Investment Profitability Evaluation on the Basis of Life Cycle Cost (LCC) and Discount Method (NPV)

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The initial thesis of this paper asserts that the present life cycle costs method is a sensitive instrument for investment profitability evaluation. To prove this thesis the analysis of life cycle cost as well as life cycle cost present value have been revealed. On this basis models have been formed which allow to estimate current value of forward life cycle costs which we will incurr to realize a particular enterprise.
Key words: life cycle cost (LCC), nett present value method (NPV), life cycle cost present value (LCCPV), discounting, investment.

1. INTRODUCTION

At present a user should not make investment decisions e.g. product purchase, relying entirely on acquisition cost. Most of all he should analyse the costs issuing from product ownership. It is these costs which emerge during the entire period of product exploitation and repeatedly are considerably higher than acquisition costs. The instrument to estimate total acquisition costs and product ownership costs is life cycle cost method (LCC). Combining this method with nett present value method (NPV) allows to estimate investment profitability including fluctuation of money value in time.

The aim of this paper is to present a method for estimating present value of forward life cycle costs (LCCPV) which we will incurr to realize a particular enterprise.

The paper comprises five sections. After the introduction, in the second part there are presented issues concerning the concept and meaning of life cycle costs estimation. Next, nett present value method has been characterised along with a means to determine discount factor and rate. Fourth section introduces a method for estimating current value of forward costs in a life cycle. The conclusion part summarises all major isues discussed in this paper.

2. LIFE CYCLE COST

Life cycle cost (LCC) is the total incurred cost of product lifecycle or investment enterprise [21].

Life cycle is comprised of a few stages. In each of them a number of actions is performed, whose realization involves considerable financial outlays. The costs incurred in these stages can be divided into two fundamental types: acquisition and ownership. In professional literature we find various classifications of LCC [1], [4], [13], [15] and [22]. Figure 1 depicts exemplary phases of product LCC which constitute a basis for further, more detailed costs ranking. The structure of costs classification depends on the person conducting the LCC analysis.

