Return on Investment Analysis for E-business Projects

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INTRODUCTION

As the late 1990s came to a close, many companies had invested heavily in Internet, e-business, and information technology. As the technology bubble burst in 2000 many executives were asking "Where is the return on investment?" When capital to invest is scarce new e-business and information technology (IT) projects must show a good return on investment (ROI) in order to be funded. This chapter will give the reader the key concepts necessary to understand and calculate ROI for e-business and IT projects. In addition, the limitations of calculating ROI, best practices for incorporating uncertainty and risk into ROI analysis, and the role ROI plays in synchronizing IT investments with corporate strategy will be discussed.

What is ROI? One conceptual definition is that ROI is a project's net output (cost savings and/or new revenue that results from a project less the total project costs), divided by the project's total inputs (total costs), and expressed as a percentage. The inputs are all of the project costs such as hardware, software, programmers' time, external consultants, and training. Therefore if a project has an ROI of 100%, from this definition the cash benefits out of the project will be twice as great as the original investment. (In the section *Review of Basic Finance* we will discuss how this definition of ROI, although qualitatively correct, does not accurately include the time value of money, and we will give a more accurate definition based upon internal rate of return [IRR].)

Should a manager invest a company's money in an e-business project if it has a projected ROI of 100%? There are many factors one should consider when making an investment decision. These factors include, but are not limited to those listed below:

The assumptions underlying the costs of the project.

The assumptions underlying the potential benefits.

The ability to measure and quantify the costs and benefits.

The risk that the project will not be completed on time and on budget and will not deliver the expected benefits.

The strategic context of the firm; that is, does the project fit with the corporate strategy?

The IT context of the project: that is, does the project align with the IT objectives of the firm, and how does it fit within the portfolio of all IT investments made by the firm?

As discussed in the section *Review of Basic Finance,* the simple definition of ROI given above is not rigorous enough for good investment decision-making. In addition, the assumptions underlying the model and risks associated with the IT project are key drivers of uncertainty in any ROI analysis. Awareness of these uncertainties and the impact of risks on ROI can significantly improve the likelihood of successful investment decisions.

The return on investment for corporate information technology investments has been the subject of considerable research in the last decade. (For reviews see Brynjolfsson & Hitt, 1998; Dehning & Richardson, 2002; Strassmann, 1990.) The most recent research suggests that investing in IT does on average produce significant returns (Brynjolfsson & Hitt, 1996). See the next section, *The Information Paradox,* for a discussion of this research.

Jeffery and Leliveld (2002) surveyed CIOs of the Fortune 1000 and e-Business 500 companies: Of the 130 CIO respondents, 59% reported that their firms regularly calculated the ROI of IT projects prior to making an investment decision, and 45% of respondents reported that ROI was an essential component of the decision-making process. ROI is therefore an important component of the information technology investment decisions made in many large companies.

However, an interesting observation is that only 25% of companies responding to the survey actually measured the realized ROI after a project was complete. ROI analysis is therefore primarily used to justify an investment decision before the investment is made. Performing post-project analysis provides valuable feedback to the investment decision process to verify the validity of the original ROI analysis, and the feedback improves ROI calculations in the future. Feedback also enables the weeding out of underperforming projects. Full life-cycle ROI analysis translates into better information to make better decisions, which in turn should impact the returns for the total corporate IT portfolio of investments.

The total IT investments made by a firm can be thought of as a portfolio, similar to a financial portfolio of stocks and options. Each IT investment will have a different risk and return (ROI) and, because capital is limited, selecting the optimal portfolio is a challenging management decision for any firm. The methodology for choosing and managing an optimal IT portfolio is called IT portfolio management. This process often includes the use of scorecards so that executive managers can rate projects on multiple dimensions and ultimately rank projects in relative order of importance to the firm. A typical scorecard will include several categories that help quantify the value of a project to the business and the risk of the project. Note that ROI is typically only one category on the scorecard and that several other factors may have equal or greater importance. In the *Executive Insights* section at the end of this chapter, an example of the IT portfolio management process at Kraft Foods and their score card used to rank e-business and IT projects are discussed.

In the following section we will briefly review the research literature on returns on investment for information technology and the related information paradox. The third section, *Review of Basic Finance,* is an introduction to the key finance concepts necessary to calculate ROI. Using these concepts, the ROI for a case example is calculated in the section *Calculating ROI for an e-Business Project,* and a template is given that is applicable to any ROI calculation. Uncertainty in assumptions and risk are important considerations, and the section *Uncertainty, Risk, and ROI* shows how to include these factors in the ROI analysis. Specific risk factors for e-business projects that may impact the ROI are also discussed. This section shows how sensitivity analysis and Monte Carlo methods can be applied to ROI models; these are two powerful tools for understanding the range of possible ROI outcomes based upon the cost and revenue assumptions and the risks in the project. The last section, *Executive Insights,* gives some tools for oversight of technology investment decisions—specifically, questions to ask when reviewing an ROI analysis and how ROI fits within an information technology portfolio management framework for optimal IT investment decisions are discussed.

