Business Case Analysis

Business Case as feasibility evidence

Business Case can be used as an evidence that the project can be done within the available budget and the expected return-on-investment.

Cost Analysis

Costs include actual client costs for system development, transition, operations, and maintenance. Costs can be categorized into one-time cost or recurring cost. Cost can also be categorized by type. Three main types are development/production/personnel cost, and capital/infrastructure cost.

For personnel cost, it is usually easier to estimate personnel cost in terms of effort or number of hours, which can later be calculated into dollar amount by using salary rate. Examples of one–time effort includes development and transition effort, while recurring effort includes operational and maintenance effort. Table 14-1 shows how to capture personnel cost.

Table 14-1 Personnel Costs – Exploration phase

<table>
<thead>
<tr>
<th>Activities</th>
<th>Time Spent (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration Phase</td>
<td></td>
</tr>
<tr>
<td>Conduct market survey (10 hours * 2 people)</td>
<td>20</td>
</tr>
<tr>
<td>Architecture Review Board (1.5 hours * 8 people)</td>
<td>12</td>
</tr>
<tr>
<td>....</td>
<td>....</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
</tr>
</tbody>
</table>

The other type of cost is capital or infrastructure cost. If your project acquires a Non-Developmental Item component or Services component, please make sure to consider all the related fees such as transaction fee, license fee, support fee, per GB fee, and maintenance fee.

Table 14-2 Infrastructure cost - Development phase

<table>
<thead>
<tr>
<th>Type</th>
<th>Cost</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware- Web Server</td>
<td>$1500</td>
<td>A new machine is needed to act as a web server for the system.</td>
</tr>
<tr>
<td>Software – Adobe Dreamweaver CS3</td>
<td>$399</td>
<td>Used in developing the system and the team website.</td>
</tr>
<tr>
<td>....</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Benefit Analysis

Quantitative Benefits

Possible benefits should be expressed in financial terms so that it can be compared to costs. Benefits include financial gain, cost avoidance, and cost expenditures. Cost avoidance is usually expressed in future expenditure, while cost saving can be categorized in current expenditure group.

The following table shows example of benefit in terms of hours saved from using the developed application.

Table 15-3 Example of Quantitative Benefits

<table>
<thead>
<tr>
<th>Current activities &amp; resources used</th>
<th>% Reduction</th>
<th>Time Saved (Hours/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application data entry (50 applications * 10 minutes = 500 minutes)</td>
<td>90%</td>
<td>7.5</td>
</tr>
<tr>
<td>Time sheet data entry (5 hours * 52 weeks)</td>
<td>90%</td>
<td>234</td>
</tr>
<tr>
<td>Job request – supervisor (7 supervisors * 1 hour * 52 weeks)</td>
<td>50%</td>
<td>182</td>
</tr>
<tr>
<td>Job request – volunteer coordinator (1 hour * 52 weeks)</td>
<td>50%</td>
<td>26</td>
</tr>
<tr>
<td>Job Assignment (10 hours * 52 weeks)</td>
<td>60%</td>
<td>312</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>761.5</td>
</tr>
</tbody>
</table>

Qualitative Benefits

The value added may also describe non-monetary improvements, which can be critical in customer support and satisfaction. Include the non-monetary benefits and its description such as:

- Increase in organizational reputation: organization’s website will be the main resource in the public relation activities
- Easier for sponsor to donate: with the online donation, sponsor will simply go to the website, which will provide convenience to the sponsor.
A cost-benefit ratio is used to determine the cost effectiveness of a business case proposal, and all benefits and costs should be expressed in discounted present value \[1, 4\].

\[
\text{CostBenefitRatio} = \frac{PV(\text{TotalCosts}())}{\text{TotalBenefits}()} \]

