

Building the Business Case

A Primer on Writing Effective Business Cases for
IT Projects

by

Martin Schedlbauer, Ph.D., CBAP, CSM, PSM

Northeastern University
College of Computer and Information Science

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PREFACE

This manuscript is intended as an overview on how to construct effective business cases for information technology projects that allow a decision maker to proceed with confidence. While it is clearly not comprehensive and does not address all issues one faces when building a business cases, it nevertheless contains all of the key elements of a business case and the techniques commonly used to derive them.

Martin Schedlbauer, Ph.D., CBAP

Boston, Massachusetts

May 2015

ABOUT THE AUTHOR

Dr. Schedlbauer is a Clinical Professor and the Director of the Information Science program at the College of Computer and Information Science at Northeastern University in Boston where he lectures on data and information science as well as business informatics, software project management, and lean development methods. He previously taught computer and information science at Suffolk University, Boston University, and the University of Massachusetts Lowell. Additionally, Dr. Schedlbauer served as CTO for Global Services at BEA Systems, Inc. where he led the development of the organization's system development methodology and prior to that as founder and CEO for Technology Resource Group, Inc., a global IS consulting firm.

He actively conducts research in business process modeling, business analysis, data analytics, and applied software development methods. Dr. Schedlbauer holds B.S., M.Sc. and Ph.D. degrees in Computer Science from the University of Massachusetts Lowell.

HOW TO USE THIS BOOK IN ACADEMIC AND CORPORATE COURSES

This book is intended for one-semester business school or information science courses on business analysis, quantitative management science, and applied data and decision analysis. Each chapter represents one week worth of work assuming 2.5 contact hours per week. If there are additional contact hours, then online cases can be used to supplement and deepen the material.

For corporate training, this course can be presented in 3 days with hands-on workshop activities. If the chapter on Forecasting is omitted, then the course can be covered in 2 days. The chapter on forecasting might challenge some practitioners and should only be covered if sufficient time is available for exercises and class discussion.

ONLINE RESOURCES

This book is supported by an online portal that hosts these instructional resources:

- Sample syllabus
- Complete slide deck for presentation
- Video tutorials for each chapter
- Supplemental questions and cases for student use
- Discussion forum for students and instructors

Additionally, instructors may request an instructor guide containing solutions to exercises and a test bank of exam questions. To request an instructor guide, please send an e-mail to request@arsdoceo.com. Be sure to include your educational affiliation, as the instructor guide is only available to instructors employed at institutions of higher education.

1 THE BUSINESS CASE

Chapter Objectives

- Understand the value of a business case
 - See how a business case is assembled
 - Identify the stakeholders involved in building a business case
-

A business case is an important tool in project selection and the evaluation of investment opportunities. It outlines the benefits of a proposed project, the objectives addressed by the project, the different actions or decisions that would achieve the business objectives, the risks that may impact the project, and the costs of the project. The Business Analyst (BA) is often the lead author of the business case, although it may sometimes be a manager, executive, or Project Manager (PM).

At the end of the day, the business case seeks to answer the question:

“Should we undertake this initiative?”

Purpose of the Business Case

Management looks to the business case for several reasons:

- Making a decision based on costs versus benefits
- Planning budgeting
- Defining project alternatives
- Maximizing returns while minimizing risk
- Monitoring progress
- Selecting the right strategy

Success Factors

A good business case is credible, practical, accurate, and quantitatively measurable. The successful business case allows the decision maker to choose a course of action with confidence. It contains facts that have evidentiary support and are based on empirical observation and actual data. The key is that the data included must be credible and “backed up” with research; they cannot be guesses, estimates, or “made up.” If data are based on “guesses” then it must be so stated.

Business Case Stakeholders

The following stakeholders are generally involved in the preparation of a business case. While the BA is generally the lead author, many of the actual inputs to the business case come from other sources. The BA must identify the required stakeholders and obtain the necessary information from them.

Stakeholders	Role & Responsibilities
Business executive sponsor	Presents Business Case to the portfolio management team for a decision to invest
Business process owner and subject matter experts	Help estimate business benefits expected from the new initiative
IT, HR, Accounting, Payroll	Establishes cost projections for the technology needed to support new solution
Senior project managers	Help the business analyst establish initial cost and time estimates
Executive team and portfolio management team	Review the Business Case and determine whether to invest in the proposed initiative

Impact on Business Operations

The business case provides details on the impact of the project initiative on business operations. There could be changes to:

- Information managed by the organization
- Business processes
- The organization’s logistics systems and infrastructure
- Workflows, roles and responsibilities, job descriptions

- Business schedules
- Contracts and service level agreements

Workshop Activity

Working in small groups or individually, elaborate on these discussion points:

1) *Are you currently responsible or involved in creating business cases?*

2) *What are some of the challenges you presently face when developing business cases?*

3) *Where do your business cases fall short? DO they allow decision makers to make decisions with confidence?*

- 4) Does your organization have a prescribed template? How well does it address your needs? Does everyone use it? Is it "prescribed"?

- 5) Upon completion of the book or course, return to this question and see what techniques you've learned can help address your challenges.

Summary

- The business case is an essential tool in evaluating and selecting new investment opportunities
- An effective business case allows a decision maker to proceed with confidence
- Data included in a business case must be real and based on actual evidence
- While the BA takes the lead in building business cases, there are many stakeholders who provide input

2 ESTABLISHING NEED

Chapter Objectives

- Determine the needs of the organization
 - Define the project goals and objectives
 - Use root-cause analysis to define the right problem
 - Identify the most important root causes using Pareto Analysis
 - List alternative solutions
-

Addressing a problem requires a precise definition of the business need and the business case has to define that need. The value of the solution is directly related to the value of the problem that is being solved. Root-cause analysis is often used to identify the real problem and not just the symptoms. Ishikawa diagramming – also often called fishbone diagramming – and the “five-why” technique are two common root-cause analysis techniques employed by business analysts. Once root causes have been identified – and there are usually many – the most impactful ones need to be addressed. Pareto Analysis is a useful technique that helps identify the root causes with the most impact on the problem – solve those and the business gets the most impact.

Ishikawa Diagram

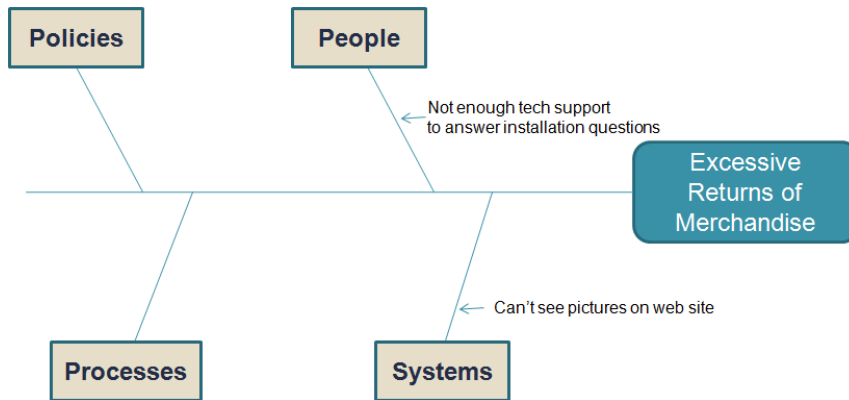
The Ishikawa diagram is a graphical tool used to identify, explore, and analyze the root-cause of problems. It is also known as a cause-and-effect diagram or a fishbone diagram.

To construct an Ishikawa diagram, use the following procedure:

- Write the problem statement at right (fish head)

- List possible causes of the problem drawn as "bones" off main backbone. Generally the four groups of Policies, People, Processes, and Systems are used as a starting point. Additional groups of causes can be added as needed.
- In a group, brainstorm causes of the problem prompted by the four groups.

Ishikawa Diagram Example



Best Practices

Fundamentally, a good business case must answer these questions:

- *What problem are we solving?*
- *Who is experiencing the problem?*

It must also address the "do nothing" alternative:

- *What is the consequence of NOT addressing the problem? Are there any costs? Are there additional risks?*
- *Measure the current state and estimate the impact of NOT addressing the need.*

Workshop Activity

Working in small groups or individually, read the case study background information below and then conduct a brainstorming session to identify potential root causes for the problem of customers complaining about inadequate and delay-ridden customer support. Use an Ishikawa to help in identifying root causes.

