1. Introduction

In this topic we will look at four of the main financial methods used to evaluate projects, namely cost-benefit analysis, payback, time value of money and the internal rate of return (IRR). We will also cover additional methods such as screening, checklists, project profiles and scoring.

Objectives: Project Evaluation Methods

Upon completion of this topic, you should be able to

- perform a financial analysis of a project using methods such as cost-benefit analysis, payback and time value of money
- apply additional project selection methods such as screening, checklist, project profile and scoring
2. Cost-Benefit Analysis

Cost-benefit analysis seeks to identify accurate measures of benefits and costs in monetary terms, and uses the ratio benefits/costs (the term benefit/cost ratio seems more appropriate, and is sometimes used, but most people refer to cost-benefit analysis).

For projects involving long time frames, considering the net present value (NPV) of benefits and costs is important.

The presentation below illustrates how project cost-benefit analysis fits in the project management roadmap.

In the adoption phase, the organisation is concerned with selecting which projects to undertake. In this phase, cost/benefits analysis is one of the key evaluation techniques used to assess which IS projects are of value to the organisation.

Click the link below for an explanation of cost-benefit analysis through a business scenario.

Cost-benefit analysis

Cost-benefit analysis

Assume that a firm is considering the purchase of a new automated machine, which they expect to be more efficient. The firm produces 20,000 units per year of a product that sells for US$2 per unit. There is an expected demand that would allow the firm to sell up to 30,000 units per year in a growing market, but existing machinery (obtained ten years ago, and totally depreciated) is only capable of producing 20,000 units per year. The quality of the existing machine has declined, and about 10% of production must be discarded as waste. This existing machinery produces the product at a unit cost of US$1.50. It could be used for another ten years.
years, with an expected rejection rate of 10%.

The benefits of owning the new machine are an expected reduction in unit cost to US$1.20, with no rejected product due to application of computer technology. The new automated machine has a capacity of 40,000 units per year. Purchase price is US$90,000, with an expected life of ten years. Operating the machinery would involve the same overhead and labour expense as the old machine, but there would be an installation and training expense of US$10,000, incurred within three months of initial operations. The company has a marginal value of capital of 15% per year.

The cost-benefit calculation for the new machine requires identification of benefits in monetary units. Use of net present value (NPV) requires identification of the timing of monetary exchanges. The benefit from the new machine consists of increased production at lower unit cost. Adopting the new machine would enable increased production, because its nominal capacity is double that of the old machinery, and its quality performance is such that there are no discarded products. This would enable the new machine to easily meet the annual demand of 30,000 units per year.

A comparison of the benefits of the old operation versus the new is shown above. The increased contribution to profit per year would be US$24,000 - US$6,000 = the new machine would result in added costs of US$100,000, incurred at the outset of the project.

**Ratio:** The nominal cost-benefit ratio US$18,000 for ten years. A comparison of the costs of the old operation versus the new is shown above. Using \( o \) (disregarding the time value of money) is: \( 10 \times \frac{18,000}{100,000} = 1.8 \). This indicates that the project is worthwhile, in that the extra initial expenses of US$100,000 would be exceeded by expected benefits by 80%. The cost-benefit ratio is easily interpreted. If the ratio exceeds 1.0, the project would be profitable if the firm’s marginal value of capital were equal to the discount rate. The ratio can be used as a basis for rank-ordering projects, with higher ratios being more attractive.

### 3. Payback

View the following presentation to find out about payback.

Another measure of project value is to identify the time for an investment to be repaid. In this case, the investment of US$100,000 (viewing the installation as part of the investment) would be recovered in \( \frac{100,000}{18,000} = 5.6 \) years. Payback is a rough estimate, but presents a view of the transaction that is very understandable and important to project managers.

Another time related factor is the need for cash flow. One alternative may be superior to another on the net present value (NPV) of the total life cycle of the project. However, cost/benefit analysis does not consider the impact of negative cash flow. For instance, in our machinery example, the cash flow by machine would be as given above.

The net benefit column is calculated by subtracting the old machine cash flow from the new machine cash flow. In the first year, this is negative, due to the high investment cost of the new machine. In years 2 through 6, the new machine provides a positive net benefit relative to the old machine.
The new machine gains a nominal advantage by the end of year 6, but US$100,000 has been sacrificed at the beginning. One of the most common reasons for company failure in the US is lack of cash flow. In this case, if the firm has cash-flow difficulties, the investment would be less attractive than if they had adequate cash reserves.

