ESTIMATING COSTS OF PUBLIC SERVICE DELIVERY

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INDEVELOPMENT

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1 ESTIMATING COSTS

In order to be able to determine how much government should charge its customers (population) for the provision of public services, it needs to know how much it spends. This document presents guidelines for network infrastructure related-public services like, public transport, roads, water supply and sanitation.
The costs of public service delivery cover the costs of all activities to produce, transport and sell public services. Typically this involves

- Management of public service delivery
- Construction of infrastructure and offices
- Maintenance of infrastructure and offices
- Operation of public service delivery
- Collection of revenues

The total annual budget is the sum of all the annual expenditures and average depreciation costs of the assets.

Management of public service delivery consists of a whole range of decision making activities. Most important management tasks relate to planning and negotiations with the government about market share, service standards, and rates but it also contains activities like supervision of the other mentioned activities.

Construction costs also involve costs for designing, engineering and supervision. In many countries, governments partly subsidise public service delivery and pay the costs for these three items. Private operators, however, will have to take into account these indirect construction costs while setting rates.

Maintenance activities are defined as all activities to ensure that public service delivery is continued. Thus maintenance is not limited to small repairs but also include rehabilitations or complete reconstructions. In addition, maintenance includes inspections.
Like construction, maintenance may require engineering and supervision services.

Operation of public service delivery is a group of activities that involves issues like:

- Administration
- Accounting
- Operating infrastructure and equipment
- Purchase of inputs

Most of the operation costs are typically man hours.

Collection of revenues may or may not be the responsibility of the service providers. When the service provider has to collect user charges, it needs to include the collection activities as a cost item.

Management, annual maintenance, operation and revenue collection

costs are typically annual recurrent costs. This means that the costs of these activities over the years will be more or less the same. Annual maintenance consists of all maintenance activities that are carried out every year or more frequent.

Minimum analysis duration

It is important to choose sufficient long periods to analyse the costs. When properly maintained (including rehabilitation and reconstruction) the assets will facilitate eternal public service delivery. The lives of assets vary considerably. Concrete brides may have lives of 100 years or more. Lives of sewer mains are usually more than 50 years and asphalt pavements need rehabilitation 10 to 17 years after construction. Maintenance activities extend the life of the assets. Annual maintenance and smaller periodic repairs are relatively cheap and reduce the average cost of public service delivery. The cost impacts of rehabilitations and reconstructions differ depending on the asset. Rehabilitation of pavement are cheaper than new construction and therefore further reduces the total costs of public service delivery. A rehabilitation of a sewer main is usually more expansive than a reconstruction and it may even be more expensive than the original construction. The duration of the analysis should therefore take into account the cost impacts of life increasing maintenance like rehabilitation. It is widely assumed that there are two types of maintenance cycles. (A maintenance cycle is the period between (re)construction or rehabilitation to the next rehabilitation. Within the duration of such a cycle only annual maintenance and smaller periodic maintenance takes place.)

1. The period between new construction and the first rehabilitation or reconstruction
2. The period between two succeeding rehabilitations or reconstructions; which are always the same

Therefore, only one maintenance cycle is needed for assets that were already depreciated (read rehabilitated or reconstructed). The duration of new assets usually involves two or three maintenance cycles depending on the cost implications of rehabilitations.

Actual analysis duration

It should be noted that any infrastructure network, irrespective if its serves transport, water supply or sanitation is composed of various assets with different lives, maintenance cycles and cost implications. The duration of the analysis will have to be synchronised. It is possible to determine the incremental life of all the major assets. This is done through multiplying the number of maintenance cycles of all the major assets till they have a common shared end life (residue value = 0).

For example, the maintenance cycle for asset A is 6 years
and for asset B is 8 years
This means that when a total life of (6*8=) 48 year is chosen both assets have a residual value of zero. The analysis duration of asset A involves 8 maintenance cycles and that of asset B involves 6 maintenance cycles.

The problem with this technique that the duration may be extremely

and unrealistically long. The advantage is however that the method of internal rate of return can be applied.