Caught in the Middle: Project Opportunities at Central Point Software

Organizations demand that their applications be interconnected and able to share information seamlessly. For this purpose, they invest in infrastructure software called middleware. Middleware connects applications and allows them to exchange data. Many middleware products additionally bridge different operating systems, computer languages, and data architectures resulting in completely interoperable software systems. Modern middleware uses a combination of open protocols and data format standards including XML, SOAP, and WSDL. Previously, CORBA was often used. Middleware is a foundation technology for service-oriented architectures (SOA) and enterprise application integration (EAI).

Central Point Software, LLC (CPS) is a globally organized software vendor offering a comprehensive middleware platform. It differentiates itself from its competitors by handling very large data volumes in disparate computing environments. Furthermore, CPS prides itself in superior customer services and handling customer sales and technical inquiries swiftly and effectively.

Founded in 2004, the company quickly outgrew its small offices in Cambridge, MA shortly after its founding. CPS moved its headquarters to San Jose, CA where it leased a building in an office park on First Ave. While the majority of the research and development work is done in San Jose and (most recently) Tel Aviv, CPS also maintains regional sales and support offices in Boston, Atlanta, Portland, Dallas, San Jose, and Toronto. Its international operations are managed from offices in Sidney, Munich, Dublin, Hong Kong, and Tel Aviv.

The most recent fiscal year completed with annual revenues of \$425 million dollars. Growth has been exceptional after early venture capital funding. No further VC investments have been necessary since and CPS is contemplating an initial public offering (IPO) within 24 months. CPS has been accelerating its growth through the strategic acquisition of several smaller tool and business intelligence software vendors that complement its product line. Additionally, they partnered with a professional services firm to provide on-site consulting and training for their clients.

Upon completion of its IPO, CPS intends to invest the proceeds in further broadening its product line through strategic acquisitions and rolling out a multi-faceted marketing strategy aimed at large to very large corporate data centers. It expects to grow revenues to well over \$1.5 billion within five after years going public.

To avoid having its primary product lines grow stale and be overtaken by competitors, CPS plans to continue its investment in R&D with the goal of releasing at least one major product upgrade every 12 months.

The management team at CPS understands that middleware products must be highly reliable and when something does go wrong customer support must be able to address issues quickly. Consequently, CPS will need to expand its customer service and technical support centers and bolster its reputation of top-notch follow-the-sun support.

In the short term, the management team at CPS must address some immediate issues that have caused customer complaints and are stalling some larger deals. These issues, in no specific order of priority, include:

- Increase customer satisfaction with technical support
- Decrease response time of technical support requests that involve senior engineering
- Reduce technical employee turn-over, particularly for software developers
- Improve “out-of-box” experience for clients by making the software easier to install, configure, and monitor and requiring less technical support during installation

As happens with most rapidly growing technology firms, CPS’s internal operations have not kept pace with the expansion of the firm’s international workforce. The

distributed development approach that has teams working in San Jose and Tel Aviv on joint projects is becoming more difficult to manage as the staff in both offices is expanding. Initially, CPS wanted to leverage the expertise of an acquired middleware company in Tel Aviv. Unfortunately, it has become difficult to coordinate among the engineering teams in California and Israel. In addition, their drive towards an agile methodology is making the lack of co-location more and more of an issue. Recently, CPS has created a development center in Cambridge, MA to leverage the strong supply of superior local engineering talent coming out of MIT, Tufts, and Northeastern. The prospect of having to integrate a third engineering group is causing great heartburn among the engineering management team. The lack of an integrated development environment, coding standards, and common tools is expected to cause a decrease in code quality and productivity.

Customers of enterprise-class middleware products need excellent 24-hour customer support. They run mission-critical system on CPS's platform and availability and reliability are paramount. To that end, CPS needs to significantly upgrade its support center structure and skill set of the support staff employed there. Additionally, a more robust self-service support facility must be created. Among the proposals considered are an online searchable knowledgebase, a customer-editable wiki, a customer-moderated online forum, and a set of short video tutorials on various technical topics distributed through *YouTube* and *Screenr*. Additionally, better tracking of support requests is needed as requests are often routed to different support centers as well as the engineering teams in California and Israel, and eventually Cambridge.

The cost of maintaining multiple call centers is being challenged by the CFO, Mark Sturgis. Mark expects margins to diminish as their middleware platform continues to face competition from open-source initiatives and new start-ups. To reduce cost, Mark has argued for the past year that CPS must provide 24-hour support through a consolidated call center. He is preparing to make his business case for a new support center infrastructure.

Vision and Mission Statements

The mission statement should be a clear and concise definition of the purpose for existence of an organization or project.

All strategic decisions are evaluated against the mission statement. As an example, here is the mission statement for Starbucks¹.



To inspire and nurture the human spirit – one person, one cup and one neighborhood at a time.

And here's Amazon's.



To be Earth's most customer-centric company, where customers can find and discover anything they might want to buy online, and endeavors to offer its customers the lowest possible prices.

Workshop Activity

Working in small groups or individually, elaborate on these discussion points:

- 1) What is your organizations "Mission Statement"? Remember that a mission statement does not always have to be for the organization at large – it can be your group's, department's, or team's mission statement.

¹ From their website at www.starbucks.com.

- 2) Why is it important for business case development to understand an organization's mission statement and vision?

Goals vs. Objectives

Projects are aligned with goals but must have clear, actionable, and measurable objectives. All goals and objectives must align with and support the mission statement of the organization.

To be useful for project evaluation and monitoring, good objectives must be *SMART*:

S	specific, significant
M	measurable, meaningful
A	achievable, attainable, actionable
R	relevant, realistic, reasonable
T	time-bound, tangible, tractable

Workshop Activity

Working in small groups or individually, write at least two objectives based on the CPS goal: "We want to dominate the middleware infrastructure market for Fortune 1000 companies." Remember that an objective must be measurable and time-bound.

1.

2.

3.

Business Objectives

The business case describes and sets targets that increase the value of the organization. The targets must be quantifiable and positively improve one or more of these:

- Market position
- Productivity
- Quality
- Financial position
- Profitability
- Customer satisfaction

Define Alternatives

Aside from defining the proposed solution, a good business must also define one or more alternative solution with varying levels of investment and organizational commitment:

- Optimal solution based on the state-of-the art and cutting-edge technology
- Creative solution that is low-cost but addresses most of the problems
- Patch solution that only addresses critical problems that reduce revenue or increase expenses
- Do nothing solution that does not invest in addressing the problem

The “do nothing” solution alternative is particularly important as we need to understand what would happen if the problem were not addressed and the investment were not made. This provides an actual value of the solution.

Dependencies and Constraints

Each project has constraints and may be dependent on other project, deliverables, or initiatives. The business case must clearly state constraints and dependencies. Any dependency that may not be met, must be classified and catalogued as a risk.

Workshop Activity

Working in small groups or individually, define at least three possible support center strategies for CPS.

1) _____

2) _____

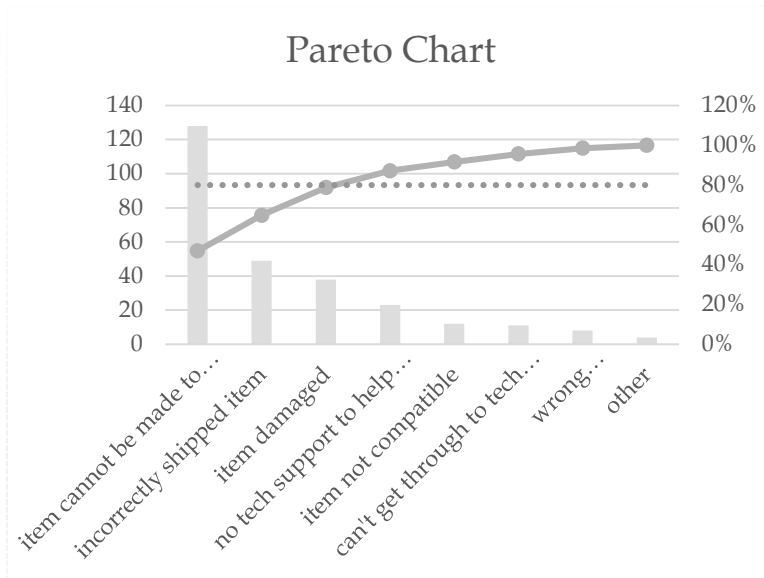
3) _____

Pareto Analysis

Not all causes have the same impact on the problem. Pareto Analysis identifies which root causes have the most impact and have higher priority. Pareto Analysis is the “80/20” rule which captures an uneven distribution of causes and effects. It means that 20% of the root causes generally cause 80% of the problems. Of course, it is not an exact 80/20; it can also be 90/10 or 70/30.

