
UNIT 2 FEASIBILITY AND TECHNICAL ANALYSIS

Objectives

After studying this unit, the student will be able to:

- understand what is meant by feasibility studies in the context of selection & evaluation of projects
- explain in general how feasibility studies are conducted, and what parameters are considered
- understand in particular the importance and salient features of commercial & technical analysis.

Structure

- 2.1 Introduction
- 2.2 Nature of Project Decision
- 2.3 The Project Development Cycle
- 2.4 Opportunity Studies
- 2.5 Pre-feasibility and Feasibility Studies
- 2.6 Technical Analysis
- 2.7 Summary
- 2.8 Self-Assessment Exercises
- 2.9 Bibliography and Further Readings

2.1 INTRODUCTION

In this unit we will discuss the context and mechanics of conducting feasibility studies for projects. We will particularly study, in a relatively greater detail, the different aspects of techno-commercial analysis of projects.

2.2 NATURE OF PROJECT DECISION

Project decisions are usually complex and long-term investment decisions involving commitment of not only financial but also other valuable resources, including personnel, facilities and time. These aim at the creation or improvement of new products or fixed assets (like land, buildings, hospital, factories, roads, power stations etc.) to meet certain needs and objectives of the investor. All such decisions, whether in public or private sector, necessarily entail some risk due to their future orientation. The risk may arise from miscalculate resources, from cost- and time- overruns, setting up of non-viable units, or building up excessive capacities, for example. Magnitude of this risk can be reduced considerably by following a rational procedure in which -

- a) a sufficiently large number of good-quality **alternatives**, whether mutually exclusive or otherwise, is generated for consideration,
- b) reliable and adequate **information** is gathered about each alternative including its sub-options, and
- c) the sub-options and the alternatives are (in that order) subjected to systematic and objective **evaluation** in relation to technical, economic, financial, and other pertinent parameters for selection of the best course of action.

Most industrial and commercial projects require large outlays and are highly involved on account of geographical, technological, economic, environmental, legal and other factors



including trans-national dealings. Once resources are committed to them, it is rather difficult to retract without suffering large losses. It is, therefore, important that project decisions are taken after much careful consideration, so that the scarce resources are utilised in the most effective and economic manner.

On the other hand, rigorously following the steps outlined above may prove too time-consuming and costly. For example, while considering the setting up of a new steel plant, several man-months and lakhs of rupees may have to be spent to analyse the viability of all alternate processes/technologies and to evaluate the costs and benefits associated with each. And after going through this elaborate exercise the results may leave one with no alternative but to abandon the proposal! It is, therefore, desirable to proceed in this matter in a systematic, but are minimised, if not avoided altogether. Such an approach not only yields better project decisions but also assists greatly in project implementation.

2.3 THE PROJECT DEVELOPMENT CYCLE

A typical project would go through a **development** process having the following three distinct phases:

1. **pre-investment** phase, leading to the authorization (investment decision) for a particular project idea under prevailing conditions;
2. **investment** phase, involving detailed design and actual implementation, leading to fructification of erection of relevant assets;
3. **operation** phase, following the "commissioning" (or start-up) of the completed project. Now the project would hopefully produce 'the stream of "benefits" for which it was originally conceived.

We shall briefly examine these phases in the following paragraphs, before proceeding to study the main subject matter of this Unit in greater detail.

1. **The pre-investment phase.** This phase would usually involve the following four stages:
 - a) **Identification** of relevant investment opportunities (or project ideas) through appropriate type of *opportunity studies*;
 - b) **Preliminary filtration** of the project idea(s) through *pre feasibility studies*;
 - c) **Project formulation**, resulting in the detailed (*techno-economic*) *feasibility report* for the each project idea considered worthy of further examination at the previous stage;
 - d) **Final evaluation and decision.** This is to be based on pre-selected, clear, and objective criteria derived from legitimate and reasonable expectations and requirements of various stakeholders, and culminates in the *evaluation report*.
2. **The investment phase.** This phase involves several inter-disciplinary tasks and has the following four stages. A task-force approach has generally been found to give the best results for successful conclusion of this phase.
 - a) **Negotiation & Contracting.** In this stage basic *specifications* for project plant & equipment are drawn up. (usually with the help of technical consultants), bids or tenders invited and evaluated, and legally enforceable duties and responsibilities of different parties (like, for example, the owners, financiers, technical consultants, know-how providers, equipment suppliers, architects, and one incorporated into contracts, *with* expert legal assistance for the more crucial aspects.
 - b) **Detailed Project Design & Engineering.** This covers detailed site investigations and tests; design and approval of plant lay-out, preparation and approval of *engineering* drawings and blue-pints, time schedules and PERT charts, final selection of technology and equipments, and detailed estimating of costs.