THE INFORMATION PARADOX

The question of how investment in information technology impacts corporate productivity has been debated for almost a decade (for reviews see Brynjolfsson & Hitt, 1998; Dehning & Richardson, 2002; Strassmann, 1990). Productivity is defined similarly to ROI in the introduction—it is the amount of output produced per unit of input—and although easy to define, it can be very difficult to measure for a firm (Brynjolfsson & Hitt, 1998). This difficulty in measurement is similar to the challenges of measuring ROI for information technology and e-business projects. The output of a firm should include not just the number of products produced, or the number of software modules completed, but also the value created to customers such as product quality, timeliness, customization, convenience, variety, and other intangibles.

One would expect that the productivity of the overall economy should increase over time, and this is indeed the case for the manufacturing sector, where the outputs are relatively easy to measure—see Figure 1a. This productivity increase is not due to working harder—because although working harder may increase labor output, it

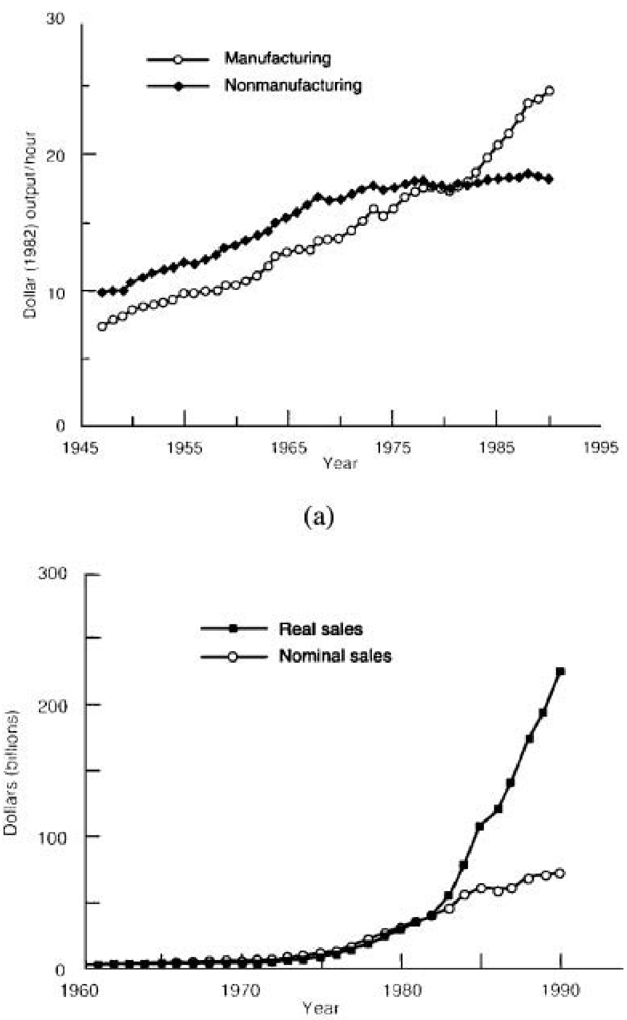

Figure 1: (a) Average productivity for the manufacturing and service sectors. (b) Purchases of computers not including inflation (nominal sales) and sales adjusted for inflation and price deflation due to Moore's law (real sales). The real sales are an indication of the actual computing power purchased. Source: Brynjolfsson (1993).

also increases labor input. True productivity increases derive from working smarter, and this usually happens by adopting new production techniques and technologies.

The greatest increases in productivity have historically been associated with "general-purpose technologies." Examples are the steam engine and the electric motor. These inventions were applied in a variety of ways to revolutionize production processes. One would expect that computers and the Internet, because they are also general-purpose technologies, should dramatically increase productivity.

However, data in the late 1980s and early 1990s suggested that the average productivity of the U.S. economy in the nonmanufacturing or service sector, which is a primary user of computers and IT, had been constant from 1970 to 1990—see Figure 1a. During this same time frame corporate investments in computers had increased dramatically, so that by 1990 investments in computer hardware averaged 10% of a company's durable equipment purchases. Furthermore, following Moore's law, the number of transistors on a computer chip doubles approximately every 18 months, and the speed of computers doubles every 2 years. Hence the "real" computing power purchased by firms increased by more than two orders of magnitude from 1970 to 1990. The apparent inconsistency of IT spending and productivity was termed the *productivity paradox,* and the conventional wisdom of the late 1980s was that there was no correlation between investment in IT and productivity. If the productivity paradox is true, it suggests that firms should not invest in IT because it does not create good ROI.

The problem with this conclusion is that it is based upon aggregate data averages of the entire U.S. economy. These data are averages that measure productivity in terms of the number of products produced. So as long as the number of products increases for the same level of input, the productivity increases. For computers, this accounting works well if they are used to cut costs, but it does not work if they are used to transform business processes or create intangible value. Brynjolfsson and Hitt (1998) use the example of the automated teller machine (ATM) and the banking industry. ATMs reduce the number of checks banks process, so by some measures, investing in ATM IT infrastructure actually decreases productivity. The increase in convenience of ATMs goes unaccounted for in traditional productivity metrics. For managers, IT can look like a bad investment when they can easily calculate the costs of the IT investments, but have difficulty quantifying the benefits.

