LIBRARY STRATEGIES

Cost-benefit analysis: examples

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Abstract

Purpose – This paper seeks to point outs that, when managing strategically, a library administrator might want to use cost-benefit analysis to prudently spend money and, consequently, would need to understand this methodology.

Design/methodology/approach – The paper discusses the various types of cost-benefit analysis and provides examples of their use.

Findings – It is helpful for library managers to have a proper knowledge of cost-benefit analysis.

Practical implications – This provides one methodology that librarians should consider when contemplating what purchases to make.

Originality/value – This article will help librarians better manage their libraries by making them aware of cost-benefit analysis.

Keywords Library management, Cost benefit analysis, Return on investment, Net present value, Internal rate of return

Paper type Technical paper

A penny saved is a penny gained (Old Scottish proverb).

Previous articles (Linn, 2009, 2010) have discussed cost-benefit analysis (CBA). The former pointed out how some who speak and write about the subject do not seem to know much about it, while the later outlined numerous types of CBA and how they are calculated. The final part of this trilogy will give a few examples of how one can use CBA to save money. Although these examples are made up, they should give the reader an appreciation of how the formulae work and how they can help an administrator save money. CBA is used “to determine whether the favorable results of an alternative are sufficient to justify the cost of taking that alternative” (Shim and Siegel, 1989, pp. 115-6). CBA can be particularly useful in saving money when deciding whether or not to make a large capital expenditure. In these difficult economic times, however, one might want to use it for smaller purchases because a penny saved is a penny gained.

Because of the importance of CBA, a knowledgeable manager who strategically invests the finances of the library would know ways of conducting a CBA and know how and when to use the various types that exist. For example, is it a better financial decision to purchase a particular machine or to lease it? Another example would be in choosing which of two similar devices to purchase when one costs more and is expected to last a few years longer than the other. CBA would help a manager make an informed decision in these situations. However, before we review these examples of how CBA can be used in a library, there will be a short review of various types of CBA.

One method of conducting CBA, the hurdle rate, is “a minimum standard for the return required of an investment, used in selecting from among alternative investment...
choices” (Helfert, 1997, p. 490). This is the minimum gain that is to be expected from a satisfactory investment. As a result, this method does not have a formula and will not be used in the examples.

Likewise, because return on investment (ROI) can be defined in numerous ways, it will not be used in these examples. Two ways that ROI is sometimes calculated are the same as average rate of return (i.e. ARR = average cash inflow/average amount invested) and accounting rate of return (accounting rate of return = return/investment). Finance experts denunciate the use of these (Linn, 2010) so they will not be used in our examples. A third way that some calculate ROI is the same as how internal rate of return (IRR) is determined.

IRR is the “discount rate at which the net present value (that is, the value of all future cash flows, in excess of the original investment, expressed in today’s dollars) of an investment equals zero” (Argenti, 1994, p. 228). The IRR is the number that makes the formula correct when it is inputted for \( r \). Thus, \( \text{IRR} = r \) in this formula:

\[
0 = \sum_{t=0}^{n} \frac{\text{CF}_t}{(1 + r)^t}.
\]

Since it is an interest rate, the answer is a percentage.

Net present value (NPV) is another common way of conducting CBA. NPV requires that one first know what the present value (PV) is. PV is the “amount of cash today that is equivalent in value to a payment, or to a stream of payments, to be received in the future” (Emery and Finnerty, 1997, p. G14) and NPV is the PV “of the expected future cash flows minus the cost” (Emery and Finnerty, 1997, p. G12). Here are two different ways of expressing the NPV formula:

\[
\text{NPV} = \sum_{t=0}^{n} \frac{\text{CF}_t}{(1 + r)^t},
\]

which can also be written as:

\[
\text{NPV} = \frac{\text{CF}_0}{(1 + r)^1} + \frac{\text{CF}_1}{(1 + r)^2} + \ldots + \frac{\text{CF}_n}{(1 + r)^n}.
\]

In these, \( t \) means time period (\( t = 3 \) if the time period is three years); \( \text{CF}_t \) stands for the net cash flow at time \( t \); \( r \) is the discount rate per period; and \( n \) is the number of time periods.

The profitability index (PI), which is occasionally called the benefit-cost ratio, provides the relative profitability of a project. “The idea underlying the PI is to measure the project’s ‘bang for the buck’” (Emery and Finnerty, 1997, p. 355). If the PI is greater than 1.0 it is acceptable, and the higher the PI, the higher the project should be ranked when compared to other possible investments. This is the PI formula:

\[
\text{PI} = 1 + \frac{\text{NPV}}{\text{initial investment}}.
\]

Because the examples in this article are for mutually exclusive projects, the NPV, IRR, and PI methods might recommend different courses of action. For independent projects, all three formulae should make the same recommendations.
Payback period (PP) is “a method of analyzing investment opportunities that determines how long it will take the cash inflows expected from an investment to repay (payback) the initial outlay” (Pringle and Harris, 1984, p. 289). One calculates payback period by using this:

$$PP = \frac{\text{net investment}}{\text{average annual operating cash flow}}$$

Because the discounted payback period is similar, but superior, to the payback period, this method will not be used in the examples.

Discounted payback period is an improved version of payback because it incorporates the time value of money. Discounted payback is defined as the number of years required to recover the investment from discounted net revenues. Like PP, when using discounted payback, one should undertake the proposed project if the discounted payback occurs within a preset timeframe. The formula for discounted payback is the same as the one for PP. The difference is that, instead of using the cash flows as inputs, one uses the PV of the cash flows.