A Pareto Chart visualizes the top causes and how they affect the problem. A good solution addresses these top contributors before focusing on others. The other causes often require effort that is not commensurate with the impact on the problem; a form of the economic “law of diminishing returns”.

The Pareto Chart below shows customer complaints. For example, “incorrectly shipped item” is mentioned a cause for a returned item 48 times. The graph is the cumulative percentage of contribution. The dotted line is the 80% cutoff. Anything to the left of the intersection between the cumulative line and the cutoff line are causes that represent 80% of the issues.



To create a Pareto Chart, follow these steps:

1. Create a table with the causes and their frequency or another quantitative impact measure
2. Sort the rows in decreasing order of impact of the causes, *i.e.*, the most impactful cause first
3. Calculate the cumulative percentage
4. Create a column chart with causes on the x-axis and impact on y-axis
5. Create a line chart with cumulative percentages
6. Draw a line at 80% on y-axis parallel to x-axis.
7. Drop the line at the point of intersection with the curve on x-axis.

Here's the data and Pareto Analysis for the above chart:

Pareto Analysis of Causes for Returned Merchandise

	Frequency	Percent	Cumulative	Cut Off
item cannot be made to work	128	47%	47%	0.8
incorrectly shipped item	49	18%	65%	0.8
item damaged	38	14%	79%	0.8
no tech support to help with installation	23	8%	87%	0.8

item not compatible	12	4%	92%	0.8
can't get through to tech support	11	4%	96%	0.8
wrong dimensions/does not fit	8	3%	99%	0.8
other	4	1%	100%	0.8

Note that the cut-off does not have to be 0.8 (or 80%); it can be any cut-off that is appropriate, such as 70% or 90%. It depends on “how much” of the problem is to be addressed.

Workshop Activity

Working in small groups or individually, create a Pareto Chart and perform Pareto Analysis for CPS. The data below was taken from a recent survey of tech support specialists conducted by HT to determine why there is so much turnover in support. The data has already been sorted in order of impact, so steps 1 and 2 have already been done.

	Frequency	Percent	Cumulative	Cut Off
1. calls could have been answered online	41			0.8
2. answers to customers require too much "leg work"	27			0.8
3. lack of work-from-home opportunities	18			0.8
4. can't see what customers are doing	11			0.8
5. salary not competitive	8			0.8
6. insufficient day care facilities near office	4			0.8
7. benefits not in line with industry	4			0.8
8. other	4			0.8



Summary

- Ishikawa diagrams can help identify the root causes of a problem
- The business need is expressed in a vision statement resulting in a set of goals
- Goals are refined into *SMART* objectives
- Alternative solutions must be identified as well

3 ANALYZING COSTS

Chapter Objectives

- Learn about the different types of costs
 - Differentiate between initial vs. life-time costs
 - Identify project, staffing, and capital costs versus expenses
 - Use depreciation to account for asset costs
 - Understand the impact of accelerating vs. delaying costs
 - Learn about opportunity costs
-

Eliciting all of the costs involved in an opportunity is the start of the cost-benefit analysis (CBA). Cost-benefit analysis defines the project's business value in terms of the costs incurred versus the benefits gained. This chapter looks at the different costs while the next chapter looks at benefits.

Types of Costs

The total cost of a project is the sum of all its costs, including all fixed and variable costs. Fixed costs are costs that are unrelated to changes in output. Fixed costs are unrelated to the actual amount of work of the project or how much time is put into it. On the other hand, variable costs are incremental costs that vary with changes in output. So, the more work we put into a project, the more its variable costs increase. Equipment and software licenses are examples of fixed costs, while salaries and consulting fees are examples of variable costs.

Initial vs. Life-Time Costs

Aside from fixed and variable costs incurred during the solution's development or procurement, a cost-benefit analysis must also account for the cost of ownership.

Identify the costs over the entire lifecycle of the solution. These costs include:

- Procurement and/or development
- Installation and transition to operational environment
- Operation, maintenance, and support
- Administrative overhead
- Sun-setting and decommissioning of replaced systems

Some organizations maintain standard cost categories and associated estimates for those costs.

The table below provides a checklist of common fixed and variable costs.

<i>Fixed Costs</i>	<i>Variable Costs</i>
<input type="checkbox"/> Computers	<input type="checkbox"/> Software
<input type="radio"/> Purchase Cost	<input type="radio"/> Per-User Licensing
<input type="radio"/> Upgrades	<input type="radio"/> Per-User Maintenance
<input type="radio"/> Maintenance	<input type="checkbox"/> Technology Licensing
<input type="checkbox"/> Software	<input type="checkbox"/> Operating Costs
<input type="radio"/> Licensing	<input type="checkbox"/> Salaries & wages
<input type="radio"/> Maintenance	<input type="checkbox"/> Subscriptions
<input type="checkbox"/> Acquisitions	<input type="checkbox"/> Per-transaction fees
<input type="checkbox"/> Support Tools	<input type="checkbox"/> Staffing Costs
<input type="checkbox"/> Development Tools	
<input type="checkbox"/> Network Upgrades	
<input type="checkbox"/> Risk Reserves	

FIGURE 3-1. CHECKLIST OF COMMON FIXED AND VARIABLE COSTS

Staffing Costs

One of the most important and largest project costs are costs related to staffing. Staffing costs include wages, salaries, and fees for employees, contractors, and external consultants:

- Project Management

- Business Analysis
- Engineering and Development
- System Administration
- Procurement
- Training
- Consultants and Outsourcing Partners

Loaded Employee Rates

For employees be sure to use a fully loaded rate that includes overhead. The loaded rate can generally be obtained from the Payroll Department. The loaded rate is generally an overhead factor, *i.e.*, a percentage that is added to each dollar paid to an employee, *e.g.*, 26%.

For example, if an employee is paid a \$75,000 annual salary, then the actual project cost is inflated by the overhead rate. So, with an overhead factor of 26%, then the actual employee cost is $\$75,000 \times 1.26 = \$94,500$ per year or $\$94,500 / 2088 = \45.26 per hour.

Workshop Activity

Working in small groups or individually, identify additional costs that you may need to account for.

Calculating the Right Costs

It is essential that the right costs are calculated:

- incremental costs, *i.e.*, the additional money the organization needs to spend as a result of undertaking the project
- opportunity cost, *i.e.*, the return of alternative investment opportunities

- sunk costs, *i.e.*, only consider future costs not what has already been spent
- overhead costs, *i.e.*, costs that are independent of the project and do not increase as a result of the project

Capital Costs versus Expenses

Capital cost has value after the project has terminated. It becomes a corporate asset. On the other hand an expense uses up or reduces capital and does not add to the balance sheet of the organization.

Accounting for Expenses

Some expenses directly reduce capital, whereas others reduce capital over time. Immediate expenses include staffing, software or other licenses (if used right away), materials, and leases. Depreciated expenses include software, hardware, licenses (if used over time), and machinery. Their costs are factored over time.

Depreciation

Depreciation is done according to a schedule:

- Straight-line (same every year)
- Accelerated (more in earlier years)

Work with the organization's Accounting Department to determine correct and most favorable depreciation schedule.

Accelerating Expenses

Due to the "time value of money", some costs may best be accelerated or delayed. Run various scenarios to determine most beneficial approach. Generally, deferring expenses is best in inflationary times, whereas accelerating is best in deflationary times or when tax rates may rise in the future.

Opportunity Cost

Opportunity cost quantifies the "cost" of investing in one project instead of another, *i.e.*, the value of the next-highest valued alternative. For example, what is the *real* cost of purchasing a software tool? It includes the cost of license for the tool, *plus* potential lost

profit of investing the licensing funds in some other way, even if it's just putting the money in the bank.

Consider another example in which a consulting firm plans to build a scheduling system for its work force. They have identified a number of programming activities for that project that require specialized skills. One of their on-staff consultants has this exact experience. That consultant's salary is \$125,000 per year. The specialized activities are estimated to require about 100 hours of his time. What is the cost to the project? The straight cost would be the consultant's hourly rate multiplied by 100 hours, which would amount to an approximate cost of \$6,000. Now, what if the consultant were not "on the bench" but rather could be billed out for those 100 hours at a rate of \$150 per hour. So, he could generate \$15,000 in billable revenue for the company. In this case, what is the cost that should be charged to the project? It should be \$6,000 plus \$15,000: his salary and the "lost revenue" which is an opportunity cost. Some might argue that the \$6,000 is a sunk cost and has to be paid no matter what so there's no incremental cost if the consultant is on the bench and therefore the project charge for his salary should be \$0. For that perspective, the opportunity cost is only \$15,000 since the \$6,000 salary is counted as a sunk cost. To summarize, there are a number of costs to consider and the calculation must be clearly explained in the business case.