Another approach is to select the asset with the highest replacement value and determine the analysis duration on basis of its maintenance cycles. Earlier replacements of the other assets are considered maintenance costs or supplementary investments. The values of assets with longer lives are accounted for by their salvage value. This methodology is less precise and thus not allow for proper discounting techniques.

The maintenance cycles are based on use-based models. These models allow for variations between specific asset links. Because many of these models are highly unreliable, planners may change the maintenance cycles on basis of their experiences.

Interest

Large expenditures, like construction, rehabilitation and reconstruction are often financed through loans. Otherwise it has to be financed from savings. In both cases, the public service provider has to recover the costs of the interest rates. This is off course not necessary when the public service provider receives subsidies in the form of grants or interest free loans from the treasury or donors to finance such large expenditures.

Construction, reconstructions, rehabilitation and large repairs are expenditures that extend the life of assets with several years. They are often financed with loans. The annual instalments can be estimated with the **annuity** methodology.

$Ann = (I-R) * [i(1+I)^n]/[(1+I)^n-1]$

Where:
I = Investment cost
R = Residue value (salvage value) at end of life
n = life of asset or repayment period (years)
i = Interest rate (%)

When the interest rate is zero, because the investments are financed through "out of pocket", the annual depreciation can simply be calculated with:

$(I-R)/n$

1.1 DISCOUNTING MONEY VALUES

Public service providers have to invest first, prior being able to provide services and collect revenues. As the value of money depreciates, it is necessary to discount the costs for time differences. The earlier described method does not take into account the depreciation of money. Nonetheless the earlier described method is very popular because of its simplicity. It is possible to adjust the needed annual revenue from year to year on basis of actual depreciation values.

Discounting is the process of finding the current value of an amount of cash at some future date, and along with compounding cash form the basis of time value of money calculations. The discounted value of a cash flow is determined by reducing its value by the appropriate discount rate for each unit of time between the time when the cashflow is to be valued to the time of the cash flow. Most often the discount rate is expressed as an annual rate.
The discount rate used in financial calculations is usually chosen to be equal to the cost of capital. Some adjustment may be made to the discount rate to take account of risks associated with uncertain cashflows, with other developments.
Financial advisers will be able to determine the discount rate. Appendix A provide some generic guidelines.
The discount factor', P(T), is the number by which a future cash flow to be received or paid at time T (years) must be multiplied in order to obtain the current present value. Thus for a fixed annually compounded discount rate (r);

$$P(T) = \frac{1}{(1+r)^T}$$

Methods like the Net Present Value (NPV) can be used to estimate needed revenues (Q_t) . Whereby the sum of the discounted revenues should be larger than the sum of the discounted costs (C_t).

Net present value

$$\mathrm{NPV} = \sum_{t=0}^{t=n} Q_t\,(1+r)^{-t} - \sum_{t=0}^{t=n} C_t\,(1+r)^{-t}$$

Where:
Q; revenues
C; costs
t; time (years)
n; is the economic production life of the project assets
r; discount rate

The mathematics involved to estimate the undiscounted revenues are significant. Most financial planners work with software which allow them to estimate the NPV. Through a system of trial and error, the revenue value resulting in a minimum positive NPV is estimated. These software packages are available at low costs (below 100 US$).

Internal Rate of Return

It is also possible to calculate the discount rate of the project where the sum of the discounted revenues and discounted costs generated during the project life is zero. The calculated discount rate is subsequently compared with the rate that reflects the opportunity costs of capital. If the calculated discount rate is higher the project is acceptable. The calculated discount rate is called the Internal Rate of Return (IRR).

APPENDIX A: DISCOUNT RATE

Typically, most public sector service providers will use the interest rate as the discount rate. They may increase it to account for risks.

Private companies also apply equity to raise capital and therefore have to calculate the weighted average cost of capital, which can be calculated with the following formula:
c= y(E/K) + (D/K) * b(1-Xc)

Where
K=D+E
and the following table defines each symbol:

Symbol	Meaning	Units
c	*weighted average cost of capital*	%
y	*required or expected rate of return on equity*, or *cost of equity*	%
b	*required or expected rate of return on borrowings*, or *cost of debt*	%
X_C	*corporate tax rate*	%
D	*total debt and leases*	currency
E	*total equity and equity equivalents*	currency
K	*total capital invested in the going concern*	currency

It is important to use market values and not the book values as they may be significant different.