**Table 14-4 Cost Benefit Analysis Worksheet [Reifer 2001]**

<table>
<thead>
<tr>
<th>Cost Benefit Analysis Worksheet</th>
<th>Nonrecurring Costs</th>
<th>Tangible Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Course adaptation</td>
<td>Cost avoidance</td>
</tr>
<tr>
<td></td>
<td>Course conduct</td>
<td>Cost saving</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recurring Costs</th>
<th>Intangible Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courseware</td>
<td>Improved employee</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Satisfaction</td>
</tr>
<tr>
<td>Continuing</td>
<td>Reduced turnover</td>
</tr>
<tr>
<td>Education</td>
<td>Other</td>
</tr>
<tr>
<td>Other</td>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Costs</th>
<th>Total Benefits</th>
</tr>
</thead>
</table>

**Table 14-5 Example of Cost Benefit Analysis Worksheet [Reifer 2001]**

<table>
<thead>
<tr>
<th>Cost Benefit Analysis Worksheet</th>
<th>Non Recurring Costs</th>
<th>Tangible Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain Engineering – Completed on IR&amp;D</td>
<td>Cost avoidance</td>
<td>$10 million</td>
</tr>
<tr>
<td>Reusable assets – project funded</td>
<td>Intangible Benefits</td>
<td>Deliver 12 months earlier than the norm</td>
</tr>
<tr>
<td>Infrastructure development – done by process group</td>
<td>10 times reduction in errors at delivery</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recurring Costs (per year)</th>
<th>Architecture stable, proven, and can be demonstrated to customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture maintenance</td>
<td>Scheduling algorithms can be optimized and improved each time a new product is built</td>
</tr>
<tr>
<td>$200K</td>
<td></td>
</tr>
<tr>
<td>Asset maintenance</td>
<td>$500K</td>
</tr>
<tr>
<td>Process updates</td>
<td>$100K</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total costs</th>
<th>$800K</th>
</tr>
</thead>
</table>

| Total benefits | $10 million |

A cost-benefit ratio is used to determine the cost effectiveness of a business case proposal, and all benefits and costs should be expressed in discounted present value \[1, 4\].
Return On Investment

Return-On-Investment (ROI) analysis is related to cost-benefit-analysis because to determine the ROI value, investment costs and benefits have to be identified as monetary value. “Return on investment is frequently derived as the “return” (incremental gain) from an action divided by the cost of that action [6].”

\[
ROI = \frac{Gains - Investment\ Costs}{Investment\ Costs}
\]

\[
ROI = \frac{Net\ Benefits}{Investment\ Costs}
\]

Moreover, to determine ROI involved with future years (not only for the current year), the time value of money typically needs to be considered [11]. Therefore, ROI is the ratio of the total present value of net benefits during the service life of the project to the total present value of the costs [7]. Consequently, the higher ROI is the better option [5].

**Table 14-6 Example of Return On Investment**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost</th>
<th>Benefit</th>
<th>Cumulative Cost</th>
<th>Cumulative Benefit</th>
<th>ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>425</td>
<td>0</td>
<td>425</td>
<td>0</td>
<td>-1</td>
</tr>
<tr>
<td>2011</td>
<td>156</td>
<td>761.5</td>
<td>581</td>
<td>761.5</td>
<td>0.31</td>
</tr>
<tr>
<td>2012</td>
<td>171.6</td>
<td>761.5</td>
<td>752.6</td>
<td>1523</td>
<td>1.02</td>
</tr>
<tr>
<td>2013</td>
<td>188.76</td>
<td>761.5</td>
<td>941.36</td>
<td>2284.5</td>
<td>1.43</td>
</tr>
</tbody>
</table>

**Figure 14-1 Return On Investment Graph**

Since costs and benefits may occur at different times, the business case analysis will usually discount future cash flows based on likely rates of interest, so that all of cash flows are referenced to a single point in time (usually the present, as in Present
One can then compare two decision options A and B in terms of their ROI profiles versus time. In Figure 2, for example, Option A’s ROI becomes positive sooner than Option B’s ROI, but its longer-term ROI is lower. The stakeholders can then decide whether the longer wait for a higher ROI in Option B is preferable to the shorter wait for a lower ROI in Option A. Option Rapid-B illustrates why stakeholders are interested in rapid application development. If Rapid-B can be developed in half the time, it will be much preferable to either of Options A or original-B.