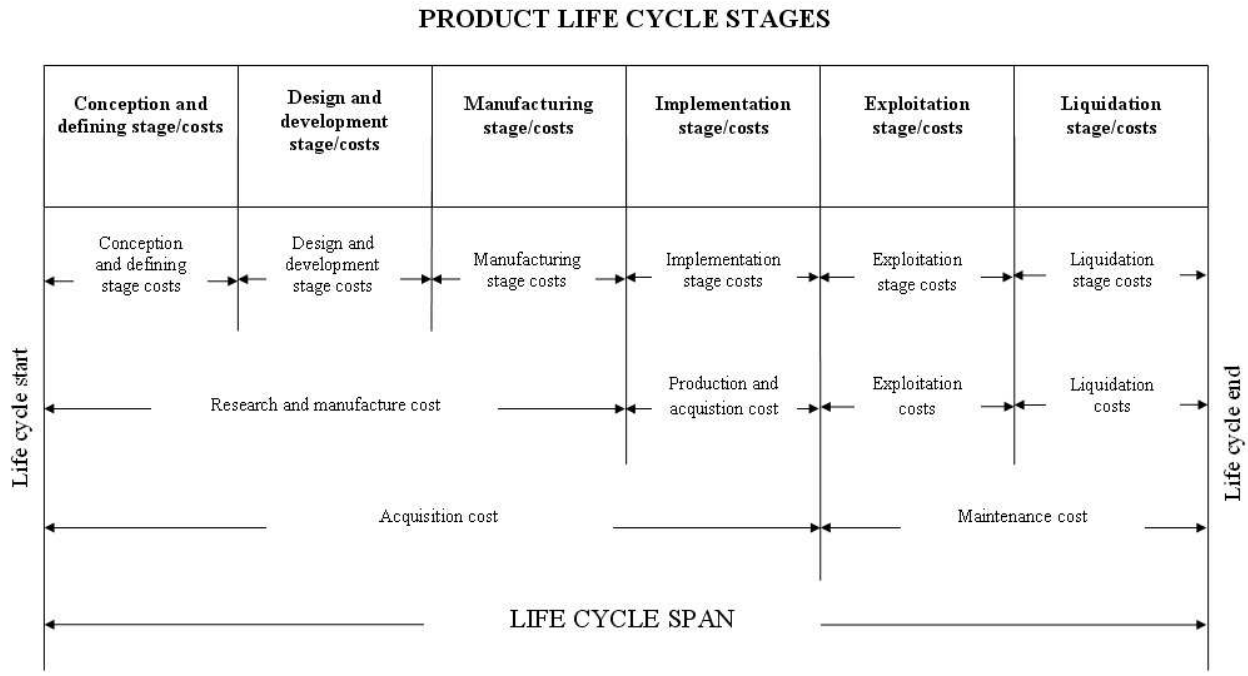

Figure 1. Product life cycle costs classification.
Source: Self analysis.

One of the most important advantages of LCC analysis is a comprehensive approach towards estimating and managing costs over a long period of time. The comprehensiveness can be noticed in the fact that the analysis encompasses all categories of used resources costs at various stages of a product life cycle [20]. The selection of correspondent stages of a life cycle, individual parts or combinations, should be adapted to particular requirements of each analysis.

The object for evaluation can therefore be the costs incurred during the entire life cycle of a product or in a part of that cycle [21]. For a customer, from economic-exploitative perspective, product 'lifecycle' begins no sooner than at the moment of its purchase. Consequently, on deciding to buy a product a consumer should analyse the cost to be incurred during its usage, namely exploitation stage.

Repeatedly, the LCC analysis is regarded as a concept which, by including life cycle costs, allows the evaluation of economic profitability of investment enterprises. It can also be applied as an instrument for comparing alternative solutions and selecting that which economically is most profitable. User can apply the LCC analysis as a decision base when buying a product. Because of estimated life cycle costs, he will be able to determine i.a. whether he can afford a particular product and which one to buy. Despite the fact that LCC results are merely estimation, it is certain that life cycle costs analysis provides valuable information and is useful in decision-making process [15].

To know current value of costs, to be incurred in the future, costs estimated by LCC method must be discounted. The necessity to discount issues from fluctuating money value in time. Quite helpful in this situation appears nett present value method.

3. NETT PRESENT VALUE METHOD

Nett present value method (NPV) is based on comparing the value of investment expenses with a present value of anticipated income, possible to achieve through investment realisation [10]. This method takes into consideration the fluctuation of money value in time and allows to install forward cash flow value (income and expenses) into the present moment – an initiating stage of investment. In other words, the NPV method discounts forward cash flow to its current value [26].

NPV is therefore a total of discounted separately for each year nett cash flows, realized during entire period of investment, with a determined interest (discount) rate. It expresses thus a total, present value of nett cash flow, which will be generated due to accomplishment of investment enterprise under examination [23].

Evaluation of enterprise economic profitability by means of NPV method is performed basing on the following equation:

$$NPV = NCF_0 \cdot d_0 + NCF_1 \cdot d_1 + NCF_2 \cdot d_2 + ... + NCF_n \cdot d_n, \quad (1)$$

which is correspondent with:

$$NPV = \sum_{t=0}^{n} NCF_t \cdot d_t, \quad (2)$$

where:

NPV - current (updated, present) nett value,
NCF_t – nett cash flux (flow), anticipated for realization period of investment enterprise t,
d_t – discount factor for consecutive years of account period,
t - 0, 1, 2, …, n – successive stages of investment enterprise realization,
n – time of investment realisation.

When investment expenditure is incurred only at the beginning, namely in reference year(zero) t = 0, the equation (1) takes the form of:

$$NPV = \sum_{t=1}^{n} \frac{NCF_t}{(1+r)^t} - I_0, \quad (3)$$

where:

r – discount rate,
I_0 – initial investment expenditure.