- c) **Construction & Erection**, involving actual construction, erection, or installation and work, interpretation and follow-up of the contracts, project management, and making suitable changes in design & engineering on account of unforeseen factors and changes in scope.
 - d) **Trial Runs, Commissioning and Optimisation**, followed by handling over of the *proven* project by the contract (s) to the management or owners.
3. **The operation phase.** This phase involves day to day operation of the completed project, and is expected to yield results which meet the original objectives for which the project had been conceived, formulated and implemented.

2.4 OPPORTUNITY STUDIES

While no investor, whether an individual or an organisation, would like to miss out on profitable opportunities to either enter a new, attractive business, or to expand an existing business, not all opportunities are worth being so pursued. The task of sifting the two types of opportunities is facilitated by opportunity studies.

Identification of suitable industrial or commercial opportunities for investment necessitate, first and foremost, a delineation of the objectives of the investor. These should be carefully prioritized and as far as possible quantified, to reduce vagueness. Secondary, the investor needs to become aware of the existence of possible investment opportunities. Information brought out by various sources can be helpful to him in this direction. In India, such sources include government departments, various Chambers of Commerce and Industry (e.g CII, FICCI, NAFEN, PHDCCI and ASSOCHAM), National Small Industries Corporation, and several other institutions including the business press, CMIE, etc. They regularly publish valuable data and analytical reports about the trends of demand, supply, costs, installed and proposed additions to capacities, etc, in various segments of industry and business.

Another way of going about this part of the pre-investment studies is to carry out a systematic analysis of the following (illustrative) list of items. This is likely to reveal a number of potentially viable opportunity alternatives to an investor without much expenditure.

- a) Agricultural outputs which can be processed further; e.g., soya can yield soya flour, proteins, protein concentrates, refined soyabean oil, etc.
- b) Packaging for various types of products (e.g. commercial, industrial, consumer durables, semi-durables, processed foods; etc.)
- c) Forest produce and related industries; for example, timber rubber, paper, boards etc.
- d) Substitutes of scarce items; for example, wood substitutes like concrete sleepers (for railways), metal frames for doors and windows, PVC partitions, and moulded plastic furniture.
- e) Existing, and new, consumer products (durables or otherwise) for which demand is expected increase owing to favourable social, income, health demographic or other changes; for t.xample,'automobiles, personal computers, washing machines, LPG stoves, hair dyes, etc.
- f) New and rapidly growing demands in service sector; for example, credit cards, information, databases, data,processing, financial intermediation, time-shared holiday; resorts, marriage bureaus, etc.
- g) Current imports, to identify opportunities for their local manufacture (import substitution) or for developing substitutes.
- h) Manufacturing/service sector items successful in other countries with similar levels of development, capital, labour natural resources and economic background.
- i) Possible interlinkage with other industries, indigenous or international.
- j) Extension of existing products/services by backward or forward integration; for example, a downstream TV unit for a company manufacturing picture tubes, or an



- k) Diversification into related (or even unrelated) areas of activity, in which the investor's existing strengths are particularly helpful.
- l) Emerging new technologies/processes; for example, genetically engineered medicines & pesticides, cellular telephones, parallel computing, etc.
- m) Expansion, or modification/ modernisation, of existing facilities to attain economies of scale or technological benefits.
- n) Incentives offered by local government for new units in specific sectors/locations.
- o) Economic & industrial policies (e.g. duties and import or export restrictions) of local and foreign governments.
- p) Export possibilities in areas having the benefit of comparative advantage. For Example, export-oriented labour-intensive units in a cheap-labour country, or ore-benefaction plants for exports to a nearby country lacking in the resource.