Unquantifiable Benefits, Uncertainties, and Risk

Two additional factors may be important in business case analysis. One involves unquantifiable benefits; the other involves uncertainties and risk. In some cases, Option A might be preferred to Option B or even Rapid-B if it provided additional benefits that may be difficult to quantify, such as controllability, political benefits, or stakeholder good will. These can sometimes be addressed by such techniques as multiple-criterion decision-making or utility functions involving stakeholders’ preferences for financial or non-financial returns. In other cases, the benefit flows in Figure 15.3 may be predicated on uncertain assumptions. They might assume, for example, that the Option B product will be the first of its kind to enter the marketplace and will capture a large market share.

However, if two similar products enter the marketplace first, then the payoff for Option B may be even less than that for Option A. If the profitability of early competitor marketplace entry can be quantified, it can then be used to determine the relative value of the rapid development Option Rapid-B. This value can then be used to determine the advisability of adopting practices that shorten schedule at some additional cost. An example is pair programming: empirical studies indicate that paired programmers will develop software in 60-70% of the calendar time required for an individual programmer, but thereby requiring 120-140% of the cost of the individual programmer. If the profitability of early competitor marketplace entry is unknown, this means that making a decision between the cheaper Option B and the faster Option Rapid-B involves considerable uncertainty and risk. It also means that there is a value in performing competitor analysis to determine the probability of early competitor marketplace entry, or of buying information to reduce risk. This kind of value-of-information analysis can be performed via statistical decision theory: a discussion and examples of its applicability to software decision making are provided in Chapter 21. An excellent overall introduction to software business case analysis is (Reifer, 2002). Good examples in this book are in Chapters 11, 22, 24, 41, and 44.
Other Financial Analysis Techniques

Breakeven Analysis

This type of analysis is used to determine the point where the benefits equal costs which normally this point is a function of volume [1].

According to [8], “The definitions used in Breakeven Analysis are

- **Fixed Cost**: The sum of all costs required to produce the first unit of a product. This amount does not vary as production increases or decreases, until new capital expenditures are needed.
- **Variable Unit Cost**: Costs that vary directly with the production of one additional unit.
- **Expected Unit Sales**: Number of units of the product projected to be sold over a specific period of time.
- **Unit Price**: The amount of money charged to the customer for each unit of a product or service.
- **Total Variable Cost**: The product of expected unit sales and variable unit cost.

\[(\text{Expected Unit Sales} \times \text{Variable Unit Cost})\]

- **Total Cost**: The sum of the fixed cost and total variable cost for any given level of production.

\[(\text{Fixed Cost} + \text{Total Variable Cost})\]

- **Total Revenue**: The product of expected unit sales and unit price.

\[(\text{Expected Unit Sales} \times \text{Unit Price})\]

- **Profit (or Loss)**: The monetary gain (or loss) resulting from revenues after subtracting all associated costs.

\[(\text{Total Revenue} - \text{Total Costs})\]

- **Break Even**: Number of units that must be sold in order to produce a profit of zero (but will recover all associated costs).

\[(\text{Break Even} = \frac{\text{Fixed Cost}}{\text{Unit Price} - \text{Variable Unit Cost}})\]

For example [9], if variable unit cost is $2.50, fixed cost is $500.00, expected unit sales is 250, and unit price is $5.00, total variable cost, total cost, total revenue and profit can be calculated and plot as the following graph.
Figure 15-3 Breakeven Analysis

From the graph, the breakeven is at 200 units. Therefore, more than 200 products must be sold to make a profit.

This section presents necessary financial concepts (e.g. present value) and financial analysis techniques for evaluating software business case analysis.