Stating Costs as a Range

Costs, as well as other quantities, should be stated as a range along with a confidence level expressed in a percentage. For example, instead of stating that the employee cost as \$125,000, it should be stated as \$100,000 to \$145,000 with a level of confidence of 70%. In other words, the estimator allows for a 30% chance that the cost is higher than the maximum or lower than the minimum. A range with a confidence level allows a decision maker to assess risk.

Workshop Activity

Working in small groups or individually, discuss why it is important to state cost estimates as a range rather than a single number.

What is the value of including a “probability” or “confidence level” along with the estimate?

How would you introduce such estimates into your organization? What obstacles do you foresee?

Impact of Inaction

The business case should also state the impact of not doing a project or addressing a need, i.e., the “*do nothing*” option. The impact can be financial or qualitative, such as increased workload, additional employee turnover, poor data quality, poor customer service, among others.

Summary

- There are a number of different costs that must be identified and quantified
- Incremental costs are costs that are incurred because of the project
- Sunk costs are generally not counted as costs because they are incurred regardless
- Opportunity cost is an often overlooked type of cost factor

4 ANALYZING BENEFITS

Chapter Objectives

- Distinguish between qualitative and quantitative benefits
 - Estimate qualitative and quantitative benefits
 - Learn how to monitor when benefits are realized
-

Benefits are the return from an investment. Benefits can be qualitative or quantitative. Qualitative benefits are generally not measurable in monetary units or in some other objective way. On the other hand, quantitative benefits are measured in monetary units or rates of change.

Benefits must be defined in financial terms in order to perform cost-benefit analysis.

Types of Benefits

Benefits can be quantitative, such as reduction in expenses, increase in revenue, increase in market share, or reduction in risk, *e.g.*, compliance. In addition, benefits can be qualitative in nature, such as improved employee morale or a more recognized corporate brand.

Information System Benefits

Benefits must be quantifiable to be of value:

- reduced processing errors
- increased throughput
- streamlined business processes
- increased revenue

- decreased expenses
- decreased business risk
- increased market share
- increased customer satisfaction

Benefits that are not quantifiable cannot be measured and monitored. How would you know that the benefits have been realized? Benefits, like objectives, must be *SMART*. They must be specific, measurable, achievable, realistic, and time-bound.

Benefits Model

Benefits should offset costs incurred by a project initiative. Therefore, benefits generally:

- Reduce expenses
- Defer expenses
- Increase revenue

Benefits can also have indirect financial value, but those cannot be used to offset costs:

- Increase in market share
- Increase in customer satisfaction
- Increase in employee retention
- Decrease in customer complaints

Workshop Activity

Working in small groups or individually, determine how you could quantify the benefit of "increased employee morale" so it can be measured?

Quantifying Benefits

For each benefit, determine:

- Quantity in monetary units using forecasting techniques
- Timing to know when financial values are realized using future value discounting
- Likelihood of realizing benefits by computing probabilities of outcomes

Estimate the variance in benefits by defining optimistic, expected, and pessimistic financial values. Perform sensitivity analysis to understand the impact of inaccurate estimates.

Like cost estimates, benefit estimates should also be stated as a range.

Best Practices

- Assume that benefit quantities are optimistic and that probabilities are overestimated.
- Specify a range of estimates and calculate a weighted average using Delphi.

Expected Benefits

Calculate the expected benefits by multiplying each benefit by its probability and summing them. Mathematically, aggregate expected benefit for an initiative is calculated as follows:

$$\text{Aggregate Benefit} = \sum_{i=1}^{\text{All Benefits}} B_i \times P_i$$

Workshop Activity

Working in small groups or individually, discuss why it is important to calculate expected benefits?

The CFO at CPS identified the following benefits for distributed virtual call center. Given the probabilities for each benefit, what is the aggregate expected annual benefit for the project?

Benefit	Estimate	Probability	Expected Benefit
Tax savings by classifying support staff as freelancers	\$876,000	30%	
Compensate freelancers per incident rather than salary	\$278,000	90%	
Ability to offer 24/7 support option to premium customers	\$1,500,000	90%	
Aggregate Expected Benefit			

Monitoring Benefit Realization

Monitor the realization of benefits using these steps:

- Define benefit metrics and how benefits will be linked to measurable outcomes
- Define points in time where benefits will be measured
- Identify a single stakeholder who will be accountable for realizing the benefits
- Understand how a benefit may be realized differently across the organization

Workshop Activity

Working in small groups or individually, discuss who should be responsible to monitor benefit realization? Think about a recent project or business case: who was responsible

for assuring that benefits were realized at the stated level? What were consequences for not realizing benefits?

Process Improvements

A common benefit of a project is the improvement of a business process. Such a benefit is quantifiable in several ways:

- Measure additional units being produced or serviced by calculating flow rate
- Measure reduced flow time, *i.e.*, increased cycle time

These are relatively simple calculations that can be done Little's Law. The BA must determine how to instrument the process in order to get those measures. Before the process improvement is implemented, baseline measures must be taken. The new measurements should only be taken after the improved business process had time "to settle" otherwise learning time would be included.

Summary

- Benefits must be quantified in order to develop a cost-benefit analysis
- Some benefits cannot be quantified yet are still valuable

- Benefits have an associated probability and we need to understand the expected benefit not just the maximum realizable benefit

5 ESTIMATION

Chapter Objectives

- Learn how to apply several cost and benefit estimation strategies
 - Understand the role of expert judgment and estimation by analogy
 - Master the Delphi group estimation technique
 - Apply bottom-up composites to estimation
-

Estimation of costs and benefits is an important part of quantifying the cost-benefit of an initiative. Rarely do we have a precise accounting of the costs and benefits for a project. More commonly, these have to be estimated. In this chapter, we will show how different estimation techniques are used to obtain approximations for quantitative measures.

Estimation Strategies

The estimation strategies can be broadly grouped into two categories: qualitative models relying on subjective input and algorithmic models that rely on objective historical data and mathematical formulas. We will restrict ourselves to the discussion of qualitative models².

² For more information on algorithmic models, see Software Estimation: Demystifying the Black Art by Steve McConnell (Microsoft Press, 2006).

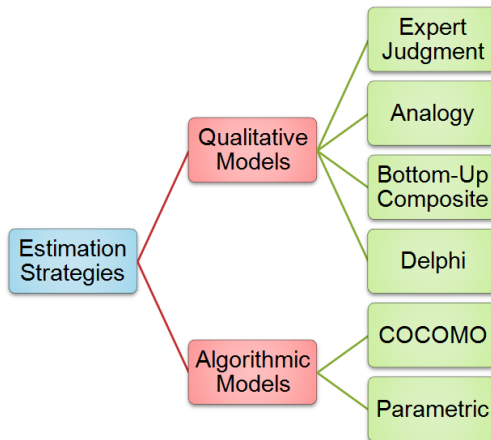


FIGURE 5-1. QUALITATIVE AND ALGORITHMIC ESTIMATION STRATEGIES

Expert Judgment

Expert judgment relies on the experience and expertise of a single individual to provide an estimate. It is the most commonly used technique in practice, although it is often not that accurate and it won't work if experts are not available. Notice that the technique relies on an "expert" not simply any individual.

Accuracy of Estimation

Although Estimation by Expert Judgment based on informal prior project analogies is used by 83% of estimators³, the estimates are often not very accurate. However, Delphi-based group estimates are often as accurate as formal estimation techniques⁴.

³ McConnell, S. (2006). Software Estimation. Microsoft Press.

⁴ *ibid*

Estimation by Analogy

Estimation by analogy uses historical data for estimation. For example, if a previous project had to observe a process and build a process model and that activity took 47 person hours, then a similar activity should take about the same.

Often a scale factor is added to account for variations in size. So, for example, if the process were about twice as large, then we would expect the work to take twice as long as previously.

Estimation by analogy requires tracking of historical data. It is important if that technique is applied that a mechanism is put in place that tracks activity data for projects, costs, benefits, and so on.

Accounting for Efficiency

When providing an estimate for personnel and staffing take into account that no person is 100% productive. Productivity factors of 50-75% are common and in some environments it might even be less. These factors must be derived through empirical measurement.