By their very nature, opportunity studies are indicative rather than detailed and hence are generally based on macro-parameters and rough estimates. Such studies may also be carried out at a more general (or macro) level to identify opportunities in one of the following three directions:

- a) a given geographical area (**Area studies**).
- b) a specific sub-sector of economy or industry, like food-processing, pharmaceuticals, or power generation (**Sub-sectorial studies**).
- c) exploitation of renewable and non-renewable natural, agricultural, or industrial produce like minerals, sugarcane, flash, fish, plants, and even geothermal energy sources, etc. (**Resource-based studies**).

Outlines of these general opportunity studies are given below to familiarise the reader with their nature and scope.

OUTLINES OF GENERAL OPPORTUNITY STUDIES

A. Outline of an Area Study

1. Basic Characteristics of the area:
 - a) Geographical location;
 - b) Size;
 - c) Important physical features (e.g. forest, agricultural, sandy, undulating, hilly, riverine, rocky, water-logged, etc.);
 - d) Contour maps;
 - e) Environmental sensitivity, if any.
2. Population size, and socio-economic data including background, employment and educational pattern and per-capital income, in the context of the country or state.
3. Major exports from, and imports into, the area.
4. Basic exploited and potentially exploitable factors of production (land, labour natural resources, etc.)
5. Structure of any existing manufacturing or service industry utilizing local resources.
6. Infrastructural facilities (like transport, power and telecommunications) necessary for developing new business or industry.
7. A comprehensive check-list of industries or businesses that can be developed exploiting the resources and facilities available in the area.
8. Revision of the above check-list of industries or businesses by excluding the following:
 - a) Those for which present or anticipated local demand is too small and cost of transportation to other markets (including export markets) too high to yield acceptable profit levels.
 - b) Those facing rather insurmountable competition (local, or from nearby areas).



- c) Those which should and can be more favourably locate in other areas. and
 - d) Those for which the vital feeder organisations or industry are located too far away.
 - e) Those for which the area's characteristics are not suitable.
 - f) Those which do not meet the investor's priorities and resource allocations.
9. Estimates of present and expected demand-supply gaps based on other studies or publisher data.
 10. Identification of approximate economic sizes of new or expanded business or industrial units, after considering estimates of both costs and revenues.
 11. Estimated lump-sum capital costs of selected industries/businesses, taking into account
 - a) Land, including site development;'
 - b) Essential civil works (buildings & outdoor works);
 - c) Technology or technologies;
 - d) Plant & Equipment (Main, Auxiliary, Standby, and Service);
 - e) Project implementation;
 - f) Preliminary expenses including for feasibility studies;
 - g) Working capital requirements.
 12. Approximate operational requirements of major inputs for each project, classified according to the source of supply (local, national, imported). These should cover:
 - A. Material inputs
 - a) Raw materials (e.g. coal for a thermal power plant),
 - b) Processed materials (e.g. coke for a steel plant),
 - c) Manufactured goods (e.g. castings for a car plant),
 - d) Auxiliary materials (e.g. steel scrap in an integrated steel plant), and
 - e) Spares and other materials for plant & machinery.
 - B. Utilities like water, electricity, steam, gas, telecommunications, etc..
 - C. Manpower -managerial, technical, and other.
 - D. Information.
 13. Estimate of production cost based on item 2 above.
 14. Estimates of annual sales revenues and impact on market share/product-mix.
 15. Organizational and management aspects of project sponsor(s) or potential enterprise.
 16. An indicative time schedule for implementation.
 17. Total investment contemplated in projects and peripheral activities like development of infrastructure, promotional activities, stock-yards, etc.
 18. Source of finance visualized.
 19. Estimated requirements/savings/earnings of foreign exchange.
 20. Financial appraisal giving approximate pay-back period and rate of return on investment.'
 21. Indicative estimates of overall economic benefits (e.g. balanced regional growth, savings or earnings of foreign exchange, generation of employment, reduction of social disparities.