**Present Value and Future Worth Concept**

One of the most basic financial concepts used in business case analysis is “cost-of-money” [1]. Present value is the cost-of-money on a given date of future payments (i.e. discounted to reflect the time value of money) [2, 3]. For example, to determine the worth in today’s dollars of the $10K that will receive in next 2 years can be calculated from the following formula.

\[
PV(F, r, n) = \frac{F}{(1 + r)^n}
\]

\[
D = \frac{1}{1 + r}
\]

\[
PV(F, r, n) = FD^n
\]

where
- \( F \) is cash flow
- \( r \) is interest rate per time period
- \( n \) is the number of time periods
- \( D \) is the discount rate calculated from interest rate

Therefore, the value in today’s dollars of the $10K that will receive in next 2 years (assume that the interest rate is 0.8%) is
The concept of discount rate and present value is often applied to other financial analysis techniques [1].

**Payback Analysis**

“The payback analysis is used to determine the number of periods required to recover one’s investment – the payback period [1].”

\[
\text{Payback Period} = \frac{\text{Investment}}{\text{Net Savings}}
\]

Payback period is a measure of time such as payback period is 2.0 years. Investment options can be compared by using the payback period; the shorter payback is the better option [1, 5].

**Value Chain Analysis**

Value chain analysis is another useful approach to evaluate value of different options by using the form of decision tree [1]. The value of each alternative can be determined by using the expected value.

\[
\text{Expected Value } (EV) = \frac{H_i + 4M_i + L_i}{6}
\]

where \(H_i\) = the highest possible value for option \(i\),
\(M_i\) = the most likely value for option \(i\),
\(L_i\) = the lowest possible value for option \(i\),

The formula above is used to compute expected value for mean of a bell-shaped curve, or normal distribution [1]. The following is the example of value of 3 options.

**Figure 14-4 Value Chain Analysis [1]**

For non-normal distribution, the expected value can be calculated from the probabilities of occurrence and value of it [15].

\[
EV(A_i) = P(S_1)V_{i1} + P(S_2)V_{i2} + ... + P(S_n)V_{in}
\]

where \(A_i\) is alternative \(i\),
\(P(S_j)\) is the occurrence probability of state of nature \(S_j\),
\(V_{ij}\) is the value of state \(S_j\) of alternative \(i\)
Pareto Analysis

“This analysis is based on the Pareto principle, which states that a few of the problems are responsible for most of the effect, sometimes called the 80-20 rule [1].” To illustrate, the following Pareto chart shows that CBB, VSS, and CNS functions (about 20% of overall functions) cause 80% of defective costs.

Figure 14-5 Pareto Chart

Thus, “Pareto charts provide insight into causes of problems [1].”

According to [10], “there are seven steps to identifying the important causes using Pareto Analysis:

1. Form a table listing the causes and their frequency as a percentage.
2. Arrange the rows in the decreasing order of importance of the causes, i.e. the most important cause first.
3. Add a cumulative percentage column to the table.
4. Plot with causes on x-axis and cumulative percentage on y-axis.
5. Join the above points to form a curve.
6. Plot (on the same graph) a bar graph with causes on x-axis and percent frequency on y-axis.
7. Draw a line at 80% on y-axis parallel to x-axis. Then drop the line at the point of intersection with the curve on x-axis. This point on the x-axis separates the important causes on the left and less important causes on the right.”
The Comparison of Financial Analysis Techniques

This section presents the situations where each analysis technique is proper to use (i.e. corresponding to its objective) and the limitations or drawbacks of each technique in tabular format as showed below.

**Table 14-7 Comparison of financial analysis techniques**

<table>
<thead>
<tr>
<th>Financial Analysis Techniques</th>
<th>Objectives</th>
<th>Limitations/Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback Analysis</td>
<td>To determine how long the project will take to earn back the money spent on [13].</td>
<td>The straight payback method does not consider the time value of money [13]. To solve this problem net present value and internal rate of return should be considered. The investment after the end of payback period is ignored [1].</td>
</tr>
<tr>
<td>Breakeven Analysis</td>
<td>This analysis is used to determine the breakeven point when benefits and costs are functions of volume [1].</td>
<td>It assumes that fixed costs are constant which it may be not [14]. It assumes that variable costs are constant per unit of output (i.e. linearity) [14].</td>
</tr>
<tr>
<td>Value Chain Analysis (Expected Value of alternatives)</td>
<td>This analysis is useful for dealing with uncertainty in evaluating alternatives (options) [1].</td>
<td></td>
</tr>
<tr>
<td>Pareto Analysis</td>
<td>This analysis is useful for evaluating the source of most system’s failure costs [1].</td>
<td>This analysis possibly excludes important problems which may be small initially, but which grow with time. Thus, other analytical tools (e.g. Failure mode and effects analysis and Fault tree analysis) should be combined [16].</td>
</tr>
</tbody>
</table>