What follows is a scenario that will provide examples of how CBA can be used in a library. These illustrations have fewer factors than one might face in a real-life situation, but this was done so that it would be easier for the reader to understand how these formulas can be put to use.

One factor that could come into play is the interest rate that may or may not have to be “paid” for the funds to purchase a machine. One possibility is that the funds to purchase this machine could come out of an endowed fund that the library controls. If the library’s parent organization had a withdrawal rate of 4.5 percent per year, one could use money from the library’s endowed fund to purchase the copier or one could leave that money in the endowed fund and earn a rate of return of 4.5 percent. Thus, one could regard this as the library “paying” a 4.5 percent penalty on the future growth of the funds by using the money now. Another possibility is that the funding for this machine would come from the annual budget. In this case, one gets no benefit from saving the money, although one would presumably be using that money for purposes other than purchasing the copier (thus, there would be an opportunity cost, but the cost would be, for instance, books not purchased, instead of money not earned). As a result, the interest rate would be 0 percent. As we will see, the most cost efficient machine to purchase with an interest rate of 0 percent can be different from the best one at 4.5 percent.

For this example the library in question needs a copy/digitizing machine for its customers to use and the library administrator is deciding between purchasing one of two machines or leasing one machine. If the library owns the machine, it will produce both expenses and revenue for the library. The costs would include paper, toner, and maintenance, which would be offset by the money that customers pay to use the machine. In addition, as the machine gets older, it is expected that its maintenance costs will increase, thus cutting back on the amount of income generated by the machine. Machine A costs $9,500 and is expected to function for ten years. As result, the amount of net income expected to come in each of the years is $1,500, $1,500, $1,500, $1,500, $1,500, $1,500, $1,300, $1,100, $900, and $700. Machine B costs $11,000, but is expected to have a longer lifespan. As result, the net income that this machine is expected to be produced by this machine over the 12 years of its expected lifetime is $1,500, $1,500, $1,500, $1,500, $1,500, $1,500, $1,400, $1,300, $1,200, $800, $500, and
$400. The other possibility is that the library would lease Machine A instead of purchasing it. In this case, the lease would run for ten years. The upfront cost would be $195.00. Thereafter, the library would get $25 per year throughout the ten-year period. In this case, the library would not benefit from the customers paying to use the machine, but they would also not have to pay the cost for paper, toner, and maintenance. To minimize the number of variables, we will assume that the machines have the same features.

Let us say that the interest rate was 0 percent. One result of this, as we will see, is that for each of the three possible transactions the answer for the payback period is the same as the answer for the discounted payback period. At a rate of 0 percent, Machine A would have an internal rate of return of 6.86 percent, a net present value of $3,500, a profitability index of 1.37, and a discounted payback period of 6.38 years. Machine B would have an internal rate of return of 5.50 percent, a net present value of $3,600, profitability index of 1.327, and a discounted payback period of 7.46 years. For the leasing option there would be an internal rate of return of 4.79 percent, a net present value of $55, a profitability index of 1.28, and a discounted payback period of 7.8 years.

In this scenario Machine A wins in a split decision. It looks like the best option according to the IRR, PI, and discounted payback period methods of analysis, while Machine B has a small advantage according to NPV. All four measures have the lease option coming in third.

If there was an interest rate of 4.5 percent, however, the net present value for Machine A would have an internal rate of return of 6.86 percent, a net present value of $1,021.95, its profitability index would be 1.11, and a discounted payback period of 8.06 years. Machine B would have an internal rate of return of 5.50 percent, a net present value of $546.30, a profitability index of 1.050, and a discounted payback period of ten years. The leasing option would have an internal rate of return of 4.79 percent, a net present value of $2.82, a profitability index of 1.01, and a discounted payback period of 9.82 years.

With these assumptions Machine A came in as the best option in all four measures, with most methods giving it a large advantage. Machine B was the second best. The lease option was third in all measures except for its small advantage over Machine B according to the discounted payback period method.

When considered together, the two scenarios demonstrate a few things. First, it shows the utility of doing CBA. Without doing the calculations, one may have selected the lease option instead of purchasing Machine A. Second, this reconfirms that it is imprudent to rely on any one method of CBA. In the first case, the library administrator would have made the incorrect selection if NPV was the only method of analysis. Similarly, in the second scenario, if the administrator used only the discounted payback period, it would lead to belief that the lease option is superior to the one for purchasing Machine B. Third, these examples demonstrate that an alteration in one variable can change the outcome. The most significant one is that the Machine A option, while being the better one at 0 percent, became a much superior one at 4.5 percent.

Of course, if the library has no money for the upfront cost, it does not matter how good the purchasing options are or how poor a value leasing would be, the administrator would have to go with the later option. In addition to there being no upfront cost, a lease gives one certainty. Despite the fact that one should be able to
forecast patron use of the copier after tracking this for the last few years, circumstances can conceivably change.

In summation, once one sees some examples of how cost-benefit analysis can be employed, one can better appreciate its usefulness. The examples in this article had facts that were complicated enough that it would have been difficult for a manager to select the most fiscally prudent choice without using cost-benefit analysis. As a result, one should now recognize that it is important to use cost-benefit analysis when evaluating capital expenditures, because a penny saved is a penny gained.

References
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