In addition, competency must be factored into a staff estimate. After all, no two persons have the same talent and skill. Some people are able to complete a task faster.

Finally, the complexity of a task may also influence its task time and must be accounted for in a estimate. Some tasks are harder and require intractable analysis, thinking, and research time.

Group Estimation with Delphi

Delphi is a group estimation technique that provides accurate estimates by asking a panel of experts for estimates. The technique generally works as follows:

1. Ask a panel of experts to provide individual estimates anonymously to avoid group bias.
2. After the individual and anonymous estimates have been received schedule an estimation meeting.
3. During the meeting, the lowest and highest estimates are defended by the individual estimators who provided the outlying estimates. This is the panel's

chance to learn what information the individual estimators relied on that may not have been known to everyone.

4. After the discussion of the outlying estimates, the panel of experts provides a second round of anonymous and individual estimates.
5. The final estimate is calculated as a simple or weighted average.

Delphi is similar to Planning Poker used by agile project teams.

Workshop Activity

Working in small groups or individually, calculate an estimate for the cost for a "Super Bowl" party at your house for 10-15 individuals.

Now calculate the cost estimate using Delphi. Identify what you would provide and what you would need. For each item in your cost breakdown structure, calculate a cost estimate using Delphi. Is it more accurate? Why?

Range of Estimates

A more accurate estimate can be derived by asking the panel of experts to provide not only their most likely estimate but to also provide maximum and minimum estimates. For each data point being estimated, each estimator provides the:

- optimistic estimate: the smallest value
- pessimistic estimate: the largest value
- best estimate: the expected or most likely value

To arrive at a single aggregate estimate, calculate the weighted average of these estimates from each estimator.

The aggregate estimate for each individual expert is calculated as a weighted average in which the best guess estimate is given a weight of 4, while the others have only a weight of 1. Therefore, emphasis is placed on the best guess.

$$E = \frac{O + P + 4B}{6}$$

The final estimate is the average of all aggregate estimates.

The standard deviation for the estimates can be calculated as follows:

$$\sigma = \frac{O - P}{6}$$

Confidence Interval

To provide a range with a 95% level of confidence, use the estimate and then add and subtract 2σ . For example, assume $O = 1200$, $P = 300$, and $B = 500$. This makes $E = 583$. The standard deviation equals 150 which makes the 95% confidence interval 283 to 883.

Workshop Activity

Working in small groups or individually, what is the meaning of a large standard deviation? When does the 95% confidence interval become narrower?

Workshop Activity

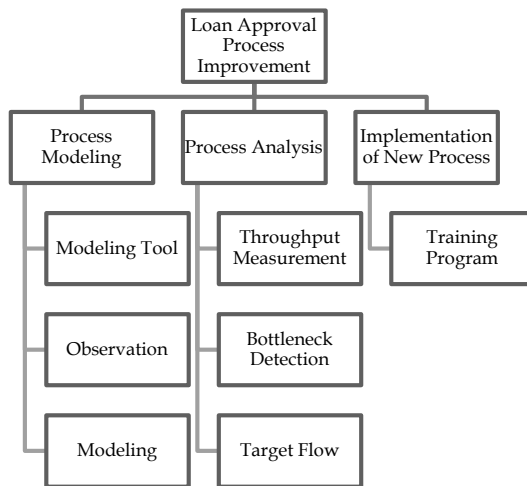
Working in small groups or individually, calculate the Wideband Delphi estimate for Fred. He estimates the tax savings for CPS's virtual call center to be \$300,000 on the conservative side and \$800,000 on the optimistic side. But he feels that it is most likely around \$500,000.

What is the 95% confidence interval for the above estimate?

Bottom-up Composite

Bottom-up composite relies on individuals with specific knowledge to provide estimates (perhaps using Delphi or expert judgment). This is particularly useful for estimating sales or expenses.

To create a cost breakdown structure and provide estimates for each item, then roll-up the estimates into a composite. Here's an example of a bottom up composite for an estimate.



Summary

- Delphi is a useful and relatively accurate estimation strategy
- Bottom-up composite requires a cost breakdown structure
- Personnel cost estimates must take overhead, productivity, and efficiency into account

6 PREPARING A COST-BENEFIT ANALYSIS

Chapter Objectives

- Learn about the different types of feasibility
 - Evaluate the economic feasibility of the solution
 - Perform various financial cost-benefit analyses including break-even analysis, net benefit analysis, internal rate of return, and ROI
-

Feasibility is an assessment of the practicality of a proposed solution in the context of the overall business and the value the solution adds to the business. Feasibility Analysis is the process of establishing feasibility. Feasibility is assessed continually throughout the project to determine whether the project should be allowed to proceed and go to the next phase. The feasibility and wisdom of investing in a project is established along four dimensions: is it worth it, can it work, can we support it, and do we have the time? These dimensions of feasibility are called economic, technical, operation, and schedule feasibility. In this chapter we will look briefly at technical feasibility, but focus principally on the first one: economic feasibility.

Technical Feasibility

- Techniques for establishing technical feasibility include:
 - proof-of-concept prototyping
 - volume forecasting
 - throughput assessment
 - availability estimation

Economic Feasibility

- Economic feasibility assesses the cost versus benefit of the solution.
- Several cost-benefit analysis techniques are used in practice:
 - break-even analysis
 - return-on-investment (ROI)
 - net benefit
- Economic feasibility starts by quantifying the costs and benefits of the solution.

Financial Analysis

- No one, single formula is used to make a decision
- Often there is some subjective analysis applied once the financial analysis has been completed

Time Value of Money

When calculating monetary costs or benefits, it is critical to take the time value of money into account:

- accounts for inflation and reduction of value of money over time, except in a (rare) deflationary economic period
- \$1,000 of today's money does not buy the same amount of goods in the future
- Similarly, a \$20,000 future benefit is not worth \$20,000 in costs today

Present Value

To calculate the present (pv) value of a future amount (fv) of money:

$$pv = \frac{fv}{(1 + d)^n}$$

where,

- n = number of years in the future
- d = discount rate, which is generally the rate of inflation or opportunity cost

For an example, what is the present value of a \$10,000 savings realized by an information system two years after deployment assuming a discount rate of 4%?

$$pv = \frac{fv}{(1+d)^n} = \frac{10,000}{(1+0.04)^2} = 9,245$$

Workshop Activity

Working individually, calculate the present value of a benefit of \$1,235,000 realized three years after deployment of a solution assuming a discount rate of 3%.

Payback Analysis

In *payback analysis*, we calculate at what point in time an investment will have a benefit that outweighs the cost. The time it takes to recover the costs is called the *payback period*. Payback analysis is also often called *break-even analysis*.

The table below shows the calculations for a cost-benefit analysis of an IT project. We can see that we will break even in year 4 or after 5 years overall.

	Year					
Expenses (Costs)	0	1	2	3	4	5
Development Labor	\$ (325,000)					
Operation & Maintenance		\$ (12,500)	\$ (14,000)	\$ (15,000)	\$ (16,000)	\$ (17,000)
Software Licenses	\$ (2,000)	\$ (500)	\$ (500)	\$ (500)	\$ (500)	\$ (500)
<i>Discount Factor (4%)</i>	1.000	0.962	0.925	0.889	0.855	0.822
Present Value of Expenses	\$ (327,000)	\$ (12,500)	\$ (13,406)	\$ (13,779)	\$ (14,104)	\$ (14,384)
Cumulative Expenses	\$ (327,000)	\$ (339,500)	\$ (352,906)	\$ (366,686)	\$ (380,790)	\$ (395,174)
Benefits						
Personnel Savings	\$ -	\$ 75,000	\$ 125,000	\$ 130,000	\$ 135,000	\$ 140,000
<i>Discount Factor (4%)</i>	1.000	0.962	0.925	0.889	0.855	0.822
Present Value of Benefits	\$ -	\$ 72,115	\$ 115,570	\$ 115,570	\$ 115,399	\$ 115,070
Cumulative Savings	\$ -	\$ 72,115	\$ 187,685	\$ 303,254	\$ 418,653	\$ 533,723
<i>Cumulative Cost-Benefit</i>	<i>\$ (327,000)</i>	<i>\$ (267,385)</i>	<i>\$ (165,221)</i>	<i>\$ (63,431)</i>	<i>\$ 37,863</i>	<i>\$ 138,549</i>

Value of Payback Analysis

Payback period is a common measure when comparing several projects. In general, shorter payback periods are better. Longer payback periods are indicators of greater risk as there is a higher likelihood that they may not be realized.

