Overview of cost definitions and costing methods by James Ruth
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1. Cost Definitions

**Cost:** The total money, time, and resources associated with a purchase or activity.

**Fixed cost:** Includes all costs that do not vary with activity for an accounting period. Fixed costs are, at any time, the inevitable costs that must be paid regardless of the level of output and of the resources used. A Fixed Cost is therefore **not** an Opportunity Cost. Overhead is considered a fixed cost, even though it may vary somewhat according to the amount of activity. Any cost that does not vary depending on production, volume, use, or sales levels, such as rent, property tax, insurance, or interest expense.

**Related Terms:** variable cost, total cost, fixed expenses

**Variable cost:** All other costs that are some function of activity. They are usually considered linear because the unit cost is computed by dividing the total other costs for a period, or event, by the amount of activity in the period. The linear assumption is a matter of convenience. As the level of activity is varied, the non linear nature of the variable costs are revealed. A cost of labor, material or overhead that changes according to the change in the volume used. Combined with fixed costs, variable costs make up the total cost. While the total variable cost changes with increased usage, the total fixed cost stays the same.

**Related Terms:** fixed cost, break-even analysis

**Total costs** are usually expressed as **Fixed + Variable Total Cost**

**Definition 1:** In accounting, the sum of fixed costs, variable costs, and semi-variable costs.

**Definition 2:** In the context of investments, the total amount spent on a particular investment, including the price of the investment itself, plus commissions, fees, other transaction costs, and taxes.

**Related Terms:** average price per share, original cost

**Mixed Cost:** A cost with both fixed and variable elements.

**Direct cost:** Costs that can be identified directly with a particular process, project, or program.

**Indirect cost:** Costs associated with an enterprise, activity, etc. which are not identified as direct costs, but which may be included in the accounting.

**Incremental Costs (& Revenue):** Those costs (or revenues) that change due to an incremental change in activity, as compared those that are unaffected.
**Marginal Cost**: The cost associated with one additional unit of production or use, also called incremental cost.

**Opportunity Cost**: The benefit foregone by choosing one course of action over another, or the net revenue that is forgone by not allocating resources to another alternative use. The opportunity cost is the correct measure of the cost of resources for Systems Analysis. Whereas it can be equal to the price paid for a resource, it is often different from the outlay cost. Resources may cost something to use (or not use) even though no monetary price is paid to another entity for them. The opportunity cost is the Shadow Price of a resource.

In effect opportunity costs, in representing the cost of having less of a resource, measure the rate of change of benefits per unit change in resource. The opportunity cost of money is a measure of the maximum benefit that, for any given situation, can be obtained from any extra unit of capital.

A useful distinction can be made between resources that can be identically replaced (such as materials, money, etc.) and those that are somehow unique (e.g. a piece of property). For strictly replaceable resources for which there is a ready market, the opportunity cost is simply the market cost of replacement, or equivalently, the salvage price of the resource if it is already at hand and will not be replaced. Measuring opportunity cost is not particularly easy. For example, if an asset such as capital is used for one purpose, the opportunity cost is the value of the next best purpose the asset could have been used for. Opportunity cost analysis can be an important part of a decision-making processes, but is not treated as an actual cost in any financial statement.

**Related Terms**: cost of capital, cutoff point, idle, comparative advantage, economic value added

**Sunk Costs**: - theoretically those prior costs which cannot be recovered. For normal private sector accounting purposes, the sunk cost is the difference between book value and salvage value of an asset. This definition is disputed by some accountants as there is a historical cost element (any prior spending), and a future (negative cost or) revenue element, if salvage is eventually undertaken. For the public sector it is usually any money spent previously on a program or project that can never be recovered, i.e., costs already incurred which cannot be recovered regardless of future events. Sunk costs should be ignored in determining whether a new investment is worthwhile.