B. Outline of a Sub-sector Study

1. The place and role of the sub-sector in the economy.
2. The size, structure and growth rate of the sub-sector.



3. The present size and rates of growth of demand of items in the sub-sector which are
 - a) not imported,
 - b) partially or wholly imported.
 4. Rough projections of future demand for each item.
 5. Identification of the items in short supply that have good growth and/or export potential.
 6. A broad survey of the raw materials available indigenously.
 7. Identification of opportunities for development using items 2, 5 and 6 and factors like infrastructure, transport costs, etc.
 8. Identification of approximate economic sizes of new or expanded business or industrial units taking into consideration economics of scale in production and sales.
- 9-19. See items 11 to 21 of Section A.

C. Outline of a Resource-based Study

1. Nature of the resource, its prospected and proven reserves, past and expected future growth rates of its extraction/utilization, and future potential.
 2. Role of the resource in national economy, pattern of its utilization and demand in the country, and exports.
 3. Industries presently based on the resource, their status (e.g. small-scale, private, public) and growth pattern, capital employed and manpower engaged, productivity, future plans and growth prospects.
 4. Major constraints and conditions in the growth of industries/businesses based on the resource.
 5. Estimated growth in demand and prospects of export of items that could utilize the resource.
 6. Identification of investment opportunities based on items 3, 4 and 5, and of costs, availability and requirements of factors like transportation, power and water.
- 7-17. See items 11 to 21 of Section A.

2.5 PRE-FEASIBILITY & FEASIBILITY STUDIES

As pointed out in Section 2.3 above, after *the identification stage*, the project ideas are subjected to a process of preliminary filtration through *pre feasibility study*. This involves the study of the project idea at a **more elaborate level** than that carried out at the opportunity study state. This is an intermediate stage between an opportunity study and a full-fledged feasibility study primarily designed to probe relatively doubtful project ideas. This stage is recommended to be followed when **project formulation**, or a detailed **techno-economic feasibility study**, which would enable the investor to arrive at definite decision about the project is both costly and time consuming. However, but for the difference of depth of analysis and the level of detail in the study, the pre-feasibility study is on the pattern of the main techno economic feasibility study. Of course, if the preliminary projections thrown up at the stage of opportunity study are themselves quite encouraging or decisive, pre-feasibility study stage may be ignored and one may straightaway take up the feasibility study itself. A pre-feasibility study should not normally take more than three months to complete, and on the basis of its results the investor should be able to decide:

- a) whether the project can be straightaway accepted or rejected,
- b) the project requires a detailed analysis (i.e. a feasibility study), or
- c) some aspects of the project need to be subjected to special investigations or studies such as market *research*, physical or mathematical modelling (e.g. for a complex nuclear plant), site surveys, laboratory tests, etc.



The basic aspects which need to be considered at the stage of pre-feasibility study are quite similar to these dealt with earlier. For example, the first step would focus at the existing gap between the demand for and supply of the product (or service). This has to be refined further in terms of the **future** scenarios that are likely to emerge during the life of the project and estimates of sales' made at different levels of market penetration. Next, the investor has to look at the availability and costs of essential factors of production like land, labour, materials, technology, plant & machinery etc., which would determine successful execution and operation of the project. Finally, operational costs like overhead, wages, expenses and revenues have to be estimated at different levels of plant utilization.

As it is not practical to discuss all such aspects for various types of investment alternatives here, we will take a look at UNIDO'S outline of pre-feasibility study only for industrial projects, a modified version of which is given below.