In the mid- to late 1990s several research studies were undertaken on new data sets that included individual data on thousands of companies (see for example Brynjolfsson & Hitt, 1996; Dewan & Min, 1997; Malone, 1997). These data enabled researchers to find a significantly better way to measure firm performance. Across all of these research studies there is a consistent finding that IT has a positive and significant impact on firm output, contradicting the productivity paradox. However, these studies also show that there is a significant variation in the magnitude of this payoff among firms.

Figure 2 is a plot of the variation in productivity and IT investments across 1,300 firms (Brynjolfsson & Hitt, 1998). The horizontal axis (labeled "IT Stock") is the total IT inputs of the firm. The vertical axis is the productivity, defined as the firm outputs divided by a weighted sum of the inputs. Both productivity and IT input are centered at the industry average. The best-fit line is clearly upward-sloping, indicating the positive correlation between IT spending and productivity at the firm level. However, the striking feature of these data is the wide variation of returns. Some companies spend more than the industry average on IT and have less productivity, whereas others spend less and have greater productivity.

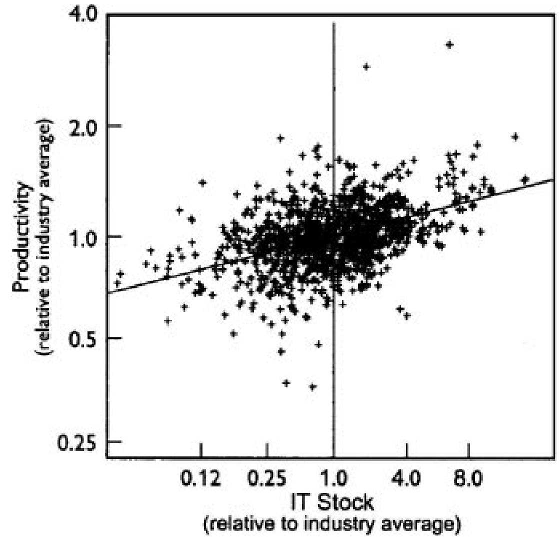

Figure 2: Productivity as a function of IT Stock (total firm IT related expenditures) for a sample of 1,300 individual firms. Source: Brynjolfsson and Hitt (1998).

The large variations in returns on IT are well known by many corporate executives. For every amazing IT success story such as Dell, Cisco, or WalMart there are many failed or out-of-control IT projects (Davenport, 1998). As examples of these failures, a Gartner survey of executives found that 55% of customer relationship management (CRM) projects do not produce results, and a Bain consulting survey of 451 senior executives found that one in five reported that the CRM system not only failed to deliver profitable growth but actually damaged longstanding customer relationships (Rigby, Reichfeld, & Schefter, 2002).

The wide variation of returns in Figure 2 is indicative of the fact that there is more to productivity than just investment in information technology. Other factors are just as important—the ability of the firm to exploit organizational change and how the IT investment fits in the context of the firm's strategy in a given industry. Research suggests that there is on average a time lag, of order 1 to 3 years, before the benefits of a large IT investment significantly impact a firm's productivity (Brynjolfsson & Hitt, 1998).

In summary, research studies of the late 1980s and early 1990s suggested that there was no correlation between IT investments and firm productivity; this was called the *information paradox*. However, studies in the mid 1990s based upon firm-level data from thousands of companies all suggest that there is a significant payoff from IT investments, contradicting the information paradox. However, these payoffs are contingent on a firm's ability to effectively adapt through organizational change to the new technology, and on a firm's ability to effectively manage the overall portfolio of IT investments. These results suggest that investing in IT is on average a positive ROI activity, but the benefits of IT investments are difficult to measure and risk factors can significantly impact the actual ROI realized.

REVIEW OF BASIC FINANCE

In this section we review the basic finance necessary to calculate ROI. The key concepts are the time value of money and internal rate of return (IRR). For a complete introduction to corporate finance see Brealey and Myers (1996). In the following section, a general framework is given for ROI analysis, and the ROI is calculated for a case example e-business project. The reader should note that ROI analysis for e-business investments and IT is in principle no different from ROI analysis for other firm investments such as plant and equipment, research and development, and marketing projects. All use the same financial tools and metrics and follow the general framework discussed in the next section.

The Time Value of Money

As an example, consider two e-business investments. Assume that both projects cost the same, but the first (Project 1) will have new revenue or cost-saving benefits of $5 million (M) each year for the next 5 years, and the second (Project 2) will have benefits of $11 M at the end of the first and second years, and nothing after that. If we only have enough capital to fund one project, which of these e-business projects is worth the most cash benefit today?

