assumed that the participation rate for graduates is the same as for nongraduates. If this is not so in a substantial degree, a more complicated calculation is required in which the differential participation rates are taken into account.

Column 6, "Number of Employed Graduate Workers," is the estimated number of workers who have graduated from the 6th year of school, who have survived to the age given, and who are employed.

Column 7, "Current Cost Per Student," is taken from table 4.

Column 8, "Total Current Cost," is column 2 multiplied by column 7.

Column 9, "Foregone Earnings Per Student," is the estimated earnings which students would receive if they were not attending school.

Column 10, "Total Foregone Earnings," is column 2 multiplied by column 5 multiplied by column 9.

Column 11, "Building and Equipment Investment," is based on table 4. It is assumed that a "seat" is supplied to each 1st-year entrant. However, because of attrition as well as an assumed 18-year life of the facility, after 6 years the average investment has been used up by 1/3 x .60, or .20. The .60 is a rough estimate of the average use of seats per entrant over the 6-year period. The figures entered represent the investment for 1,000 entrants.

Column 12, "Difference In Earnings Per Worker," is obtained from table 3 and is the difference between earnings of people with no years and 6 years of schooling.

Column 13, "Total Difference in Earnings," is column 6 multiplied by column 12.

Column 14, "Total Net Return Flow," is the algebraic sum of column 8, column 10, column 11, and column 13.

Column 15, "Discount Factors, 12%," is a list of the continuous flow discount factors which are applied to column 12 to obtain the present value of the total net return flow. If the present value exceeds zero, the return is greater than 12 percent. The discounting procedure should be repeated using a higher rate, perhaps 15 percent; if at the higher rate the present value of the surplus flow is negative, we know the internal rate of return is greater than 12 percent but less than 15 percent. The approximate internal rate can be obtained by interpolation.

A number of approximations in the calculation of table 5 would be satisfactory for most preliminary appraisals (or sector appraisals). However, depending on the country's conditions (death rates, different living conditions of students and educated workers) and the type of calculation (high school or professional school), somewhat different procedures and refinements may be required.

The implied assumption in table 5 is that the same life survival factor applies to students and nonstudents. Because of different living conditions (family, government support, effect of knowledge), in some circumstances the survival factors for graduates could be markedly higher than for nongraduates. In this case a more refined calculation may be necessary (separate life survival rates) or table 5 would underestimate the net national return. In most circumstances this would not be the case, largely because the high death rates lie outside the most relevant ages (6-50).

In principle, column 3 of table 5 should reflect disability as well as deaths. In most instances this would not make much of a difference.

Building and equipment investment (column 9) is clearly an approximation which is satisfactory where, as in primary schools, it is not a large item. For large one-time projects where buildings and equipment bulk large, a more elaborate allowance for building investments (like that shown in the example in the General Guidelines) would be more appropriate, along with more detailed student programming costs and benefits; that is, the calculations would be done in terms of actual students programmed rather than in terms of 1,000 students entering first grade.

Table 5 carries out the calculation for 35 years from the first year (age 6) to age 40. This underestimates the benefits somewhat. Although in principle the calculation should be carried out for the lifetime of the worker, in the illustration the difference will be small, reflecting the fact that beyond 35 years the discount factor at 12 or 15 percent becomes quite small and life survival factors also start decreasing more substantially. Factors that would make longer periods of calculation necessary would be lower discount factors, longer periods of schooling, and longer working lives with peak earnings reached rather late in life. All factors but the first would characterize professionals, so that in general we can say that the more professional the training, the greater need for longer periods of calculation.

For the project illustrated in table 5, at 12 percent, the present value of the net national flow is positive, indicating that the internal rate of return is in excess of 12 percent. If the opportunity cost of capital in the economy is 12 percent or less, the illustrative project represents an economical use of resources in that particular economy. Any benefits other than those reflected in the increased productivity of graduates, as measured by higher earnings, would be in addition to those reflected in the NIRR. Such benefits would include not only the unquantified benefits accruing to graduates and to society at large but also partial benefits accruing to those who left school before the 6th year.

Sensitivity Analysis

Sensitivity analysis should be used in appraising many development projects (General Guidelines, chapter VII). The values placed on the outputs of the project and the cost of inputs may be sensitive to many factors. By judging the sensitivity and the probability of the event occurring, the analyst can present conditional judgments on a project's worth; he can identify key factors requiring more detailed study and in general can seek to guarantee or safeguard the project against some types of risks. For example, if a project's worth would be upset by a failure to have a sufficient number of teachers available, greater emphasis would be placed on assessing the availability of teachers.

Rates of return to educational projects are extremely sensitive to the society's future supply and demand for educated persons and the opportunities for productive employment of such persons. These are reflected in the values provided in table 3.

A project may be sensitive to other developments in the sector or in other sectors. For example, how will the demand for liberal arts graduates be altered by the rate of overall economic growth or by changes in the make-up of the national budget that are favorable or otherwise to the social sectors?

If the demands for the graduates are closely linked to a specific event, such analysis is relevant. Also, if the availability or cost of inputs is highly speculative, further analysis is again called for.

For certain types of educational projects which recur (such as primary schools), the cost limits (such as building and current operating costs) are likely to lie within a narrow range. For such types of projects, one need not be concerned with potential variations and there is no need for sensitivity analysis. For one-of-a-kind projects that are novel for the country, costs are likely to be more uncertain and are therefore more likely to require sensitivity analysis.

Since there is replication over time for many types of educational projects, there is economy in having prototype projects analyzed for sensitivity in a sector study. The project analyst can make use of results from such sensitivity analysis, perhaps modified by special local factors. This can free the project analyst to concentrate on manners in which the orientation and content of the project can give greater assurance of the productivity of graduates.

It may be valid for the project to be subjected to continuing sensitivity analysis, providing for periodic evaluation of previous estimates in the light of current developments.

Once sensitivity has been analyzed, the rate of return on the project should be recalculated, taking into account the likelihood of occurrence of the event that would significantly alter costs or benefits. What begins as a rate of return of 12 percent might then appear as 10 or 16 percent, given certain assumptions on the events occurring.

Evaluation Summary

In accordance with the General Guidelines (Appendix C) an evaluation summary should be prepared in which the major findings are presented for consideration. In the presentation of findings of CPA's in the field of education, it is especially important that the full range of extra or noneconomic benefits be placed before those persons who will make the decision on the project.