Outline of a Pre-feasibility Study

1. **Executive Summary :** Gives the title, brief description and objectives of the proposal, and a summary of all the essential findings and recommendations of the study in about two pages.
2. **Project background and history :** Identifies the project's sponsor(s) and gives a chronological account of the project and various studies, surveys or investigations carried out, alongwith their results.
3. **Analysis of demanded supply:**
 - a) **Demand capacities and market :** Outlines profiles of customers and their needs, estimates of present and future trends of gross demand, production capacities set up and their utilization levels, and imports/exports. Describes the characteristics, potential and role of the industry in national and regional economy, and government's policy towards it.
 - b) **Sales forecast and marketing:** Covers the qualitative and quantitative aspects of competition to the project, distributional requirements of the product/ service. Proposes viable sales organisation and sales programme, giving estimates of annual revenues and costs of marketing and sales (in local/foreign currencies).
 - c) **Production programme:** Proposes production levels of products and by-products. Estimates consequential wastes and emissions (solid/liquid/gas), and annual expenditure on their disposal or treatment.
 - d) **Plant capacity:** Determines feasible normal plant capacity (i.e. the production level achievable under normal working conditions duly taking into consideration the feasible equipped capacity; holidays; stoppages for' shift-change, tooling, preventive maintenance and repairs, and other reasons; and nature of the production process - continuous, batch or job) and specifics quantitative relationship(s) between sales, plant capacity, and major inputs.
4. **Analysis of inputs:** Gives approximate requirements of raw, semi-processed/ processed materials, utilities auxiliary materials, tools and spares, etc. alongwith availability, sources or supply and estimates of annual costs (local/foreign).
5. **Location and site:** Recommends geographical location and sitting of the plant/ facilities and specifies essential related activities and cost-estimates.
6. **Engineering & technology:** Describes in suitable detail,
 - a) the exact scope of the project,
 - b) technology(ies) and processes that can be applied to the project considering the proposed capacity, location, and nature of inputs, and estimates of costs (local/ foreign) of the inputs.
 - c) rough *layout* of the basic plant & equipments (covering production/auxiliary/ service equipments) and related costs (local/foreign), and
 - d) *Civil engineering works* (covering site preparation and development, buildings & structures, special civil works, and outdoor works) together with rough cost estimates (local/foreign).



7. **Organisation:** This gives,
 - a) an outline of one recommended organisation structure for production, sales, and administration; and
 - b) estimates of overhead costs (covering factory, administration and financial arrangements).
8. **Manpower:** Provides estimates of manpower requirements in different categories of levels and skills, alongwith estimates of annual direct and indirect costs of manpower, for different years of operation.
9. **Execution schedule & methodology:** Gives a rough time-schedule for implementing the project, and estimates of costs to be covered during the implementation phase. Broadly outlines the approach recommended to be followed for implementation, e.g. turnkey contracting, in-house construction, item-rate contracting, etc.
10. **Financial & economic evaluation:** This covers -
 - a) estimates of total costs of investment and their cash-flow pattern,
 - b) proposed capital structure, modes of financing, and annual financial costs (interest, lease-charges, etc.)
 - c) estimates of total fixed and variable costs of production
 - d) financial evaluation of the project, in terms of -
 - pay-back period
 - break-even point
 - return on investment
 - internal rate or return
 - e) economic evaluation of the project using cost - benefit analysis (based on relevant show price for goods, services and foreign exchange.
 - f) cost-effectiveness analysis for projects whose benefits cannot be quantified in money terms relative changes in the project's Net Present Value, Benefit-Cost ratio, or IROR with respect to marginal variations in key project variables like sales, product-milk, capacity utilization, operating costs, etc.

As compared to a pre-feasibility study the analysis involved in a feasibility study in much more rigorous and requires specialised skills of a higher order, even though the basic framework is similar to the outline presented above. Further, it is usually based on additional, and more reliable, data especially gathered through research, surveys, pilot plant studies or tests for the project idea, its location, and its techno-economic environment.

One must not lose sight of the fact that a feasibility study is basically an aid to decision making, and hence the deployment of time, money, and other resources on it should never be allowed to outgrow the potential benefits that it may hopefully yield. In terms of time, it has been preceded by a pre-feasibility study. Moreover, it should be able to generate capital cost estimates with a margin of error not exceeding 25% and help the investor to decide whether to abandon, postpone, or go ahead with, the project, Its findings should also help one to assess the relative strengths and weaknesses of prospective participants in the project at the negotiation stage in the investment phase.