The "weight" of a source of financing is simply the market value of that piece divided by the sum of the values of all the pieces.

The market value for equity for a publicly trade company is the price per share multiplied with the outstanding shares.

The market value of debts are values of publicly traded bonds and book values of debts with banks.

The market value of preferred stock is again usually easily found on the market, and determined by multiplying the cost per share by number of shares outstanding.

Preferred equity is equivalent to a perpetuity, where the holder is entitled to fixed payments forever. Thus the cost is determined by dividing the periodic payment by the price of the preferred stock, in

percentage terms.

The cost of common equity is usually determined using the capital asset pricing model.

The cost of debt is the yield to maturity on the publicly traded bonds of the company. Failing availability of that, the rates of interest charged by the banks on recent loans to the company would also serve as a good cost of debt.

Since a corporation normally can write off taxes on the interest it pays on the debt, however, the cost of debt is further reduced by the tax rate that the corporation is subject to. Thus, the cost of debt for a company becomes (YTM on bonds or interest on loans) × (1 − tax rate). In fact, the tax deduction is usually kept in the formula for WACC, rather than being rolled up into cost of debt.[1]

[1] http://en.wikipedia.org/wiki/Weighted_average_cost_of_capital

APPENDIX B: CAPITAL ASSET PRICING MODEL

The **capital asset pricing model** (**CAPM**) is used in finance to determine a theoretically appropriate price of an asset such as a security. The formula takes into account the asset's sensitivity to non-diversifiable risk (also known as systematic risk or market risk), in a number often referred to as beta (β) in the financial industry, as well as the expected return of the market and the expected return of a theoretical risk-free asset.
According to the CAPM, the relation between a given asset ***i***, and a proxy portfolio ***m*** (here, the market portfolio) is described as:

$$E(r_i) = r_f + \beta_{im}(E(r_m) - r_f).$$

Where:

$E(r_i)$ is the expected return on the capital asset
r_f is the risk-free rate of interest
β_{im} (the *beta*) the sensitivity of the asset returns to market returns, or also

$$\beta_{im} = \frac{Cov(r_i, r_m)}{Var(r_m)}$$

$E(r_m)$ is the expected return of the market
$(E(r_m) - r_f)$ is sometimes known as the *market premium* or *risk premium* (the difference between the expected market rate of return and the risk-free rate of return).

The CAPM returns the asset-appropriate required return or discount rate - i.e. the rate at which future cash flows produced by the asset should be discounted given that asset's relative riskiness. Betas exceeding one signify more than average "riskiness"; betas below one indicate lower than average. Thus a more risky stock will have a higher beta and will be discounted at a higher rate; less sensitive stocks will have lower betas and be discounted at a lower rate. The CAPM is consistent with intuition - investors (should) require a higher return for holding a more risky asset.

Since beta reflects asset-specific sensitivity to non-diversifiable, i.e. market, risk, the market as a whole, by definition, has a beta of one. Stock market indices are frequently used as local proxies for the market - and in that case (by definition) have a beta of one. An investor in a large, diversified portfolio (such as a mutual fund) therefore expects performance in line with the market.

Once the expected return, $E(r_i)$, is calculated using CAPM, the future cash flows of the asset can be discounted to their present value using this rate to establish the correct price for the asset.
In theory, therefore, an asset is correctly priced when its observed

price is the same as its value calculated using the CAPM derived discount rate. If the observed price is higher than the valuation, then the asset is overvalued (and undervalued for a too low price). Alternatively, one can "solve for discount rate" for the observed price given a particular valuation model and compare that discount rate with the CAPM rate. If the discount rate in the model is lower than the CAPM rate then the asset is overvalued (and undervalued for a too high discount rate).[2]

[2] http://en.wikipedia.org/wiki/Capital_asset_pricing_model