We might argue that the first investment's cash flows are worth $5 M times 5 years, which is $25 M, and the second project's payouts are $11 M times 2 years, or $22 M. From a purely financial perspective, assuming all other factors are equal, we would conclude by this reasoning that we should invest in the first project instead of the second. However, intuitively we know that $1 today is worth more than $1 in the future—this is the "time value of money." The dollar today is worth more because it can be invested immediately to start earning interest. So just adding the cash flows ignores the fact that $5 M received today has more value than $5 M received 5 years from now.

The correct approach is to discount the cash flows. That is, $1 received in 1 year is actually worth $\$1/(1+r)$ today, where r is called the discount rate and is the annual interest rate investors demand for receiving a later payment. In this example, if r is 10%, a dollar received in one year is worth $\$1/1.1 = 91$ cents today. Similarly, cash received 2 years from now should be discounted by $(1+r)^2$, so that the dollar received 2 years in the future is worth $\$1/(1.1)^2 = 83$ cents today.

This argument can be generalized to a series of cash flows $A_1, A_2, A_3, \ldots, A_n$ received in time periods 1, 2, 3, …, n. The value of these cash flows today is calculated from the discounted sum

$$PV = A_1/(1+r) + A_2/(1+r)^2 + A_3/(1+r)^3 + \cdots + A_n/(1+r)^n. \quad (1)$$

where n is the number of time periods and PV is called the present value of the cash flows. Discounting a series of cash flows is mathematically equivalent to weighting cash received in the near term more than cash received further in the future. The effect of inflation is generally ignored in the cash flows, so that $A_1, A_2, A_3 \ldots, A_n$ are given in today's prices. Inflation can be included in the present value calculation by adding an inflation factor to the discount rate. This is particularly important in economies that have high inflation rates. For a complete discussion of how to incorporate inflation see Brealey and Myers (1996).

In general, the series in Equation (1) can easily be calculated using the built-in present value function in personal computer spreadsheet software (such as Microsoft Excel) or using a financial calculator. For the special case when the cash flow is the same for each period ($A_n = A$), such as in a bank loan, the sum can be calculated in closed form:

$$PV = \sum_{k=1}^{n} \frac{A}{(1+r)^k} = A\left[\frac{1}{r} - \frac{1}{r(1+r)^n}\right]. \quad (2)$$

Returning to our original example, the present value of the two cash flows is calculated in Figure 3a assuming $r = 10\%$. In this example, PV(Project 1) = $19 M and PV(Project 2) = $19.1 M, so the expected cash benefits of the second project actually have more value today in present value terms than the first project. If the projects cost the same to execute, and this cost is less than $19 M, a manager should prefer to invest in Project 2.

In order to compare projects that have different costs (investment amounts), it is useful to subtract the initial investment costs I from the present value, thus obtaining the net present value (NPV):

$$NPV = PV - I. \quad (3)$$

If the costs of the project are spread out over multiple time periods, then I is the present value of these costs. Hence from Equation (1), Equation (3) is equivalent to

$$NPV = -C_0 + \frac{(A_1 - C_1)}{(1+r)} + \frac{(A_2 - C_2)}{(1+r)^2} + \frac{(A_3 - C_3)}{(1+r)^3} + \cdots + \frac{(A_n - C_n)}{(1+r)^n}, \quad (4)$$

where the costs of the project $C_0, C_1, C_2, C_3, \ldots, C_n$ have been subtracted from the cash benefits $A_1, A_2, A_3, \ldots, A_n$ in the corresponding time periods 1, 2, 3, …, n.

When making investment decisions, one always strives to invest in positive NPV projects. If the NPV of a project is negative, this means that the initial investment is greater than the present value of the expected cash flows. Investments in projects with negative NPVs should not be made, because they do not add value to the firm and actually extract value.

(a)

Project 1

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Final Payout Cash Flows		5	5	5	5	5
Present Value (US $ million)	**19.0**					

Project 2

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Final Payout Cash Flows		11	11	0	0	0
Present Value (US $ million)	**19.1**					

(b)

Project 1

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Final Payout Cash Flows		5	5	5	5	5
Initial Investment	(9)					
Present Value (US $ million)	19.0					
Net Present Value (US $ million)	**10.0**					
Profitability Index	1.11					

Project 2

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Final Payout Cash Flows		11	11	0	0	0
Initial Investment	(10)					
Present Value (US $ million)	19.1					
Net Present Value (US $ million)	**9.1**					
Profitability Index	0.91					

Figure 3: (a) The present value (PV) of Project 1 and Project 2 cash flows. (b) The net present value (NPV) and profitability index calculation. The discount rate is 10% for both (a) and (b).

