Annex 4D.6

Discounted Cash Flow Analysis (DCF) and Average Incremental Cost Analysis (AIC)
The economic evaluation of municipal SWM projects involves comparing projects on the basis of their different cost streams projected over time. Because different projects have different cost profiles (involving different cash outlays on capital and operating expenditures) it is necessary to find a tool by which these variable cash flow streams can be compared.

This is done using DCF analysis, a technique which translates cash flows extending into the future into their present values.

The present value (PV) is an amount which if received today as a single payment would be equivalent to the value of the future cash flow. The present value is determined by discounting the future cash flow at the appropriate discount rate.

When only the costs of service are measured and not the benefits - the specific DCF technique used is known as cost-effectiveness analysis (CEA). This technique is used for comparing the cost-effectiveness of alternative projects which provide identical benefits, where cost effectiveness is defined as the present value (PV) of the projected future cash flow.

Project options are then ranked according to their calculated present values, and the one with the lowest PV is considered to be the most cost-effective. The project option having the lowest PV would therefore be preferred, all other factors being equal. A final assessment should not however be made until all project outcomes have been subjected to rigorous sensitivity analysis (discussed further below).

The approach of ranking projects on the basis of their relative PVS relies on their providing identical benefits. One way of overcoming this limitation is to use an extension of cost-effectiveness analysis known as average incremental cost (AIC) analysis. This is a powerful method for establishing the average unit cost of service (e.g. average collection costs measured in Rupees/tonne), a measure which can be used for both comparing the costs of projects having different project lives or benefits and for providing a good general indication of the affordability to society of the proposed measures.

Note that cost-effectiveness analysis only provides a basis for comparing the relative economic merits of project options and that - unlike cost-benefit analysis - it does not provide a basis for demonstrating the economic viability of a project. This important limitation implies that project justification must be based on subjective rather than on quantitative criteria. It also means that greater significance rests on the financial analysis to establish the overall long-term (financial) sustainability of the preferred MSWM strategy option (Section 7.7 refers).
The outputs normally required for a cost-effectiveness analysis are the present value (PV) of the discounted net cash flow and the average incremental cost (AIC), discussed below.

Undertaking economic and financial analyses needs an understanding, at least, of the basic underlying economic and financial concepts and of modelling techniques using a proprietary spread-sheet package, such as Microsoft Excel.

The main criteria are to keep the model as simple and as flexible as possible.

• Keeping it simple is sometimes not easy, as there can be a tendency to introduce unnecessary information. Before constructing the model time should be spent thinking carefully about the results wanted from it (the output), the nature of the information to be dealt with (the input), and how this can be analysed to provide the required results (the analysis). Organise information on the project in a logical and systematic manner before attempting to build a model around it.

The economic model should consist of three elements: data input sheets, data analysis sheets, and output (results) sheets. With modern spreadsheet packages this is now easy to do, using a different worksheet of a workbook for each table. Data should be input to a data input sheet only, and should be input only once. Analysis sheets should contain the mechanics of the model, drawing upon and analysing data introduced in the input sheets. Output sheets provide summary tables or graphical representations of the results of the analysis. No manual data inputs should be made on the analysis or output sheets.

• The model should be sufficiently flexible to answer with only minimal adjustments the variety of “what-if” questions which may be asked to test the sensitivity of outcomes to plausible changes in key variables. Preferably, these should be capable of being accomplished merely by changing input values. Keeping the model flexible again means thinking carefully about what is required from it, and spending time when constructing it.
AVERAGE INCREMENTAL COST ANALYSIS

Average incremental cost analysis is an extension of cost-effectiveness analysis which provides a basis for comparing projects with different benefits, and for estimating the average unit cost of service provision. It can also be used for comparing the relative costs of the various components of a strategy. This is an approach used by the World Bank and other institutions to approximate the marginal cost pricing conditions needed for establishing indicative tariff structures. It simply involves dividing the present value (PV) of project cash flows by the PV of the waste throughput stream to produce an average cost per tonne of waste treated. As discounting is a financial concept its application to physical flows may seem peculiar at first glance. This is understandable, and it is necessary to understand the mechanics of the approach to appreciate why discounting waste flows is appropriate. A justification for the approach is provided in Box 2.1 at the end of this text.

AIC is a measure of average cost per tonne. The analysis involves finding the revenue stream whose present value when discounted at the chosen discount rate is equivalent to the present value of the projected expenditure stream. Revenue in any one year is equal to the AIC multiplied by the projected waste arisings in that year.

AIC is an important parameter for the following reasons:
- it can be used as an alternative measure to PV in the comparison of project options which treat the same annual waste volumes and which offer identical benefits - as it is an indicator of unit costs of service it may in fact be more relevant than PV;
- it can be used as a measure for comparing the cost implications of project options which treat the same annual volumes of waste but which provide different levels of benefits (possibly comparing a daily collection service with a weekly one);
- it can be used as a measure of the average tariff required to generate revenues sufficient to achieve full cost recovery over the life of the service - this can be particularly valuable when used as part of the financial evaluation to estimate the average level of user-charges needed to achieve full cost recovery;
- it can be used to estimate the average unit costs of the investment and operating cost cash flows separately, thereby enabling the relative importance of each to be assessed.
The fact that physical flows are discounted is merely an outcome of the mathematical analysis of monetary values on which the method is based. AIC is a measure of average cost per tonne. The analysis involves finding the revenue stream whose present value (PV) when discounted at the chosen discount rate is equivalent to the PV of the projected expenditure stream (ES) when similarly discounted. Revenue in any one year is equal to the AIC multiplied by the projected waste arisings (WA) in that year. AIC times WA is therefore a monetary value. The objective is to find the AIC.

Thus,
$\text{PV}(\text{AIC} \times \text{WS}) = \text{PV}(\text{ES})$ where WS is the waste arisings stream.

Since AIC is constant it can be taken outside the brackets to give:
$\text{AIC} \times \text{PV}(\text{WA}) = \text{PV}(\text{ES})$
or,
$\text{AIC} = \frac{\text{PV}(\text{ES})}{\text{PV}(\text{WA})}$

Thus, AIC is calculated by dividing the present value of the expenditure stream by the present value of the waste arisings stream. This is possible only because its multiplier, AIC, is constant in real terms.