It seems appropriate to strike another note of caution. This relates to the fundamental distinction between form and content. In other words, even if a feasibility report has systematically covered *all* the relevant aspects, it may still lead to an incorrect project decision if -

- a) the project formulation suffers from incomplete or inadequate data; or
- b) the underlying data or assumptions are unrealistic or incorrect or incorporate excessive safety margins; or
- c) the report has been deliberately tailored to meet (or fail) acceptance criteria, for example by inflating (deflating) revenues and deflating (inflating) outlays; or
- d) unknown or unpredictable factors intervene.



2.6 TECHNICAL ANALYSIS

In this Section we will examine how the technical aspects of a typical project idea can be scrutinized in detail to evaluate its technical feasibility, as distinct from commercial, financial, economic and managerial feasibility. For the sake of comprehensiveness we will cover *Environmentat Impact Analysis* (EIA) also, as a part of this analysis. While the various aspects to be examined will obviously vary from project to project, the following summary covers the more common ones briefly.

1. **Objectives:** First, the project proposal must fall within the ambit of the stated *mission* of the sponsor(s). Next the proposal must be able to further the objectives and priorities of the sponsor(s). These must therefore be ascertained and clearly recorded, alongwith detailed specifications for the output (product/service). Together, these constitute the basic frame of reference for all future decisions.

The private sector would usually expect a project to earn a high enough profit, i.e. a stated level of return on investment. Only for core projects (which are intended to basically support other highly profitable projects) may this requirement be relaxed. In contrast, the public sector generally has multiple objectives and profitability normally takes a back seat. In either case, it is essential for the project analyst to keep the organisation's objectives - a alongwith their inter-se priorities - in sharp focus, to ensure that his efforts follow the correct direction.

2. **Location and site:** Initially, as many locations as possible should be identified which meet the most fundamental operational requirements of the proposed project. These should then be evaluated and an optimum location selected using the criteria of material versus market orientation (see note below), quality standards, infrastructural status, local laws, and socio-economic and living conditions. Within the geographical location so selected, alternative sites are similarly identified and the most optimal one selected after considering factors like terrain, local climate land its impact on plant & equipment and their operation), availability and cost of land (plus its development), local infrastructural facilities and their costs (power; water: road/ air/water transport; telecommunications; etc.), socio-economic conditions, availability and quality of labour and construction equipment, valid waste disposal alternatives and their costs, local living conditions, public policies, local law, and taxes, etc. [Note: Resource-oriented projects like mining of minerals involve items like geological analysis covering geological structure, hydrological conditions, characteristics of the resource, resource reserves, prospecting status, and expected geological problems.

The locational decision should be made after giving due consideration to various benefits and incentives offered by governments or local bodies for setting up production or service facilities in certain specified areas. These may include assistance in the form of or in respect of capital loans and grants, tax, concessions, clearances, subsidies, infrastructure, etc. One way to do this is to evolve (or use available). Location Cost Indices (LCI) for different sites. If the cost (in a specified currency) of setting up a plant is C_A at location A and C_B at location B, the LCI for location A is defined as $100 \times C_A/C_B$. If reliable values of LCI for different locations, whether within one or more countries, are available, the selection of an appropriate location becomes a bit more easy. Such valuable information is however kept a closely guarded secret by a consulting company and is therefore difficult to come by.

3. **Plant Size:** Determination of an optimum plant size is critical to the success of a project. A plant represents sunk costs and any under utilisation of its capacity means either reduced profits or, for levels below the Break-Even Point, losses. The adverse impact of an extra-large capacity is felt all the more keenly during the early years when profits are all the more important for survival. It is therefore normally better to err on the lower side and to build a plant having a capacity that is likely to be fully utilized quickly, rather than to go in for a large capacity in the fond hope of a growing share of the market.