**Life Cycle Costs** are the total cost to an organization for acquisition and ownership of a product or asset over the life of the asset. For example, the life cycle cost of a school includes all of the future maintenance and repairs, as well as the initial construction and fixtures cost. This is sometimes referred to as capital costs plus operating costs, or one-time costs plus recurring costs. Any program should calculate life cycle costs.

**Cost-Effectiveness Analysis**. A program is cost-effective if, on the basis of life cycle cost analysis of competing alternatives, it is determined to have the lowest costs expressed in present value terms for a given amount of benefits.
Cost-effectiveness analysis can also be used to compare programs with identical costs but differing benefits. In this case, the decision criterion is the discounted present value of benefits. The alternative program with the largest benefits would normally be favored.

OMB Circular No. A-94

**Depreciated Cost:** The original cost of an asset minus total its depreciation thus far, also called net book value or written-down value.

**Standard Costing:** A management tool used to estimate the overall cost of production, assuming normal operations.

**Transaction Costs:** Costs incurred when buying or selling assets, such as commissions and the spread.

**Unit Cost:** Cost per item.
2. Costing Methods

Costing is important because it provides a quantified basis for defining poverty reduction strategies and programs, as well as for forecasting resource gaps and needs, and for mobilizing additional resources, either internally or externally.

While it is usually not possible to obtain reliable cost estimates for the long-term, costing is essential for coordinating the national budget and aid allocations with the prioritized development goals. The price tag and the financing plan of the programs or projects can only be ascertained meaningfully within a short-to-medium time horizon.

There are several common costing methodologies, and they all have their usefulness in specific situations. However, no one single methodology is appropriate for every situation. All cost estimates must be interpreted with caution and scrutinized carefully. Nobody should be utterly confident of their precision. In short, there is no universally robust or best way of costing programs or projects.

Since it is better to be broadly right than to be precisely wrong, cost estimates are sometimes best seen as orders of magnitude, expressed as a range rather than a single figure.

Some of the common generic approaches to costing are:

adapted and edited from [http://projecttools.co.uk/ProjectTools/Estimating.htm](http://projecttools.co.uk/ProjectTools/Estimating.htm)

- Top-Down, Algorithmic, or Parametric (often used when fine detail is not available)
- Bottom-Up, or Industrial Engineering (usually used when fine detail is available)
- Expert Judgment (experts estimate or ‘guesstimate’ project costs)
- Work Forward, Work Back (when the project has a specific due date)
- Activity Based Costing (time consuming and requires accurate data)
- Analogy (comparing similar and like for like projects)
- Quick and Dirty Costing (fast, but accurate to an order of magnitude only)

Three specific alternative approaches to costing Poverty Reduction Strategy (PRS) goals are:

- **Average Costs:** The cost of achieving a subset of goals using estimated average costs of service and estimated population lacking access to priority services. Data sources include: activity based budgeting and census/DHS/LSMS data for unserved populations.
- **Multivariate Analysis/Determinants Analysis:** Determinants of key poverty outcomes (e.g. infant mortality) are used for sensitivity analysis with respect to different policies. Alternative policies can be translated into unit costs, with total costs calculated for attaining certain goals.
- **Cost Effectiveness:** Ranking of existing projects and programs according to the relevance of their objectives to the PRS. Priority services and target groups are identified. Information obtained from sectors and donors about the most cost
Effective designs for priority social services, including the costing of main and complementary inputs required.

http://www.prspsynthesis.org/brief4.doc

2.1 Brief Example of Cost Estimating Methods

Engineering economy studies and problems often concern future outcomes, estimating future cash flows during analysis is a critical step. More accurate estimates contribute to better decision making.

Cost estimation should take place in an integrated, problem solving framework. Once the problem has been recognized and feasible alternatives have been found, the cash flows for each alternative must be researched and estimated. This can be an iterative process.

An integrated approach to develop the net cash flows for feasible project alternatives is shown below.