Use Business Case to track earned-value management

A technique often used to implement project monitoring and control functions in the software CMM or the CMMI is Earned Value Management. It works as shown in Figure 14-6
The Earned Value Management process is generally good for tracking whether the project is meeting its original plan. However, it becomes difficult to administer if the project’s plan changes rapidly. More significantly, it has absolutely nothing to say about the actual value being earned for the organization by the project’s results. A project can be tremendously successful with respect to its cost-oriented “earned value,” but an absolute disaster in terms of actual organizational value earned. This frequently happens when the resulting product has flaws with respect to user acceptability, operational cost-effectiveness, or timely market entry. Thus, it would be preferable to have techniques which support monitoring and control of the actual value to be earned by the project’s results.

**Business-Case and Benefits-Realized Monitoring and Control**

A first step is to use the project’s business case (discussed in Section 15.3) as a means of monitoring the actual business value of the capabilities to be delivered by the project. This involves continuing update of the business case to reflect changes in business model assumptions, market conditions, organizational priorities, and progress with respect to enabling initiatives. Monitoring the delivered value of undelivered capabilities is difficult; therefore, this approach works best when the project is organized to produce relatively frequent increments of delivered capability.

A related next step is to monitor assumptions and progress with respect to all of the Initiatives and Outcomes involved in the project’s Results Chain. The suggested monitoring approach in (Thorp, 1998) involves coloring in the degree to which Initiatives and Outcomes have been realized. This can be extended to monitor Contributions and validity of Assumptions as well.

For example, monitoring the Contribution, “Reduce time to deliver product” in Figure 15-1 could uncover the problem that speeding up order entry will create more order fulfillment delays unless a complementary order-fulfillment Initiative is established.

The resulting value realization feedback process is shown in Figure 15-6. With respect to the order-entry example just above, finding out that value was not being realized via reduced delivery times would lead to some corrective action, most likely the establishment of an order-fulfillment speedup Initiative. This would require updates of the overall plans and business case, and new time-phased cost and benefit flows to monitor.

A further option in the value realization feedback process involves adjusting the value function to reflect progress with respect to the product’s production function as illustrated in Figure 15-7. The usual economic production function is an S-shaped curve in which the early “Investment” segment involves development of infrastructure and architecture which does not directly generate benefits, but which is necessary for realization.
of the benefits in the High-payoff and Diminishing-returns segment of the curve. This means that tracking direct benefits realized usually produces pessimistic results during the Investment segment of the curve. One can either manage stakeholders’ expectations to accept low early benefit flows (as with the ROI profiles in Figure 15.3), or use an alternative value function (the dotted line in Figure 15.7), which ascribes additional indirect value to the early investments in infrastructure and architecture. (Actually, the real-options techniques in (Sullivan et. al., 2001) and Chapters 11, 24, and 41 can estimate such values). The preferred approach will depend on the project’s stakeholders and their expectations.

Of course, the actual and potential benefit values realized by each increment of capability need to be monitored and adjusted for changes. For example, a low-cost and user-friendly animated graphics package may increase the net value of animated graphics for certain classes of applications (e.g. education and training), and limited domain speech understanding systems have shown considerable labor-saving value.

![Example Production Function for Software Product Features](image)

**Figure 15-7 Example Production Function for Software Product Features**

**References**


CSCI510 Lecture, Chapter 14 Present versus Future Expenditure and Income


CSCI510 Lectures, Chapter 19 Coping with Uncertainties: Risk Analysis and Chapter 20 Statistical Decision Theory: The Value of Information