4. The Time Value of money

View the following presentation to find out about the time value of money.

**Time value of money**

We can modify the cost/benefit ratio by considering the time value of money.

In this project, for instance, the nominal expected gains of US$180,000 are spread out over ten years, while the extra costs of US$100,000 are all incurred at the beginning. This is not an attractive situation, as having the US$100,000 would mean that the company would not be able to adopt some other investments (and maybe even force the firm to borrow money). The marginal value of money for the firm is 15% per year. Net present value converts a time stream of money back to its worth in today's terms (or in terms of the project's start, or any other specific time of reference).

The table above shows the changes in cash flow between the old machine and the new machine (shown in the net difference column, calculated as the new machine value minus the old machine value). Discounting each year's net change in cash flow by the discount rate of 1.15 per year to the power of t, where t is the time period, we get the following data. Note that initial expenses are treated as occurring at the end of year 0. This has the effect of dividing by $1.15^0 = 1$, or stating that the net value of initial expenses is equal to their current value.

<table>
<thead>
<tr>
<th>Year (t)</th>
<th>Old machine</th>
<th>New machine</th>
<th>Net difference</th>
<th>Divide by 1.15^t</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>-US$100,000</td>
<td>- US$100,000</td>
<td>- US$100,000</td>
</tr>
<tr>
<td>1</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ S$15,652</td>
</tr>
<tr>
<td>2</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ US$13,610</td>
</tr>
<tr>
<td>3</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ US$11,835</td>
</tr>
<tr>
<td>4</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ US$10,292</td>
</tr>
<tr>
<td>5</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ US$8,949</td>
</tr>
<tr>
<td>6</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ US$7,782</td>
</tr>
<tr>
<td>7</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ US$6,767</td>
</tr>
<tr>
<td>8</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ US$5,884</td>
</tr>
<tr>
<td>9</td>
<td>US$6,000</td>
<td>US$24,000</td>
<td>+ US$18,000</td>
<td>+ US$5,117</td>
</tr>
</tbody>
</table>
Viewed in this light, relative to obtaining a return of 15% per year on alternative investments, obtaining the new machine would be unattractive, equivalent to writing a check for US$9,662 to someone today. If there were some alternative investment on which the company could obtain 15% on their US$100,000 initially invested, they would be ahead by adopting the alternative investment to the tune of almost US$10,000 over a ten-year period.

The cost-benefit ratio using net present values of benefits and costs requires decomposing the net present value (NPV) into its components for benefits and costs. The NPV of the benefits would be the sum of discounted values for years 1 through 10 in this case, or +US$90,338. The discounted costs are US$100,000, because all of the costs were incurred at the beginning of the project. The ratio of benefits to costs is therefore:

\[
\frac{90,338}{100,000} = 0.90
\]

Since this ratio is less than 1.0, the investment is not attractive at a discount rate of 1.15.

### 5. Internal Rate of Return (IRR)

A related concept is *internal rate of return* (IRR), which is the marginal value of capital for which the NPV of a stream of cash flow would break even, or is equal to zero. In this case, the IRR amounts to 1.124 or 12.4% average return. Therefore the NPV at 15% is negative, and the new machine does not appear to be attractive.
6. Expected Value

Expected value of a project is needed when there is a probability of various outcomes. For instance, if everything goes well, a project may be expected to gain US$5 million in net present terms. Conversely, if all goes poorly, the project may be cancelled, and a net present cost of US$4 million may be incurred. The probability of all going well might be 0.1, the probability of all going poorly 0.2, and a 0.7 probability that the overall gain from the project might be US$1 million. The expected value calculation simply sums the products of each outcome multiplied by its probability, as seen in the example below:

\[
\begin{align*}
\text{US$5,000,000} \times 0.1 &= \text{US$500,000} \\
\text{US$1,000,000} \times 0.7 &= \text{US$700,000} \\
\text{-US$4,000,000} \times 0.2 &= \text{-US$800,000} \\
\text{Expected value} &= \text{US$400,000}
\end{align*}
\]

The meaning of expected value is that if this project were adopted many times, on average the outcome would be a net gain of US$400,000.