Returning to our example, assume that the initial cost of Project 1 is $9 M and the initial cost of Project 2 is $10 M. From Figure 3b the NPV(Project 1) = $10 M and NPV(Project 2) = $9.1 M. Hence both projects have positive NPV, and should add value to the firm. However, if capital is limited (or rationed) one must select investments that have the most "bang for the buck." In other words, one must select projects that have the greatest returns for a given dollar of investment. A useful ratio capturing this idea is called the profitability index:

$$\textit{Profitability Index} = \frac{\textit{Net Present Value}}{\textit{Investment}}. \tag{5}$$

For our example in Figure 3b, the profitability indices are 1.11 and 0.91 for Project 1 and Project 2, respectively, and NPV(Project 1) = $10 M > NPV(Project 2) = $9.1 M. Because the profitability index is greater for Project 1 than Project 2, if the funding decision is based purely upon financial metrics Project 1 is the preferred investment.

The present value and net present value clearly depend upon the discount rate. What discount rate should we use for an e-business investment? The discount rate used for investments in a specific firm is defined by the expected return of the combined debt and equity of the firm for a given industry. This discount rate is called the weighted average cost of capital (WACC) of the firm. Calculating the WACC for a firm is beyond the scope of this chapter; the interested reader is referred to Brealey and Myers (1996). However, as a rule of thumb, discount rates typically range from 10% to 25%, and a WACC of 15% or more is common in the technology industry. The Chief Financial Officer's (CFO's) office in a large company will usually calculate the WACC for use in investment decisions.

The discount rate is related to the risk of an investment so that firms in high-risk industries (such as technology) have higher WACCs—these companies in turn have higher expected returns in the stock market. Due to this risk–return relationship, the discount rate for more risky technology project investments is sometimes increased relative to that for less risky investments when NPV is calculated. A potential issue with this approach is that the discount rates chosen for riskier projects can be somewhat arbitrary. Arbitrarily increasing the discount rate adds additional uncertainty into the NPV calculation and may reduce one's objectivity in comparing projects. A better approach for technology investment decision-making incorporating project risk, and other factors such as the business value of the project, is discussed in the *Executive Insights* section.

The CFO's office will often compare investments based upon NPV, because this makes possible objective comparison and selection of the most profitable investments. The CFO is most likely managing a large portfolio of investments, and the power of the NPV approach is that is takes the guesswork out of financial decision making by placing all investments on a common footing. One limitation of NPV is that it does not take into account management flexibility to defer decisions into the future. The value of this management flexibility, or option value, is discussed in the *Executive Insights* section.

ROI, Internal Rate of Return (IRR), and Payback Period

Return on investment was defined in the Introduction as

$$ROI = \frac{Project\ Outputs - Project\ Inputs}{Project\ Inputs} \times 100\%. \quad (6)$$

where the project outputs are all of the benefits of the project quantified in terms of cost savings and revenue generation, and the project inputs are all of the costs of the project. The major problem with this definition is that it does not include the time value of money.

Specifically, ROI, defined by Equation (6), is rather vague, because a 100% ROI realized 1 year from today is more valuable than a 100% ROI realized in 5 years. In addition, the costs of the project may vary over time, with ongoing maintenance and professional services support. The benefits of the project may also vary over time, so that the cash flows are different in each time period. Equation (6) is therefore not a convenient way to compare projects when the inputs and outputs vary with time, and it is also not useful for comparing projects that will run over different periods of time. Due to these deficiencies, one typically uses internal rate of return (IRR) (Brealey & Myers, 1996). For good management decisions the ROI defined rather loosely in Equation (6) should translate in practice into calculating the IRR of a project's cash flow.

What exactly is IRR? The IRR is the compounded annual rate of return the project is expected to generate and is related to the NPV of the project, defined in Equations (3) and (4). The IRR is the discount rate at which the NPV of the project is zero. That is, the IRR is the average discount rate where the cash benefits and costs exactly cancel. From this definition, the internal rate of return is calculated by solving for IRR in

$$NPV = -C_0 + \frac{(A_1 - C_1)}{(1+IRR)} + \frac{(A_2 - C_2)}{(1+IRR)^2} + \frac{(A_3 - C_3)}{(1+IRR)^3} + \cdots + \frac{(A_n - C_n)}{(1+IRR)^n} = 0. \quad (7)$$

where $A_1, A_2, A_3, \ldots, A_n$ are the positive cash benefits and $C_0, C_1, C_2, C_3, \ldots, C_n$ are the costs of the project in each time period 0, 1, 2, 3, ..., n. In practice one most often uses spreadsheet software, or a financial calculator, and the built in IRR and NPV functions for calculations.

How do we make financial management decisions using IRR? When the IRR is greater than the project discount rate, or WACC, we should consider accepting the project—this is equivalent to a positive NPV project. When the IRR is less than the WACC the project should be rejected, because investing in the project will reduce the value of the firm. The tenet of basic finance theory is that all projects that have positive NPV, or IRR > WACC, should be funded. This is based upon the assumption that the firm has unlimited capital and, because positive NPV projects have an IRR better than the WACC of the firm, accepting these projects will increase shareholder value. As discussed in the previous subsection, however, in practice capital is limited (or rationed) and managers must make decisions based upon limited resources. The profitability index, Equation (5), can be used to calculate which projects have the greatest return per investment dollar. Hence positive NPV (or good IRR) is only one factor to consider in a technology investment decision.