The integrated approach includes three basic components:

1. Work Breakdown Structure (WBS). This is a technique for explicitly defining, at successive levels of detail, the work elements of a project and their interrelationships (sometimes called a work element structure).
2. Cost and revenue structure (classification). Delineation of the cost and revenue categories and elements is made for estimates of cash flows at each level of the WBS.
3. Estimating techniques (models). Selected mathematically models are used to estimate the future costs and revenues during the analysis period.

These three basic components, together with integrating procedural steps, provide an organized approach for developing the cash flows for the alternatives.
2.2 A Model of Estimating Techniques

The purpose of estimating is to develop cash flows projections – not to develop exact data about the future, which is virtually impossible. Neither a preliminary estimate nor a final estimate is expected to be exact; rather, it should adequately suit the need at a reasonable cost and is often presented as a range of numbers. Cost and revenue estimates can be classified according to detail, accuracy and their intended use as follows:

- Order of magnitude estimates: used in the planning and initial evaluation stage of a project.
- Semi detailed or budget estimates: used in the preliminary or conceptual design stage of a project.

2.3 Bottom up costing, or the engineering approach

The bottom-up approach relies on detailed engineering analysis and calculation to determine an estimate. To apply this approach, an official from the Ministry of Finance or Ministry of Planning would need the detailed design and configuration information for various components and accounting information for all material, equipment, services, and labor required of a program or project. A conceptual design is built from scratch (hence the name “bottom-up”). This approach generates a fairly detailed forecast. One of the advantages of this approach is that many issues can be addressed, and the effect of each issue can be well understood. For example, we could isolate the effect of choosing an alternative form for delivery of a service in a program, a new material in a construction project, or a new manufacturing or operating method. However, the bottom-up method has some drawbacks. First, the analysis process is time consuming. Often, a great deal of time must be spent generating the conceptual design and corresponding cost estimate. A second drawback of the bottom-up approach is that the analyst must be an expert in the operating aspects of a program or design of the technology being employed. Specific design details must be considered to apply the method correctly. The user (i.e., government official at the Ministry of Finance or Ministry of Planning assigned to do cost estimation) must also understand design tradeoffs and the current state of technology. A third disadvantage is that the system must be well defined - there is little allowance for unknown factors. For example, a program or component’s cost must be estimated even though that program or component might represent a first-of-a-kind use or technology. Finally, the user of the bottom-up approach must either create from scratch, have access to, or maintain an extensive and detailed database of, development, production, and operating and support costs for the particular program or technology.

2.5 Top-down macro approaches

Top-down macro costing often builds on econometric models that are extensions of the Harrod-Domar model, used for calculating the required investments that will be needed
in order to reach a target growth rate.\(^1\) The resulting financing gap between required investment and available resources is often assumed to be filled with foreign aid. A top-down model would often be based on a given incremental capital output ratio (ICOR), which is a broad measure of the productivity of investments in each country. It would result in yearly aggregate estimates of investment costs, which in turn could be disaggregated into budget classification codes used in the planning and accounting systems. More often, however, investment costs generated by top-down econometric models are used as overall estimates of total costs, which in turn are used as checks against more detailed cost estimates.

This model has been extended in several ways; one of the most important is to adjust it for the MDG on poverty reduction when it is used for estimating the cost of halving poverty. This requires that assumptions of poverty elasticities, etc., are added to the model’s standard assumptions of countries’ ICOR.

There are a number of dynamic general equilibrium models and tools which can be used to analyze macroeconomic effects of sectoral plans and strategies, and to provide benchmark estimates of overall costs. General equilibrium models are a useful tool to design a public investment strategy and design different scenarios involving various investment choices and financing modalities.

The MAMS (Maquette for MDG Simulation) model developed for costing the MDGs combines micro and macro elements with the goal of developing a dynamic CGE (computable general equilibrium) model which would be able to capture the combined effects of many MDG-related policies and required foreign aid which a low-income country can apply to reach MDGs. The model is used to assess the financing required to achieve a sub-set of the MDGs and absorptive capacity constraints. MAMS has several components including i) a macro-model providing baseline scenarios for growth, aid and public expenditure; ii) a sectoral supply-demand model modeling MDG outcomes through production functions; iii) budgetary and technological constraints to explain changes in production factors and their costs and iv) human capital constraints related to availability over time of a sufficiently skilled labour force\(^2\).