7. Exercise

Click the link below for an exercise to practise using some financial methods for project evaluation.

Exercise: Project evaluation using financial methods

Exercise Alternate Text

Exercise Alternate Text

Exercise

A utilities company recently provided online services to its customers allowing them to pay their bills via the Internet. The company has been overwhelmed by the success of its online services and the numbers of customers conducting billing transactions have tripled what they had originally anticipated. To cope with the increasing number of customers using its online services, the company is thinking about replacing its old IS systems with a new system that will reduce the cost of conducting transactions from US$1.20 per transaction to US$0.50. The company conducts about 250,000 transactions per year, and the acquisition costs for the new system (including licensing, installation and training) is US$100,000. The following table shows the cost–benefit analysis calculation.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Old system</th>
<th>New system</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Costs</strong></td>
<td>250,000 transactions per year * US$1.20 = US$300,000 per year</td>
<td>250,000 transactions per year * US$0.50 = US$125,000 per year</td>
</tr>
<tr>
<td><strong>Net</strong></td>
<td>-US$300,000 per year</td>
<td>-US$125,000 per year</td>
</tr>
<tr>
<td><strong>Saving per</strong></td>
<td>= 300,000 – 125,000 = US$175,000</td>
<td></td>
</tr>
</tbody>
</table>
Q1. Using the data to do the calculation, what is the cost–benefit ratio?
1. -0.5
2. 1.0
3. 1.5
4. 1.75
The correct answer is
- option 4, 1.75

Q2. Looking at the cost–benefit ratio, is it worth implementing the new system?
1. Yes
2. No
The correct answer is
- option 1, Yes. It is worth implementing the new system.

In a review of its e-business strategy, the company is considering a more advanced system than the one for US$100,000 they were considering earlier. Although the transaction savings from the more advanced system are the same as the earlier proposed system, the more advanced system provides much better support for future needs. However, at US$600,000, the new advanced system costs six times as much as the earlier proposed system. You have been asked to look into the payback for the new advanced system, and have begun to draft some notes about payback calculation below:

<table>
<thead>
<tr>
<th>Year</th>
<th>Old system</th>
<th>New advanced system</th>
<th>Net benefit</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-300,000</td>
<td>-125,000-600,000</td>
<td>-425,000</td>
<td>-425,000</td>
</tr>
<tr>
<td>2</td>
<td>-300,000</td>
<td>-125,000</td>
<td>175,000</td>
<td>-250,000</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q3. Based on your notes, what is the appropriate payback?
1. 3.4 years
2. 3.8 years
3. 4.0 years
4. 4.2 years
The correct answer is
- option 1, 3.4 years
8. Screening

Screening is a process that is very useful in cutting down the dimensions of the decision problem. The way in which screening operates can vary widely in details, but essentially involves identifying those factors that are important, establishing a minimum level of importance, and eliminating those projects that fail on any one of these minimum standards.

Obviously, if the standards are set too high, the decision problem disappears as no projects survive the screening. This is appropriate if the minimum standards reflect what management demands in return for their investment.

To demonstrate screening, assume that 100 IS project proposals are received this month. All of the projects were evidently worthwhile in someone's mind, but management must consider budgets and other resource limitations. Assume that the following criteria and minimum performance levels are required:

<table>
<thead>
<tr>
<th>Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected return on investment</td>
</tr>
<tr>
<td>Qualified project team leadership</td>
</tr>
<tr>
<td>Company has expertise in this area</td>
</tr>
<tr>
<td>Project completion time</td>
</tr>
</tbody>
</table>

If any of the 100 proposed projects failed to meet all four of these standards, they would be rejected pre-emptively. This reduces the number of proposed projects for more detailed analysis. This approach can be implemented by checklists, which give clearly defined standards on those areas of importance to management.

Screening is good at quickly weeding out those projects with unacceptable features. The negative side of screening is that trade-offs between very good features and these unacceptable features are disregarded. The willingness of decision-makers to accept lower Return On Investment (ROI) for projects with strategic importance is disregarded. For those projects for which such trade-offs are not important,
screening is a very efficient way to reduce the number of proposals to a more manageable number.