The investment is profitable when the Nett Present Value is positive. Negative value indicates unprofitableness of particular investment realization. Comparing a few investments we choose the one with the highest NPV rate [14], [23].

On the one hand the NPV rate depends on value and continuing over time of nett cash flow, on the other on assumed discount rate.

4.1. DISCOUNT FACTOR

Discount factor is expressed by pattern [11]:

$$d_t = \frac{1}{(1+r)^t} \quad (4)$$

Discount factor presents a balancing factor between prospective capital value and its present value.

4.2. DISCOUNT RATE

Discount rate is a minimal return rate required by the investor, which guarantees profit for him entering the realization of a particular investment. It is a return rate to acquire on financial market, or capital cost [3]. The current degree of loan rates in Poland, can be found online at Money.pl [12].

The degree of capital cost is dependent on investment risk – the higher the risk, the higher the anticipated investor income and consequently greater capital cost. When an investment is to be financed only with home capital, the investor has to consider the anticipated profit of the investment to realize. When the investment risk is fairly small he will be content with a moderate income, at the minimum higher than return on investment or treasury bonds. With a high risk, the investor needs to assume high discount rate, reflecting the expected income. When the entire investment is financed with outside capital, the investor must inquire into what is the available loan rate and as a discount rate of NPV, assume a high-interest loan. Effective loan rate to total capital cost (with paid interests). More information on the subject matter can be found on related websites [7], [8] and [9]. For instance when loan interest equals 20% with income tax of 19%, it will be 20% • (1 - 0,19) = 16,2%. NPV index in this instance provides the investor with information on the final income after repaying a loan along with interest.

Most often investment is financed with both home and outside capital. In such a case, for a particular investment, so called *weighted average capital cost (WACC)* must be determined [10]. This financial marker is a weighted average of costs of the capital financing a particular investment and is illustrated by general formula [26]:

$$WACC = \sum_{i=1}^{N} k_i w_i, \quad (5)$$

where:

WACC – weighted average capital cost,
k_i – cost of i-element of capital,
w_i – participation of i-element of capital in financing sources,
i – 1, 2, …, N,
N – number of various elements of capital.

With outside capital (debt) there is a notion of 'tax shield'. Debt interests are included into corporate expenses, reducing taxation base. Hence the notation (1-T) in weighted average capital cost formula. Thus formula (5) can be noted as:

$$WACC = \left(\frac{E}{V}\right) \cdot \mathrm{Re} + \left(\frac{D}{V}\right) \cdot Rd \cdot (1 - T), \quad (6)$$

where:

Re – home capital cost,
Rd – outside capital cost,
E - home capital value,
D – outside capital value,
V – total capital value,
E/V – percentage share of home capital,
D/V - percentage share of outside capital,
T – corporate income tax.

For example, if an investment is financed in 20% with home capital, and in 80% with a loan bearing 20% yearly interest, on the assumption that the investor wishes to acquire a 25% income of the capital employed, then after equation (6) average capital cost will be:

$$WACC = (0{,}2 \cdot 0{,}25) + 0{,}8 \cdot [0{,}2 \cdot (1 - 0{,}19)] =$$

$$0{,}05 + 0{,}1296 = 0{,}1796 \approx 18\%$$

On estimating investment profitability, investor should adopt 18% as a discount rate. It must be noticed that with NPV rate (for this investment) equal to zero, the income will defray loan costs allowing investor to gain 25% of yearly income of capital employed [10].

Interest rates to attain on capital market or capital cost (WACC) are *nominal interest rates* (excluding inflation). However, if with discounting we want to take inflation rate into account, we must employ *real interest rate*. The formula for discount rate is:

$$a = \frac{(1+b)}{(1+i)} - 1, \quad (7)$$

where:

a - real discount rate,
b - nominal discount rate,
i – inflation index.