In a feasibility study, one-begins by looking 'at projections of the demand-supply



gap in the market and anticipated arrives' at the possible range of project sizes after considering various constants like availability of materials, technology, equipment, public policy (for example, a large company may be precluded from setting up capacities beyond a size) and finances, etc.. The best possible size of plant & equipment is then recommended after analysing the availability, economics, and practicability of different size options.

4. **Technology:** The same product or service can generally be obtained using quite different technologies. Electricity, for example, can be generated using solar panels, coal (thermal plants), hydraulic power plants, nuclear power plants and so on. Basic telephone Sol-vices can similarly be provided using manual, semiautomatic, or automatic exchanges. And, even the last-named category is available if] various technological versions like Stronger, Crossbar, Analogue electronic and Digital electronic. Needless to say, the latest technologies usually represent many improvements over the existing or older ones. They may also offer certain unique features. However, newly emerging technologies may have some inherent dangers as well.

What is important for formulating a successful project is to weigh available alternative technologies and select the one that is most appropriate in the prevailing situation, rather than blindly adopt the latest, state-of-the-art technology assumin^g that it will work since it works elsewhere. A technology is considered appropriate only if it is assessed to be satisfactory, and relevant, vis-à-vis the following aspects in lie specific situation of the project.

- Specifications of the task/product
- Task uncertainties and interdependence
- [Especially for public sector] Developmental imperatives (e.g. growth of employment; maximising use of local resources; reduction of disparities in income levels)
- Required gestation period versus the time actually available of the project.
- Source(s) and ease of availability. [Remember the Cray super computer deal between USA and India'?)
- Indigenous availability of comparable technology
- Field validation status in comparable situations. If necessary, field trials may have to be set up.
- Adaptability to the qualitative characteristics of the locally (or indigenously) available resources including energy and efficiency in their usage
- Dependence on nonrenewable sources of energy
- Capacity of the organisation to absorb/adopt the technology
- Required operational parameters of ambient environment. For example, a technology which has proven itself in cold climates may fail in tropics. ,
- Timely availability of manpower with requisite skills for installation, operation and maintenance
- Cost of' acquisition, installation, repairs and maintenance versus availability of funds (local/foreign)
- Safety characteristics
- Requirement or availability of R & D facilities • Environmental and sociocultural sensitivities
- Likelihood, and time frame, of obsolescence

After the existing technologies have been ranked on the basis of the above point, these have to be further assessed vis-à-vis acquisitional aspects. viz., the available modes of procuring it and the associated costs in focal or foreign currencies. The important questions to be asked include: Is the technology available as a technical know-how, or through a technical collaboration, or a joint venture? Are patents, trademarks, or licensing involved? At what terms and with what legal obligations'? Will it tie down the investor to procure equipment(s) as well from a specific country or company?



5. **Design, Layout & Plant & Machinery:** The feasibility study should broadly specify the recommended design of the processes and plant (giving essential assumptions and design calculations). It should also present a rough layout of various facilities and list out all the major equipments needed, with key specifications and available source(s) of supply. Moreover, it should consider, and evaluate, alternative equipments as well and give reasoned recommendations about them.

The importance of thoroughness of planning at this stage of the feasibility study can hardly be overemphasized. Many delays, cost overruns, and even failures of projects can be avoided provided the design and physical formulation of the project are based on a sufficiently deep analysis and have the support of the owner at the highest level. Otherwise, the project is likely to encounter mid-stream changes, with untoward consequences. There is a general impression that "minor" midstream changes would not pose much of a problem. This is not so. A project is a multi-task entity with complex linkages and interrelationships between its various constituents, and even "small" changes, which may result in certain made-to-order procured equipments being rendered unsuitable and thus throw the project schedule and costs haywire.

The aim of all the efforts at this stage is to design a viable operating entity which not only works, but works harmoniously (and with minimum costs) in relation to the stipulated inputs and local environment. Apparent as well as latent and relatively infrequent factors having a bearing on the effectiveness of the project must therefore be identified and considered. Neglect of climatic and geographical aspects (e.g. monsoons, floods, snowstorms, dust-storms, heat/cold-waves, earthquakes, typhoons, etc.) at this stage can prove quite costly later on. It is equally important to ascertain and give due consideration to local industrial and safety standards.