9. Checklist

You should be familiar with the list of risk factors for IS projects. These could be implemented as a checklist by management, specifying minimum acceptable measures that can be used to screen individual projects. But not all risk elements might apply for a given organisation's checklist.

An example checklist is given below:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project manager ability</td>
<td>Qualified manager available</td>
</tr>
<tr>
<td>Experience with this type of application</td>
<td>Have experience or application in a strategically key new technology</td>
</tr>
<tr>
<td>Experience with the programming environment</td>
<td>Personnel with experience can be obtained</td>
</tr>
<tr>
<td>Experience with the language or system used</td>
<td>Personnel with experience can be obtained</td>
</tr>
<tr>
<td>Familiarity with modern programming practices</td>
<td>If not, training is available</td>
</tr>
<tr>
<td>Availability of critical equipment and software</td>
<td>Each critical component available</td>
</tr>
<tr>
<td>Completeness of project team</td>
<td>Key personnel identified and agree to work, support personnel widely available</td>
</tr>
</tbody>
</table>

Checklists ensure implementation of policy limits. Checklists screen projects based on factors deemed important by the management. The next step in analysis is to more directly compare alternative project proposals.
10. Project Profile

The intent of a project profile is to display how the project proposal compares to standards, as well as how the project compares to other proposals. Profiles have a benefit over screening limits, because poor performance on one factor can be compensated for by strong performance on another factor.

For instance, match with company strategic programs can be an important factor. There could be other project proposals that contribute nothing to the company's strategic program, yet have an outstanding cost improvement for administrative work. This would be reflected in very strong performance on return on investment. Conversely, another project may have a slightly negative return on investment calculation, but may involve entering a new field in which the company wants to gain experience.

To demonstrate project profiles, assume a firm has a number of IS projects proposed. This is generally a large list because of the many beneficial things information technology (IT) can do for organisations. Here we give a short list of six proposals, measured on resources used, as well as benefits expected.

<table>
<thead>
<tr>
<th>Project identifier</th>
<th>Estimated cost</th>
<th>Systems analysts</th>
<th>Cash flow this period</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>A265</td>
<td>230,000</td>
<td>3</td>
<td>100,000</td>
<td>0.43</td>
</tr>
<tr>
<td>A801</td>
<td>370,000</td>
<td>4</td>
<td>-190,000</td>
<td>0.51</td>
</tr>
<tr>
<td>A921</td>
<td>790,000</td>
<td>5</td>
<td>360,000</td>
<td>0.46</td>
</tr>
<tr>
<td>B622</td>
<td>480,000</td>
<td>3</td>
<td>-52,000</td>
<td>0.11</td>
</tr>
<tr>
<td>B837</td>
<td>910,000</td>
<td>7</td>
<td>-200,000</td>
<td>0.22</td>
</tr>
<tr>
<td>C219</td>
<td>410,000</td>
<td>3</td>
<td>170,000</td>
<td>0.41</td>
</tr>
</tbody>
</table>

A profile displays the characteristics of individual projects. Estimated cost is needed to determine if available budget can support a project. The same is true for other scarce resources, such as systems analysts in this case. A tabular form is given above. Graphical displays and ratios are often valuable to give a measure with which
relative performance can be measured. For measures such as IRR, cut-off levels can be used to screen out projects. For instance, a 40% return on estimated cost in IRR might be desired. Project B622 and B837 are both below this limit, and might be screened out. However, both of these projects are listed as key to the organisation's strategy, and management might be willing to accept lower return for potential in order to advance organisational strategy.

11. Scoring

Scoring uses a system of scores and weights to quantify value of each alternative, which can then be used to rank-order these alternatives. Scoring involves multiplying weights (reflecting attribute importance) times values, which are controlled to fall between 0 (worst case) and 1 (best possible).

For instance, for estimated cost, the best imaginable cost might be 0, and the worst imaginable US$1 million. A formula for estimated cost score could be:

\[
\frac{(1,000,000 - \text{estimated cost})}{1,000,000}
\]

Any IRR above 0.5 might be given a score of 1.0, while any IRR 0 or negative might receive a score of 0. Between these values, the score might be estimated IRR/0.5. Scores can also be based upon subjective direct assessment of some value between 0 (very bad) and 1 (very good). Scores for the data given above for project profiles could be:
The resulting score reflects both attribute importance (weights) and alternative scores on each attribute (between 0 and 1). The product of these can be used to rank-order proposals. In this case, the rank-order would be A921, C219, A265, A801, B622 and B837. The first three were quite close in score, and could be considered almost equally attractive. The last two were much lower in score, and could be considered unacceptable. Scoring provides a relatively quick and accurate way to incorporate managerial judgment.