5. LIFE CYCLE COST PRESENT VALUE

Life cycle cost present value method (LCCPV) as the name itself indicates, is a compound of LCC and NPV methods [15]. The employment of NPV method when estimating LCC allows a comparison (at the present moment) between forward flows of expenses of alternative solutions as well as the choice of most profitable investment.

To acquire life cycle cost present value, on deciding e.g. to buy a product, a potential user should immediately determine its exploitation period. Next, he must estimate current (e.g. yearly, monthly) costs, relating to product exploitation. It is assumed that the anticipated costs are incurred during the first year of product maintenance, which designates reference year (year 0) in LCCPV analysis. With already calculated e.g. average yearly exploitation costs, the only thing which remains to do is, to discount them to reference year in order to consider fluctuation of money value in time. The following notation is used [21]:

$$CPV = \sum_{t=0}^{n} \frac{K_t}{(1+r)^t}, \quad (8)$$

where:

CPV – costs present value,
K_t – cost in year t,
t – 0, 1, 2, …, n – consecutive years of product exploitation,
n – anticipated product life cycle (exploitation years number),
r – discount rate applied in evaluation.

Let us notice that the above notation (8) is a duplication of model (2), with one single difference. Notation (2) includes nett cash flow (NCF_t), therefore both income (profit), as well as costs (expenses), whereas notation (8) encompasses only negative cash flow, namely costs (K_t). Notation (8) is used with recurrent costs. With fixed costs of product life cycle,

annual cost must be multiplied by discount index - notation (4).

Since acquisition costs are incurred in reference year (t = 0), formula (8) can be noted as follows:

$$LCCPV = K_n + K_e = K_n + \sum_{t=1}^{n} \frac{K_e}{(1+r)^t}, \qquad (9)$$

where:

LCCPV – life cycle cost present value,

K_n – acquisition cost,
K_e – exploitation cost.

Due to difficulties with accurate inflation anticipation, most often the analysis of LCC is conducted pursuant to fixed prices, which means that in notations (8) and (9) nominal discount rate is applied. The use of real discount rate in calculating life cycle cost present value requires notation (8) transformation which results in the following form [5], [17] and [19]:

$$CPV = \sum_{t=0}^{n} \frac{K_t \cdot (1+a)^t - 1}{a \cdot (1+a)^t} \qquad (10)$$

In reference literature one can come across an approach which on estimating current value of LCC, includes both inflation index as well as nominal discount rate [6]. Then lifecycle costs are calculated by means of a pattern:

$$LCCPV = K_n + \sum_{t=0}^{n} \frac{K_e \cdot (1+i)^t}{(1+b)^t} \qquad (11)$$

In reference literature, the LCCPV method is applied mainly to selecting one from among various alternative solutions. Practical use of the notations above can be found in papers i.a.: [2], [4], [15], [17], [19] and [24]. It must be pointed out that when comparing lifecycle cost present value, the best choice is the alternative with the lowest total current costs value.

6. CONCLUSIONS

The life cycle cost present value method is an exact instrument for investment profitability evaluation. The calculation basis is determined by costs related with the evaluated investment, whose value is determined by LCC analysis. The LCCPV method is easy to apply since calculation method is simple and its employment not too complex.

The LCCPV method profiled in this paper, allows, with higher or lower degree of probability, to determine the present value of forward life cycle costs which will be incurred during realisation of a particular investment. Because of discount account in LCC analysis, it is possible to include into evaluation distribution in time of the anticipated costs of a specific investment. Quite important here are factors determining money value (interest and inflation rate) as well as expected life cycle. Determining the present value of forward costs, discounted for the time of evaluation, forms the basis for further inference.

Undoubtedly, the results of LCCPV method can apply in decision-making process and in search for most cost profitable solutions. It is apparent that for the investor such information will facilitate the choice between project rejection or adoption. Or most often, from among several available projects, it will help to select the one which for him is most profitable (i.e. of lowest cost value), most promising or due to other adopted criteria.

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