Another concept that is a useful tool when combined with IRR and NPV is that of payback period. The payback period, or payback, is the time it takes for the project to recoup the initial investment. The payback period is calculated by cumulatively summing the net cash flows (projected revenues and cost savings less costs) of a project. When the sign of the cumulative sum of the net cash flows changes from negative to positive the project has "paid back" the initial investment. (For an ROI analysis where a new project is compared to a base case, without the project, the payback should actually be calculated from the incremental cash flows. See the case example in the following section.)

The payback period for a typical e-business project can be in the range of 6 months to 2 years, depending upon the type of project. It is unusual for an e-business project to have a payback period longer than 2 years. In making investment decisions, projects that have good IRR and the shortest payback periods are most often selected.

This section on introductory finance did not include tax or depreciation in the IRR analysis. The reader should note that the financial metrics PV, NPV, and IRR calculated with and without tax and depreciation can be very different. Tax and depreciation are important factors and are incorporated into the case example discussed in the following section.

In summary, return on investment analysis for technology projects is the process of calculating the IRR for a project. The calculation of IRR is based upon sound financial theory and is related to the NPV of the project. NPV and IRR are equivalent ways of incorporating the time value of money into financial investment decisions. In the following section these concepts are applied to an example e-business project and a template is given that is applicable to any technology IRR calculation.

CALCULATING ROI FOR AN E-BUSINESS PROJECT

The overall process of calculating IRR for a new project business case is straightforward. The first step is to calculate the base case revenue and costs expected in the future if the business continues as it is now. The next step is to calculate the net cash flows with the new proposed project; this includes total revenue, potential cost savings, and all costs of the project. Finally, the base case cash flows are subtracted from the projected cash flows with the new project. The results of these subtractions are called the incremental cash flows for the project. The IRR is then calculated from these incremental cash flows. An equivalent approach is to calculate the additional benefits of the project directly to obtain the incremental cash flows. For complex business models, however, separating out the additional benefits when there are multiple variables can be more difficult than calculating the total cash flows with the new project and then subtracting the base case.

As discussed in the previous section, if the IRR calculated from the incremental cash flows is greater than the project discount rate, or WACC, the project should be considered for funding—this is equivalent to a positive NPV project. The challenge is to accurately incorporate the business drivers in the base case and all of the project costs, potential cost savings, and potential revenue benefits in the new project's cash flows.

In order to put the ROI calculation process in context, and to discuss some of the important details, it is useful to walk through an example. This section discusses a case example of ROI analysis applied to a Web-portal e-business project. The Web portal in this example is a Web site with a product catalog, and customers can buy products and transact orders using the portal. The Web-portal front end acts as a customer interface and, for a large firm, is typically connected internally to the firm's back-end IT systems, such as an enterprise resource planning (ERP) system, and other enterprise systems, such as customer relationship management (CRM) software.

The particular example discussed in this section is for a midsize electronics manufacturing company with global sales and operations. The example has been simplified to illustrate the main features of ROI analysis, and all numbers have been changed for confidentiality reasons. The cost and revenue numbers in this example are therefore for illustrative purposes only. The objective of this case example is to illustrate the general process and the important mechanics for calculating ROI rather than the exact costs and benefits of a Web-portal project. For a detailed discussion and analysis of ROI for a Web-portal e-business initiative and for an example of management of a Web-portal development project see the two case studies in the references (Jeffery, et al., 2002a; Jeffery, et al., 2002b).

Base Case

The first step in setting up any ROI analysis is to understand the base business case. That is, what are the primary costs and revenues expected if the firm continues operations and does not implement a new e-business solution? Answering this question should focus on the major costs and revenue drivers that the new technology project is expected to impact. The process of understanding the existing business is called business discovery.

A best practice of business discovery is to understand the cost and revenue drivers in a particular business process and then benchmark against competitors in the industry. For example, if the average transaction cost for order processing in a firm is $35 per order, and the industry average is $10 per order, there is clearly an opportunity for improvement. Similarly, if the industry average take-rate (fraction of customers who accept a marketing offer) is 3% and a firm has a take-rate of 1%, there is an opportunity for improvement.

If e-business or other information technology is used by competitors to achieve cost or revenue improvements, benchmarking data provide estimates of the improvements that might be expected if a similar solution were applied to existing processes within a firm. Benchmarking data for IT are provided by several consulting groups. Because consulting services are most often the source of benchmarking data, one must be cautious that these data are accurate and applicable.

Understanding the key business drivers, and which factors can improve business performance, is essential and can have important bottom-line implications. For example, a major U.S. general retailer with over $40 billion in revenues used a Teradata enterprise data warehouse (EDW) combined with analytic CRM software to improve the target marketing of 250,000 catalogs mailed to customers each year. This initiative resulted in 1% improvement in the number of trips to stores generated among mailed customers, 5% improvement in the average purchase dollars per trip, and 2% improvement in gross margin, as the products featured in the advertisements for specific customer segments captured sales without reliance on "off-price" promotions. The initiative ultimately resulted in an increase in mailer revenue of $215 M per year, and the catalog targeting project alone with the new EDW and CRM technology had an NPV exceeding $40 M.