Payback Period: Approach A

To get a better idea of the actual break-even point we can apply one of two payback analysis techniques. Approach A uses a simple algebraic estimation, while Approach B uses a regression trend curve.

The break-even point for Approach A is calculated as follows:

$$t = Y + \frac{-B_Y}{C_{Y+1}}$$

where,

Y = the last year with a negative cumulative benefit

B_Y = the cumulative benefit that year

C_{Y+1} = the net cash flow the following year

This approach uses a standard cash flow forecast that does not account for the present value of future costs and benefits. The cash flow statement is shown below.

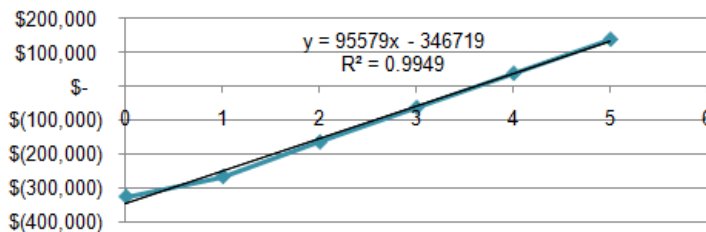
	Year					
	0	1	2	3	4	5
Expenses (Costs)	\$ (325,000)					
Development Labor		\$ (12,500)	\$ (14,000)	\$ (15,000)	\$ (16,000)	\$ (17,000)
Operation & Maintenance						
Software Licenses	\$ (2,000)	\$ (500)	\$ (500)	\$ (500)	\$ (500)	\$ (500)
Total Annual Costs	\$ (327,000)	\$ (13,000)	\$ (14,500)	\$ (15,500)	\$ (16,500)	\$ (17,500)
Benefits						
Personnel Savings	\$ -	\$ 75,000	\$ 125,000	\$ 130,000	\$ 135,000	\$ 140,000
Total Annual Benefits	\$ -	\$ 75,000	\$ 125,000	\$ 130,000	\$ 135,000	\$ 140,000
Net Annual Cash Flow	\$ (327,000)	\$ 62,000	\$ 110,500	\$ 114,500	\$ 118,500	\$ 122,500
Cumulative Benefit	\$ (327,000)	\$ (265,000)	\$ (154,500)	\$ (40,000)	\$ 78,500	\$ 201,000

So, to calculate the payback period, we take the last year of a negative cumulative benefit which is year 3. The cumulative benefit for that year is -\$40,000. The net cash flow for the following year is \$118,500. This makes the payback period 3.34 years or 3 years and 4 months.

$$t = 3 + \frac{-(-40000)}{118500} = 3.34$$

Payback Period: Approach B

Use trendline forecasting to determine the “exact” break-even point by finding the trendline via regression (linear or higher-order).



Once the regression line has been found, calculate the intercept with the x -axis. For the above example, break-even is at: $95579x - 346719 = 0$, which equals 3.63 or 3 years and 8 months.

Return of Investment (ROI)

The ROI is the ratio of total benefits compared to total costs.

$$ROI = \frac{b}{c} \quad \text{Annual ROI} = \frac{ROI}{n}$$

where,

b = net present value of benefits, i.e., total savings
 n = deployed life of solution in years
 c = net present value of costs, i.e., total costs

Here's how to calculate the ROI for the cost benefit analysis show below. The investment (cumulative expenses) is \$395,174 while the total benefits (cumulative savings) are \$533,723. This makes the net benefit (b) equal to \$533,723 - \$395,174 = \$138,549. The ROI is therefore 138549/395174 or 35%. Over an investment period of 6 years, the annualized ROI would be 35%/6 or 5.8%.

	Year					
Expenses (Costs)	0	1	2	3	4	5
Development Labor	\$ (325,000)					
Operation & Maintenance		\$ (12,500)	\$ (14,000)	\$ (15,000)	\$ (16,000)	\$ (17,000)
Software Licenses	\$ (2,000)	\$ (500)	\$ (500)	\$ (500)	\$ (500)	\$ (500)
Discount Factor (4%)	1.000	0.962	0.925	0.889	0.855	0.822
Present Value of Expenses	\$ (327,000)	\$ (12,500)	\$ (13,406)	\$ (13,779)	\$ (14,104)	\$ (14,384)
Cumulative Expenses	\$ (327,000)	\$ (339,500)	\$ (352,906)	\$ (366,686)	\$ (380,790)	\$ (395,174)
Benefits						
Personnel Savings	\$ -	\$ 75,000	\$ 125,000	\$ 130,000	\$ 135,000	\$ 140,000
Discount Factor (4%)	1.000	0.962	0.925	0.889	0.855	0.822
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Cumulative Cost-Benefit	\$ (327,000)	\$ (267,385)	\$ (165,221)	\$ (63,431)	\$ 37,863	\$ 138,549

Net Benefit

Net Benefit is the difference between the present value costs and present value benefits of a proposed solution.

$$\text{NetBenefit} = \text{Benefits} - \text{Costs}$$

This is often used when multiple solution alternatives are compared. Choose the solution with the highest positive net benefit. Clearly a solution with a negative net benefit is not desirable and requires substantial intangible benefits to be of value.

Internal Rate of Return

The internal rate of return (IRR) is a measure of the efficiency of an investment. When comparing multiple investment, organizations generally choose the investment with the highest IRR. To be valuable an investment must have an IRR greater than the discount rate.

Workshop Activity

Working as a group or individually, complete the cost-benefit analysis for one CPS call center option shown on the next page. Specifically, calculate:

- Total Benefits per year
- Present value of Benefits assuming a discount rate of 4%
- Total Costs per year
- Present value of Costs assuming a discount rate of 4%
- Net Cash Flow
- Net Present Benefit Per Year
- Total ROI for the project
- Annual ROI
- Breakeven point

Building the Business Case

xFusion Customer Support Center Cost-Benefit Analysis		Year				Aggregate
		0	1	2	3	
Benefits						
	Avoidance of revenue loss		\$ 3,700,000	\$ 6,400,000	\$ 18,500,000	
	Increased revenue from additional sales support			\$ 11,000,000	\$ 11,330,000	
Total Benefits						
Present Value of Benefits						
Costs						
	Telco equipment & maintenance		\$ 400,000	\$ 600,000	\$ 600,000	
	Marketing campaign	\$ 3,500,000				
	Recruitment costs for TSRs		\$ 720,000	\$ 252,000	\$ 252,000	
	Knowledge base license cost & support	\$ 700,000	\$ 100,000	\$ 100,000	\$ 100,000	
	Servers for knowledge base	\$ 130,000				
	Data conversion and implementation	\$ 960,000				
	Operating costs	\$ 240,000	\$ 480,000	\$ 480,000	\$ 480,000	
	Project management	\$ 1,344,000				
	SMEs		\$ 1,920,000	\$ 1,920,000	\$ 1,920,000	
	Call center fit up	\$ 1,200,000				
	IT vendor support	\$ 480,000	\$ 192,000	\$ 384,000	\$ 384,000	
Total Costs						
Present Value of Costs						
Net Cash Flow						
Net Present Benefit						
Total ROI						
Annual ROI						

Summary

- There are multiple ways to evaluate the financial value of a project
- ROI and IRR weigh an investment against other investments
- Net benefit and payback analysis determine the financial feasibility of a project
- There is a time value to money that affect net benefit

7 IDENTIFYING AND ANALYZING RISK

Chapter Objectives

- Understand the different types of risks that can derail projects
 - Learn how to quantify and prioritize risks
 - Learn how to plan a risk response
 - Calculate the expected cost of risks
 - Calculate the risk reserve for a project
-

Risks are uncertain events that may adversely affect the likelihood of delivering business value or the probability of meeting cost and schedule targets. Any event that could jeopardize the ROI of a project must be documented. A business case must clearly specify any risks, their likelihood of occurrence, their consequence, and the strategy and cost for dealing with the risks.

Writing a Risk Statement

Each risk statement includes a condition, followed by a consequence. For example:

- The consulting partner has a history of changing resources on the project, therefore additional learning time may be required.
- The stakeholders are not willing to be interviewed, therefore requirements may not be fully identified.

Risk Team Members

Enlist an experienced project manager or ensure team members have a working knowledge of:

- Risk management principles and concepts
- Financial analysis and project projection models
- Business analysis structure, operations
- Organizational readiness for the change initiative
- Technical feasibility of the proposed solution both to build and maintain the technology

Tolerance for Uncertainty

Risk tolerance reflects an organization's and stakeholders' attitude toward risk and the amount of risk an organization wants to take. Risk capacity is the amount of risk an organization needs to take to reach its goals.