A framework for analysis of MDGs with the help of a MAMS model should consider: (i) Synergies between different MDGs; (ii) Increasing marginal costs; (iii) Possible rise in unit service costs with input costs (wages); (iii) Role of non-government service providers; (iv) Demand side conditions (incentives infrastructure, incomes); (v) Role of economic growth and (vi) Macro-consequences of increased public spending and/or foreign aid. MAMS models, for example in the case of Ethiopia, have been used to provide benchmark estimates of overall costs (in particular infrastructure investments linekd to growth); phasing of different types of interventions (such as frontloading.

\(^1\) See Burnside, Craig and David Dollar, "Aid, Policies, and Growth," World Bank mimeo, November 1996.

infrastructure investments); and providing constraint scenarios with trade offs made explicit in policy scenarios.

2.4 Top down costing or parametric costing of projects

Parametric estimating is a technique that uses validated relationships between a project’s technical, programmatic, and cost characteristics and the historical resources used during the development and manufacture of an item or formulation of a program. A number of parametric techniques exist. Such techniques include Cost Estimating Relationships (CERs) and Parametric Models. CERs are mathematical expressions or formulas that are used to estimate the cost of an item or activity as a function of one or more relevant independent variables, these are sometimes also known as cost driver(s). Parametric models are more complex than CERs because they incorporate equations, ground rules, assumptions, logic and variables that describe and define the particular situation being studied and estimated. They make extensive use of databases by storing program technical and cost history.

2.5 Analogy costing, or estimating by analogy

A related approach to the bottom-up method is to estimate by analogy. With this approach, an analyst selects a system that is similar to or related to the system undergoing the cost analysis and makes adjustments for the differences between the two systems. This approach works well for derivative or evolutionary improvements. Its main advantage over the bottom-up approach is that only the changes or differences must be estimated, thus saving time. However, a good starting baseline must exist to apply the method successfully. For radical changes or new technologies, the bottom-up approach is clearly the better choice. As with the bottom-up approach, the user (an official from the Ministry) must have a thorough knowledge of the applicable technology to employ the estimate by analogy approach.

2.6 Activity based costing (ABC)

A cost accounting method that measures the cost and performance of process related activities and cost objects. It assigns cost to cost objects, such as products or customers, based on their use of activities.

ABC focuses on the activities of a production cycle, based on the premises that (a) an output requires activities to produce, and (b) activities consume resources. ABC systems use cost drivers to assign costs through activities to outputs. The ABC cost assignment is a two-stage procedure. The first stage assigns the costs of resources to activities and the second stage assigns activity costs to outputs.

A major advantage of using ABC is that it avoids or minimizes distortions in product costing that result from arbitrary allocations of indirect costs. By tracing costs through activities, ABC provides more accurate service or product costs.
Also important is that ABC encourages to evaluate the efficiency and cost effectiveness of activities. Some ABC systems rank activities by the degree to which they add value to the organization or its outputs. Managers at the Ministry use such value rankings to focus their cost reduction programs. ABC encourages to identify and examine (a) what activities are really needed (value-added activities) in order to accomplish a mission, deliver a service, or meet customer demand, (b) how activities can be modified to achieve cost savings or product improvements, and (c) what activities do not actually add value to services or products (non-value-added activities). ABC integrates with cycle time analysis and value added analysis.