For the case example discussed in this chapter we can assume that the business discovery yielded a set of assumptions that are summarized in Figure 4. Specifically, the revenue and cost drivers are assumed to be the sales transactions to 1,700 customers and the transaction costs for processing these orders, respectively. The average sales revenue per order is $258, the average cost of goods sold (COGS) is 70% of each order, and the transaction cost

General Assumptions	
Discount rate (WACC):	12%
Tax rate:	35%
Customers in Year 0:	1,700
Transactions in Year 1:	141,000
Average order size in Year 1:	$258
COGS as a % of the sales price:	70%
Average order size annual growth rate:	3%
Base Case	
Number of transactions annual growth rate:	3%
Average processing cost per order:	$30
With the Web Portal	
Initial implementation cost:	$5M
Ongoing maintenance and marketing each year:	$1M
Jump in total transactions in Year 1:	20,000
Number of transactions annual growth rate after Year 1:	10%
Average processing cost of a Web transaction:	$3
Average processing cost per order:	$16.50
% total transactions with the Web portal in Year 1:	50%

Figure 4: Assumptions for the Web-portal case example.

using phone and fax averages $30 per transaction. In the next year (Year 1) the company anticipates 141,000 total transactions through existing channels and without a Web portal. Multiplying the average revenue per order by the number of transactions, and subtracting COGS and transaction cost, one can calculate the net income in Year 1. If the tax rate is 35%, the net Year 1 after-tax free cash flow is expected to be $4.3 M.

Cash flows projected into additional future years can be estimated by multiplying the Year 1 numbers by anticipated annual growth rate factors. One must make assumptions based upon the expected increase in sales and costs for the next few years. As part of the business discovery, these assumptions may be based on data for the firm's performance in the past. For simplicity in the present example we can assume that the firm is in a mature industry and anticipates 3% growth in the total number of transactions, assuming the Web-portal imitative is not implemented. The base case 3-year future (also called pro forma) cash flows derived from these assumptions are given in Figure 5a.

Note that this base case is simplified for this example and in practice may be much more complicated. For example, the revenue may come from multiple market segments with different transaction costs, and the number of transactions may be very large. See the references (Jeffery et al., 2002a ; Sweeney, et al., 2002a; Sweeney et al., 2002b) for examples of market segmentation and business discovery for complex ROI analysis.

Incorporating the E-business Project

The Web-portal case example has two primary business objectives: (1) enable self-service order entry by customers, thus reducing costs, and (2) enable access into a broader market for customers, potentially increasing revenues. In addition to these business goals, the Web portal has strategic value, because in the electronic components manufacturing industry a Web portal is becoming a requirement for conducting business.

The costs of a project are often the easiest component of the IRR analysis to quantify. These costs may include items such as hardware, software, license fees, programmers' time, professional services (consulting), project management, hosting fees, outsourced contractors, and ongoing operating expenses. IT managers strive to keep the total cost of ownership of new products and systems at a minimum.

Minimizing total cost of ownership is related to the build vs. buy decision for a new IT or e-business project. This is because custom-built applications can have high total cost of ownership over their useful life. A useful rule of thumb is that if less than 10% custom modification to a packaged enterprise application is necessary then it is generally cheaper to buy than build. Greater than 10% custom modification puts the cost of building vs. buying about even, because new version releases of the packaged software will require continual custom modifications.

Web-portal technology was novel in the mid 1990s, but by 2001, several vendors were offering stable solutions. Hence, for this case example the best approach is most likely to integrate commercial off-the-shelf packaged applications with the firm's existing enterprise software systems. The major costs will most likely be integration with existing systems and infrastructure to support high availability (24/7 operation with little or no down time) across multiple geographic markets. The cost of outsourcing the system, versus keeping it in house, may also be considered. Detailed costing and a work breakdown structure would be completed for the final project plan. Cost estimates can also be obtained from similar projects that have been completed in the past.

For the purpose of this example we assume the project cost is $5 M, with ongoing costs of $1 M in each year. The ongoing costs include maintenance, upgrades, license fees, and professional services. To help facilitate the second business goal the Web-portal initiative must include a marketing campaign in target markets. For simplicity in this example, these marketing costs are assumed to be included in the ongoing costs of the project. In practice the marketing plan would contain detailed costing and would most likely be broken out into a separate line item in the cash flow statement.

The primary anticipated benefits, or outputs, of the Web-portal initiative are reduced transaction costs and increased revenue generation. The cost savings occur because phone and FAX orders for this company average $30 per order, and electronic processing is anticipated to cost $3 per order. The revenue generation benefit is expected to come from the Web portal's ability to have a global reach, so that with targeted marketing more customers can access the firm's products without increasing the size of the sales force. Other benefits of this initiative include fewer errors in processing transactions, reduced time to process orders, improved information on customers, and improved customer satisfaction, because customers can place orders 24/7 and have access to up-to-date product data.