6. **Construction Process:** This needs to be tackled in the feasibility study in terms of its five aspects, First, the methodology to be followed - viz., capital intensive or otherwise and its feasibility under prevailing conditions. Second, whether the construction or installation is to be done in-house, or on a turnkey basis, or by farming out a number of contracts for different work packages, and their feasibility. A recommendation may also be made whether any special agency(ies) should be engaged as a part of backup or contingency arrangements for critical activity(ies). Third, the determination of such construction equipments, materials and other essential inputs (like cement, sand, steel, stores etc.) as are to be arranged by the owner, alongwith their alternatives, availability, source of supply (local/foreign), lead-times, and infra-structural requirements (like uninterrupted supply of power, clean water, gas, steam, etc). Fourthly, the recommended sequence and time schedule of different activities in the form of a bar-chart/PERT network. Lastly, assessment of the financial implications of this phase based on the latest available unit costs and with provision for inflation and contingencies.
7. **Inputs:** These relate to the operation phase of the project, but need to be identified at this stage of the feasibility study to examine the technical feasibility of the proposed system(s). For this, classification of the inputs into following categories will be found useful.
- raw materials,
 - processed materials,
 - components & sub-assemblies,
 - spares and wear & tear parts,
 - water & steam,
 - gas, fuels and electricity.

Next, their qualitative and quantitative requirements (including buffer stocks, where applicable), availability, feasibility alternatives and reliable sources of supply should be carefully ascertained and record. The problems involved in their storage and handling should be also assessed.

8. **Infrastructural Facilities:** Availability and characteristics of roads, bridges, railway facilities (like station, yards), air transportation, waterways, ports, etc. depending



upon their relevance to the assessed requirements of the project at both implementation and operation stages need to be studied. After studying the appropriateness of the infrastructure existing around the project location, the infrastructural requirements at the project site itself. A large part of the land area is normally required to be reserved for service roads, storm water mains, railways, over-ground or overhead gas, steam, and air pipelines, water reservoirs, and even harbors for certain large-scale industrial projects. A detailed study of all such requirements, and of their implications in terms of time, resources, and approximate costs is necessary to avoid surprises later on.

9. **Manpower:** The availability in needed numbers, of manpower of requisite skills where and when required, has to be studied. This covers both the project implementation and the operation (& maintenance) phases. In case imparting of training is also involved, timely availability, and costs, of the training facilities have also to be assessed.
10. **Environment Impact Assessment (EIA);** This study -
 - a) identifies the environment in which a project is to be implemented,
 - b) assesses the short -- and long-term impacts the former is likely to be subjected to as result of the project activities during construction as well as operation phases, and
 - c) generates preferred alternative courses of action, if possible.

Its inclusion at the feasibility study stage is necessary for certain projects since, under the Environmental Impact Assessment Notification, 1994, issued by the Ministry of Environment & Forests, Government of India, any expansion or modernisation of an existing activity which is likely to increase the pollution load, or setting up of a new project listed in Schedule I, *ibid.*, is not permissible unless cleared by the Central Government. The Schedule covers about two and a half dozen projects including petroleum refineries, chemical fertilisers, bulk drugs, asbestos, thermal power plants, paper, cement, and even highway projects.

The EIA process can prove to be of immense benefit to the project promoter, if sincerely carried out, by ensuring that the natural resources are conserved or used efficiently and serious problems likely to arise out of any adverse effects on community or natural systems are duly anticipated and provided for at the planning stage itself. For identification of impacts, a list of parameters relevant to the project is drawn up, covering natural physical resources, natural biological/resources, and quality-of-life values including aesthetic and cultural values. For instance, for rail/road/highway project the following parameters have been identified:

- a) surface water quality
- b) air quality
- c) seismology/geology
- d) erosion
- e) land quality
- f) fisheries
- g) forests
- h) terrestrial wildlife
- i) noise
- j) aesthetics
- k) industries 1) resettlement
- m) archaeological/historical significance
- n) public health
- o) socio-economic factors