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**Financial Analysis Techniques**

**Activity Based Costing (ABC)**

- Captures the current cost of performing an activity
- Targets High Cost activities
- Provides a context for establishing and monitoring performance measures
- Provides the link between activity modeling and economic analysis
- Is useful for forecasting financial baselines

**Business Case Development**

- Focuses on "bottom line" results (savings vs. investment)
- Adjusts for future risks
- Identifies performance measures

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**Steps for Performing ABC**

1. Analyze Activities
2. Gather Costs
3. Trace Costs to Activities
4. Establish Output Measures
5. Analyze Costs

**Analyze Activities**

First the scope of the activities to be analyzed must be identified. It is suggested that the program include at least a half-dozen organizational units having a common functional orientation, and preferably also a common budget somewhere in the reporting chain. The depth and detail of analysis will be determined by activity decomposition, since activity decomposition is complete when one common or homogeneous primary output per activity is reached. Any prior work captured in IDEF0 models and their related definitions is considered here. This is where the core team can use activity models as a basis for selecting and interviewing key people associated with the business process.
A determination then is made if an activity is value or non-value added; also if the activity is primary or secondary, and required or not needed. Value added is determined if the output of the activity is directly related to customer requirements, service or product, as opposed to an administrative or logistical outcome that services the providing organization. For instance, if the output of an activity were an inventory report or update for products (for which there are customers), the output would be non-value added, but necessary to the organization, i.e., "overhead." A major goal of reengineering is to reduce non-value added activities and eliminate those that are not necessary. Primary activities directly support the organization's mission while secondary activities support primary activities. Required activities are those that must always be performed while discretionary activities are performed only when allowed by the operating management.

**Gather Costs**

In this step costs are gathered for the activity producing the products or services provided as the outcome. These costs can be salaries, expenditures for research, machinery, office furniture, etc. These costs are used as the baseline activity costs. When documents for the costs incurred are not available, cost assignment formulas may be used.

**Trace Costs to Activities**

In this step the results of analyzing activities and the gathered organizational inputs and costs are brought together, which produces the total input cost for each activity. A simple formula for costs is provided - outputs consume activities that in turn have consumed costs associated with resources. This leads to a simple method to calculate total costs consumed by an activity - multiply the percent of time expended by an organizational unit, e.g., branch, division, on each activity by the total input cost for that entity. Here we are not calculating costs, just finding where they come from.

**Establish Output Measures**

In this step the actual activity unit cost is calculated. Even though activities may have multiple outputs, only one is identified as the primary output. Activity unit cost is calculated by dividing the total input cost, including assigned costs from secondary activities, by the primary activity output volume; the primary output must be measurable and its volume or quantity obtainable. From this, a bill of activities can then be calculated which contains or lists a set of activities and the amount of each activity consumed. The amount of each activity consumed is extended by the activity unit cost and is added up as a total cost for the bill of activity.

**Analyze Costs**

In the final step, the calculated activity unit costs and bills of activity are used to identify candidates for improving the business processes. Managers can use the information by stratifying, for a Pareto analysis, the activity costs and identifying a certain percentage of activities that consume the majority of costs. The thing to keep in mind is that the identification of non-value added activities occurs through this process with a clarity that allows us to eliminate them, and at the same time permits the product or service to be provided to the customer with greater efficiency.

http://www.faa.gov/ait/bpi/handbook/chap5.htm
3. Strengths and Weaknesses of Costing Methods

3.1 Problems with costing in general
Costing can be undermined by these weaknesses:

- The impossibility to define the optimal policy framework \textit{ex ante} (what is a good policy, a good institution?)
- Fixed absorptive capacity constraints, lack of institutional capacity
- The limits of the “unit cost” approach and other methods
- The interconnectedness between the goals (allocating symbiotic effects)
- Unpredictable future shocks

From: Raj Nallari, World Bank Institute, PREM

3.2 Bottom-up estimation
Bottom up costing is usually used when the fine detail of the project or program components are well defined. It is based on more information and done in more detail. This type of estimate can be much more precise than top-down.

Problems in coming up with credible estimates stem from generally weak prioritization, limited unit cost data, inadequate links between programs and indicators/targets (including in sector programs) and over-ambitious medium term targets.