Common Risks

Among the most common risks particularly among information technology projects are:

- Uncertain/Creeping requirements
- Inadequate communication with stakeholders
- Software that meets requirements but fails to meet the true business need
- Inability for products to grow to meet future needs
- High maintenance costs and effort
- Friction between contractor and clients
- Disruption to operational continuity

Risk Assessment Process

The risk assessment process is summarized in the chart below.

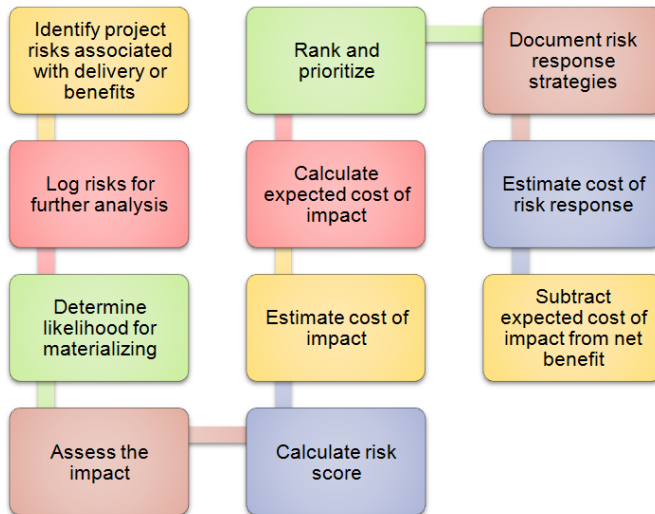


FIGURE 7-1. RISK ASSESSMENT PROCESS

Common Risk Areas

Risks generally arise from two areas: implementation and realization of benefits. The table below summarizes the typical risks encountered on projects. Use this as a checklist when analyzing the opportunity.

Implementation Risks

- Unproven or new technology
- Scope ambiguity
- Project horizon > 12 months
- Lack of stakeholder commitment
- Lack of resources
- Excessive reliance of external vendors
- Poorly defined delivery process that lacks incremental deliverables

Benefits Risks

- Vague measures of outcomes
- Lack of benefits monitoring
- Poor understanding of sensitivity of outcomes to input parameters
- Significant changes to business processes required
- Potential challenges from existing or coming regulations

FIGURE 7-2. COMMON RISK AREAS

Risk Catalog

The risk catalog is a matrix of identified risks along with relevant attributes that assist in the management of the risk. The risk catalog is continually updated and reviewed periodically. It also forms the basis of calculating risk reserves for the cost-benefit analysis.

Risk Attribute	Description
<i>Unique Identifier</i>	A unique identifier for the risk, such as R001 or K001.
<i>Description</i>	A narrative risk statement defining the condition and the consequence.
<i>Prior Probability</i>	The probability or likelihood of the risk occurring before any remediation is attempted. If the probability cannot be estimated, assume 0.5 or a 50/50 chance.
<i>Impact</i>	A quantification of the relative impact on the project should the risk materialize.
<i>Score</i>	$\text{Impact} \times \text{Prior Probability} \times 10$
<i>Rank</i>	The relative rank of the risk based on its score. Risks with high scores are addressed immediately.
<i>Response</i>	One of mitigation, avoidance, acceptance, or transfer.
<i>Owner</i>	Person, group, department, or third party tasked with addressing the risk.
<i>Posterior Probability</i>	The estimated likelihood of the risk occurring after a risk response has been applied.
<i>Cost of Response</i>	The cost of mitigating or avoiding the risk. There is no cost to acceptance, although there is a cost to the consequence. The cost of response must be added to the overall project costs.
<i>Cost of Impact</i>	The cost to the project should the risk materialize.
<i>Expected Cost</i>	$\text{Cost of Impact} \times \text{Posterior Probability}$. This is added as a “risk reserve” to the project’s cost. This ensures that projects with different risk profiles are evaluated fairly.

Assessing Risk Probability

The risk’s prior probability is the likelihood of risk occurring before any attempt has been made to address the risk through mitigation or avoidance. The posterior probability is the

likelihood that the risk might still occur after mitigation. The posterior probability is zero if the risk has been avoided.

Probability thresholds help ensure consistent interpretation. These are subjective, but could be improved with a Delphi estimate. The table below summarizes the numeric risk probabilities.

Likelihood	Numeric Probability Recorded
Very unlikely	0.1
Somewhat unlikely	0.3
Maybe	0.5
Somewhat likely	0.7
Very likely	0.9

FIGURE 7-3. RISK PROBABILITIES

Risk Impact

The impact of the risk is a quantification of the effect that the risk would have on the project should it materialize. The table below provides guidelines for assessing impact.

Level of Impact	Consequence	Numeric Impact Score
Very low	Insignificant cost or time increase	1
Low	Increase of less than 10% in cost and/or time	3
Moderate	Increase of 10-20% in cost and/or time	5
High	Increase of 20-40% in cost and/or time	7
Very high	Increase of more than 40% in cost and/or time	9

FIGURE 7-4. RISK IMPACT

Risk Score

The risk score is the product of the risk's probability and its impact.

$$Score = P \times I \times 10$$

The score is used to establish the relative ranking of risks so that severe risks can be addressed immediately.

Risk Response

There are four basic strategies for dealing with risks:




- Avoid: redefine the strategy so that the risk cannot occur
- Transfer: assign the consequence of the risk to a 3rd party, *e.g.*, insurance or contractual obligation
- Mitigate: find ways to reduce likelihood of occurrence or severity of impact
- Accept: deal with the consequence once the risk materializes

Transfer is often difficult to implement, so project teams generally focus on avoidance, mitigation, or acceptance.

Risk Matrix

The risk matrix shows the risk scores and if the associated risk level.

Risk Score Assessment Matrix					
Probability	Impact				
	Very Low/1	Low/3	Moderate/5	High/7	Very High/9
0.1	1	3	5	7	9
0.3	3	9	15	21	27
0.5	5	15	25	35	45
0.7	7	21	35	49	63
0.9	9	27	45	63	81

Risk Level: Low  Medium  High 

- Responses to Common Risks

Accounting for Risk

For each risk calculate the expected risk impact cost which is the impact cost times the posterior probability. Then add all of these expected risk impact costs to arrive at the total expected risk impact cost for the initiative. This cost is then subtracted from the net benefit for the project.

Alternatively, expected risks costs can also be added to the cost-benefit analysis as costs if the occurrence of the risk is time-bound, i.e., we can estimate during which time period the risk is likely to occur. If the risk can occur at different times periods (at different probabilities), the expected impact cost is accounted for as a cost in each time period. The probabilities for the risk across all time periods must add to 1.

Workshop Activity

Working as a group or individually, calculate the risk reserve for a CPS call center initiative that has identified the following risks:

- Regulatory challenge to classifying freelancers as statutory employees (Impact Cost = \$700,000 with $P = 0.4$)

- Reduction in customer satisfaction and subsequent reduction on renewal of support contracts or renegotiation of terms (Impact Cost = \$400,000 with $P = 0.3$)
- Increased staff turnover causing increased training costs (Impact Cost = \$225,000 with $P = 0.6$)

Summary

- Risks must be quantified through their risk score which is the product of the risk's probability and its impact
- Risks have an associated expected cost that must be accounted for in a cost-benefit analysis concisely

8 DECISION MAKING

Chapter Objectives

- Learn how to build decision tables to make decisions under uncertainty and under risk
 - Master the EMV, Criterion of Realism, and Equal Likelihood strategies for decision making under risk
 - Build decision trees
-

Tmain objective in methodical decision making is an element of analysis and objectivity into the decision making process. Structured and methodical decision making is based on enumerating the choices and the factor and the probabilities that influence the choice. There are two main elements in the decision making process: the alternative or choices and the factors that influence the decision. These factors are generally called the *states of nature* as they are outside the control of the decision maker. Generally, the states of nature are afforded an associated probability as there is a risk as to the exact state of nature that will materialize.

Decision Making Process

There are six simple steps to making a methodical decision:

1. Define the decision that needs to be made
2. List the alternative from which we need to choose
3. Enumerate the different external factors that influence the decision
4. Identify the various payoffs for each decision under each extern factor
5. Select an appropriate decision making strategy
6. Apply the strategy and analyze the results

Decision Making Techniques

We evaluate our decision alternatives, the monetary outcomes (payoffs) of our decisions and the possible external events influencing the decision by constructing a decision table. This decision table is also known as a payoff table. A decision table helps us organize all the different possible outcomes and probability. Aside from building a decision table, we can also enumerate the possible outcomes and alternatives in a decision tree. The choice is personal and made by the business analyst.