Reading:

12. Self-Assessment

Now, try the self-assessment questions to test your understanding of the topic. Click the following link to open the Self-Assessment in a new window.

<table>
<thead>
<tr>
<th>B837</th>
<th>0.09</th>
<th>0.30</th>
<th>0.05</th>
<th>0.44</th>
<th>0.274</th>
</tr>
</thead>
<tbody>
<tr>
<td>C219</td>
<td>0.59</td>
<td>0.70</td>
<td>0.80</td>
<td>0.82</td>
<td>0.799</td>
</tr>
</tbody>
</table>

**Q1.** Which one of the following statements applies to the evaluation of expensive IT projects?

1. They use completely subjective methods, as no accurate estimates of costs or benefits are available
2. Usually profiles are used to compare various quantitative and qualitative features of alternative means of project accomplishment
3. Usually subjective judgment is applied, although quantitative inputs are used when accurate data is available
4. Cost–benefit ratio is applied in the vast majority of cases, using the best numbers available
5. Almost always, projects are selected on the basis of net present value

The correct answer is
- option 3, Usually subjective judgment is applied, although quantitative inputs are used when accurate data is available

**Q2.** Five means of implementing an ERP are available. If the CEO has stipulated that impact on workers is to be minimal, and security should present minimal risk, which alternative would you choose from the following screening findings?
### Project Evaluation Methods

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Expected NPV</th>
<th>Expertise available</th>
<th>Impact on workers</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor system</td>
<td>+US$20 million</td>
<td>Yes</td>
<td>Very severe</td>
<td>Good</td>
</tr>
<tr>
<td>Partial vendor system</td>
<td>+US$16 million</td>
<td>Yes</td>
<td>Severe</td>
<td>Good</td>
</tr>
<tr>
<td>Customise</td>
<td>+US$25 million</td>
<td>Problematic</td>
<td>Significant</td>
<td>Good</td>
</tr>
<tr>
<td>Develop own system</td>
<td>+US$15 million</td>
<td>No</td>
<td>Minimal</td>
<td>Good</td>
</tr>
<tr>
<td>Application Service Provider (ASP)</td>
<td>+US$40 million</td>
<td>Yes</td>
<td>Minimal</td>
<td>Risky</td>
</tr>
</tbody>
</table>

1. Select the vendor system
2. Select the partial vendor system
3. Select the customised system
4. Develop the system within the organisation
5. Select the ASP

The correct answer is
- option 4, Develop the system within the organisation

**Q3.** If a system costs US$10 million to develop (starting now, complete in two years), and after two years generates savings to the organisation of US$2 million per year, what is the payback?
1. 2 years
2. 3 years
3. 5 years
4. 7 years
5. 10 years

The correct answer is
- option 4, 7 years

**Q4.** If a project involved an initial investment of US$10,000 and was expected to yield gains in net present value (NPV) terms of US$4,000 in 12 months, another US$6,000 after 24 months, and yet another US$5,000 after 36 months, what is the cost–benefit ratio and what is the payback?
1. The cost–benefit ratio is 1.5, and the payback is 12 months
2. The cost–benefit ratio is 1.0 and the payback is 24 months
3. The cost–benefit ratio is 1.5 and the payback is 12 months
4. The cost–benefit ratio is 1.5 and the payback is 24 months

The correct answer is
- option 4, The cost–benefit ratio is 1.5 and the payback is 24 months
13. Summary

This topic covered the following main points:

- Financial methods used for evaluating projects include the cost-benefit ratio, payback, net present value and the internal rate of return.
- The time value of money, or the worth of future financial gains in today's terms, is included in net present value and internal rate of return calculations.
- Other methods for evaluating projects, which might also make reference to financial methods, involve screening, checklists, project profiles and scoring.
- Checklists identify factors which are deemed important to a project.
- Project profiles compare projects using the same criteria.
- Scoring enables projects to be ranked by means of a weighted score.