There are several advantages to using the bottom up method, not the least is it’s potential comprehensiveness and the fact that it leaves an excellent audit trail for a post mortem examination. The data developed or collected during the process can be invaluable later for other projects. The bottom up estimate will clearly state all of the presumed elements of a program, which will be a pro forma checklist in fact. A bottom up cost estimate can be scanned by parties in advance to determine reasonableness or detect obvious errors and omissions.

Strengths:
- More detailed basis
- More stable
- Fosters individual commitment
- Cause and effect understood
- Very detailed estimate

Weaknesses:
- More time consuming
- Not applicable early in life-cycle due to insufficient information
- Difficult to develop and implement
- Substantial, detailed data are required
- Requires expert knowledge
3.3 Analogy (Comparative) Estimation
Estimate by comparing the current project costs with completed Projects costs, where you can base your estimate on the measure of time and resource used for the completed project. The estimate is therefore based on actual experience rather than opinion, but will only be useful if the analogy is valid. Analogy can be a good way to estimate costs provided the information is available and the two projects are comparable.

Strengths:
- Based on actual project data and experience
- Identifies project differences and impacts
- Uses parametric techniques
- Cause and effect understood
- More easily applied than the bottom-up method

Weaknesses:
- Lack of similar project or historical precedents is a nullifying factor
- Possible questionable accuracy of historical data
- Appropriate baseline must exist
- Substantial, detailed data are required
- Requires expert knowledge

2.4 Top-Down (Parametric, Algorithmic) Estimation
Parametric cost estimating is the use of historical cost data and statistical techniques to predict future costs. Statistical techniques are used to develop Cost Estimating Relationships (CERs) that tie the cost or price of an item (e.g., a product, good, service, or activity) to one or more independent variables, that is, cost drivers.

Parametric models are usually used in the early design stages to get an idea of how much the product (or project, or program) will cost based on a few physical attributes (such as weight, volume, and power). The output of the parametric models (an estimated cost) is used to gauge the impact of design decisions on the total cost. Awareness of the effect that engineering design decisions have on total cost is essential to developing a program that is both economically and technically sound.

List the major tasks that will need to be done for the project to be completed. Breaking the project into stages helps to identify these main tasks and the costs that will be involved. Use experience and judgment to estimate the time and resources required for each task. Check the relative size of the estimates to ensure that each is logical and consistent. Sum the results to give the overall estimate of the project costs.

This technique is usually used at an early stage in a project when the overall outcome and approach is known, but the fine detail is unclear. As it is a high level process, the result will not be precise, and may be best expressed as a range. For example - "Project 'X' will require 200 to 350 days work effort and can be done in 10 to 20 weeks". Estimated resources costs will also be a range.

Strengths:
• Objective, repeatable, & analyzable
• Efficient, good for sensitivity analysis
• Objectively calibrated to experience
• Easiest to implement
• Non-technical experts can apply method

Weaknesses:
• Subjective inputs
• Assessment of exceptional circumstances
• Calibrated to the past, not the future
• Uncertainty of the forecast is generated
• Can be difficult to develop
• Factors might be associative but not causative (i.e., lack of direct cause-and-effect relationships)
• Extrapolation of existing data to forecast the future, which might include radical technological changes, might not be properly forecast

3.5 Expert Judgment
This is making an estimate based on expert judgment and not really an estimating technique. It requires the use of the output from any or all of the above techniques, but it is probably more useful when building top-down estimates. Essentially a number of experts independently estimate the cost of the program or project. The results are reviewed and combined to provide a single best estimate.

Strengths:
• Factors-in differences and exceptional circumstances
• Adjusts for impacts from variables (e.g., new technology)
• A good compliment to other estimation methods

Weaknesses:
• No better than the participants
• Biases, incomplete recall
• Difficult to document factors

3.6 Work forward, work back
Useful if you have an imposed end date. From the imposed end date, work back with your estimates to today. This will show if the timescale looks achievable. If it doesn't, you can alert the Project Sponsor early and look for solutions - for example finding extra resource or scaling down the scope.