Both techniques are used to make decisions under uncertainty, where the probabilities of certain scenarios are unknown and under risk, where the probabilities of certain scenarios are estimable.

Decision Table Layout

A decision table lists the choices or decision alternatives in the rows and the different external factor, scenarios, or states of nature as columns. The payoffs or outcomes are listed in the intersecting cells. Decision tables are easily modeled in a spreadsheet.

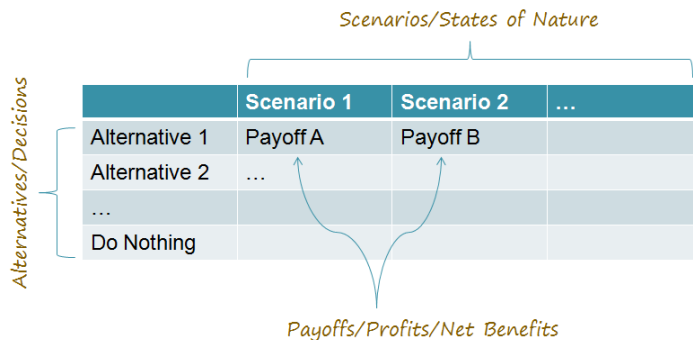


FIGURE 8-1. DECISION TABLE LAYOUT

Decision Making Criteria

There are several decision making strategies depending on whether we can estimate the probabilities of the states of nature or not.

When the likelihood (probabilities) of various scenarios are estimable, then use one of these criteria:

- Expected Monetary Value (EMV)
- Expected Opportunity Loss

If the probabilities are not known and cannot be estimated, then use either:

- Equal Likelihood
- Criterion of Realism

We will take a look at all but Expected Opportunity Loss in this chapter.

Expected Monetary Value

One of the most commonly used decision making strategies is the Expected Monetary value (EMV) strategy. It works as follows:

1. For each scenario, estimate its probability of occurring. The probabilities must add up to 100%.
2. Multiply each payoff for each alternative by the scenario's probability and add all of the weighted payoffs to arrive at an expected payoff (its expected monetary value.)
3. Pick the alternative with the best “average” expected payoff.

The technique is summarized below.

	Scenario 1	Scenario 2	...
Alternative 1	Payoff A	Payoff B	
Alternative 2	...		
...			
Do Nothing			
Probability	p_1	p_2	...

$$EMV(A) = \sum p_i \times Payoff_i$$

Let's consider the example of having a company build out its support capabilities. They have identified the four options summarized below:

- A single support center located in San Jose, staffed 24-hours with Technical Support Specialists
- Several smaller centers located in the major geographical areas
- Complete outsourcing of the support operations to an external offshore vendor
- Virtual support through Technical Support Specialists working from home or very small office suites located throughout the world

These four choices are influenced by several external factors (states of nature) with these estimated probabilities of occurring:

- Slowly increasing number of clients worldwide (25%)
- Steady number of clients worldwide (5%)
- Enormous increase in international clients, but steady growth in the U.S. (60%)
- Decreasing client base in the U.S., but increasing clients internationally (10%)

For each of these options, a cost-benefit analysis with risk accounting resulted in the expected payoffs summarized in the decision table below:

	<i>States of Nature (with probabilities)</i>			
	Slow Increase Worldwide	Steady Growth	Enormous Growth	Decrease in US
<i>Probabilities</i>	<i>0.25</i>	<i>0.05</i>	<i>0.60</i>	<i>0.10</i>
Single Support Center	\$ 376,000	\$ 409,000	\$ 287,000	\$ 179,000
Several Support Centers	\$ 209,000	\$ 198,000	\$ 247,000	\$ 202,000
Outsource Operations	\$ 125,000	\$ 120,000	\$ 78,000	\$ (35,000)
Virtual Support	\$ 508,000	\$ 635,000	\$ 1,090,000	\$ 492,000

For each decision alternative, we need to calculate the expected payoff (EMV) which is the sum of the payoffs multiplied by its probability. For example, the EMV for option 1 (Single Support Center) is calculated as follows:

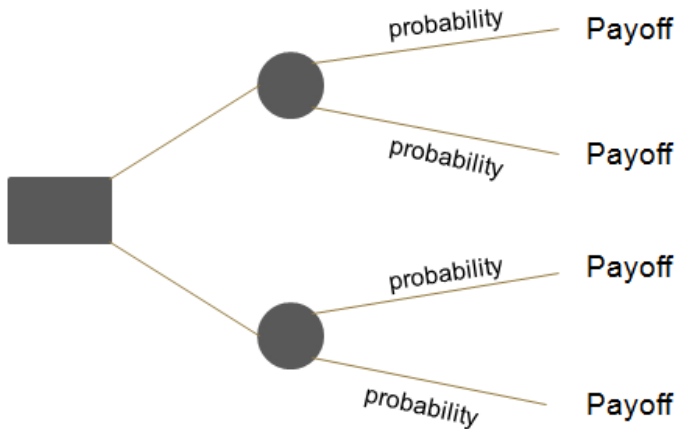
$$376,000(0.25) + 409,000(0.05) + 287,000(0.6) + 179,000(0.1) = 304,550$$

The complete decision table with all EMVs is below. The option with the largest expected payoff based on the estimated probabilities is the Virtual Support option, so that's the decision that the organization should make.

	<i>States of Nature (with probabilities)</i>				
	Slow Increase Worldwide	Steady Growth	Enormous Growth	Decrease in US	EMV
<i>Probabilities</i>	<i>0.25</i>	<i>0.05</i>	<i>0.60</i>	<i>0.10</i>	<i>1.00</i>
Single Support Center	\$ 376,000	\$ 409,000	\$ 287,000	\$ 179,000	\$ 304,550
Several Support Centers	\$ 209,000	\$ 198,000	\$ 247,000	\$ 202,000	\$ 230,550
Outsource Operations	\$ 125,000	\$ 120,000	\$ 78,000	\$ (35,000)	\$ 80,550
Virtual Support	\$ 508,000	\$ 635,000	\$ 1,090,000	\$ 492,000	\$ 861,950

Decision Trees

A decision tree is the graphical equivalent to a decision table. It lists the decisions, payoffs, and probabilities of outcomes in a tree fashion rather than a table. It is functionally equivalent to a decision table, but sometimes it is preferred by business analysts because of its visual nature.



As before we calculate the EMV for each chance node by multiplying the payoff by its probability and then select decision with maximum EMV.

Equal Likelihood

The Equal Likelihood decision making criterion simply takes the average of the payoffs for each alternative. In other words, it is equivalent to the EMV criterion with probabilities of $1/n$. It is useful when the probabilities of the different scenarios cannot be estimated. Once again, we choose the alternative with the largest average payoff.

Criterion of Realism

In this decision making approach developed by Dr. Leonard Hurwicz we ignore all but the best and worst payoffs for each alternative and calculate a weighted sum.

The sum is weighted by a *coefficient of optimism* (α) that captures the level of optimism of the decision maker. We pick the alternative with the best value.

$$V_i = \alpha \max(\text{Payoff}_i) + (1 - \alpha) \min(\text{Payoff}_i)$$

Returning to the call center example, what if we can't estimate the probabilities but can estimate our level of optimism that the best scenario would occur with a likelihood of 0.8. Then the Hurwicz criterion would have the following results for each option:

	Slow Increase Worldwide	Steady Growth	Enormous Growth	Decrease in US	Hurwicz (0.8)
Single Support Center	\$ 376,000	\$ 409,000	\$ 287,000	\$ 179,000	\$179,000
Several Support Centers	\$ 209,000	\$ 198,000	\$ 247,000	\$ 202,000	\$198,000
Outsource Operations	\$ 125,000	\$ 120,000	\$ 78,000	\$ (35,000)	\$ (35,000)
Virtual Support	\$ 508,000	\$ 635,000	\$ 1,090,000	\$ 492,000	\$492,000

Just as with the other two approaches we pick the alternative with the largest value which again would be the Virtual Support option.

Sensitivity Analysis

Sensitivity analysis is concerned with determining how likely the decision is going to change if the probabilities change.

Summary

- Decision making can be quantified through the use of decision making criteria
- EMV is the best criterion to use if probabilities of scenarios are known
- Equal Likelihood and the Criterion of Realism are useful when the scenarios cannot be assessed

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