Accurately quantifying all of the benefits of an e-business or IT system is the most challenging part of any ROI analysis. In practice one can often quantify the major hard cost savings. Revenue growth is more difficult to estimate and must come from market research, industry data, and past experience. It is often not possible to quantify soft benefits such as customer satisfaction and strategic advantage. The analysis therefore typically includes cost savings and revenue generation that can be estimated, and unquantifiable soft benefits are not included. This means that the ROI calculated will potentially be less than the realized ROI including soft benefits. One must then subjectively consider the project's soft benefits and how important they are to the firm. An ROI analysis is only as good as the assumptions that go into the analysis. The best practices for incorporating assumptions into an ROI model are discussed in the following section.

The details of the financial analysis calculation including the Web portal are described as follows. See Figure 4 for the assumptions and Figure 5b for the complete cash flow statement. Please note that what is most important in this chapter is the structure of the overall analysis, not the specific details.

For the case example, the average transaction cost is the easiest benefit to quantify and is straightforward to calculate. For all of the transactions processed, 50% of the

(a)

Base Case (No Web Portal)

	Year 0	Year 1	Year 2	Year 3
Customers	1,700	1,751	1,804	1,858
Number of Transactions		141,000	145,230	152,492
Average Order Size (US $)		258	265	273
Baseline Revenue (US $ thousands)		36,308	38,519	41,658
COGS (US $ thousands)		25,415	26,963	29,161
Order Processing Cost		4,230	4,357	4,575
Net Income		6,662	7,199	7,923
Free Cash after Tax (US $ Thousands)		4,330	4,679	5,150

(b)

New Web Portal Initiative

	Year 0	Year 1	Year 2	Year 3
Customers	1,700	2,081	2,299	2,454
Number of Transactions		161,000	177,100	194,810
Average Order Size (US $)		258	265	273
Revenue (US $ thousands)		41,458	46,971	53,219
COGS (US $ thousands)		29,020	32,880	37,253
Total Order Processing Cost		2,657	2,922	3,214
Gross Profit		9,781	11,169	12,751
Costs of the Web Portal Initiative				
Upfront Costs	(5,000)			
Ongoing Maintenance/Marketing		(1,000)	(1,000)	(1,000)
Depreciation Expense		(1,667)	(1,667)	(1,667)
Net Income		7,114	8,503	10,085
Net Income (After tax)		4,624	5,527	6,555
Add back the depreciation		1,667	1,667	1,667
Free Cash (US $ Thousands)	(5,000)	6,291	7,193	8,222

(c)

Incremental Cash Flows

	Year 0	Year 1	Year 2	Year 3
Net Incremental Cash Flows	(5,000)	1,960	2,514	3,072
Net Present Value (US $ thousands)	941			
Discount Rate	12%			
Tax Rate	35%			
3 yr Internal Rate of Return (IRR)	**21.9%**			

(d)

Payback Period Calculation

	Year 0	Year 1	Year 2	Year 3
Net Incremental Cash Flows	(5,000)	1,960	2,514	3,072
Cumulative Cash Flows		(3,040)	(525)	2,546
Payback is in 3rd month of Year 3 ===>				0.17

Figure 5: Case example of ROI analysis: (a) The base case free cash, (b) the free cash calculated including the Web-portal initiative, (c) the incremental cash flows, IRR, and NPV calculation, and (d) the payback period calculation.

customers are assumed to use the Web portal and 50% are assumed to use fax and phone methods of ordering. The average total transaction cost is the weighted average of the number of transactions expected using the new Web-portal system (assumed to be 50% of total transactions) multiplied by the transaction cost of $3 for each electronic transaction and $30 for each phone and fax order: $0.5 \times (\$3 + \$30) = \$16.50$ per order. With a larger fraction of customers using the e-business system, the average transaction cost per order decreases significantly from $30.

For this case example, we assume that with the new portal market penetration will increase and that there will be an initial jump in the number of total transactions in Year 1 as the global customer base is enabled to do online transactions. With the Year 1 14% increase in transactions, and a 10% yearly growth in the total number of transactions driven by the marketing campaign in Years 2 and 3, the effective growth in gross revenues is 13.3% per year. Because it costs only $3 to process an order using the Internet, in addition to revenue growth there is also a substantial cost savings of $2 M due to the reduced average transaction cost to process an order.

Figure 5b incorporates the revenue and cost savings of the new Web-portal initiative into a pro forma cash flow statement. The upfront and ongoing costs of the new initiative are also included. The revenue generation is incorporated in the increased number of transactions, and the cost savings are encapsulated in the total order processing cost line of the cash flow statement Figure 5b. For the calculation of net income we subtract out the depreciation of the project, assuming a 3-year straight line schedule.

In the United States, for tax reasons new IT projects cannot be expensed in the year they are capitalized. The hardware, software, and professional service costs must be depreciated using a 5-year MACRS (modified accelerated cost recovery schedule). This is an accelerated depreciation schedule described in Stickney and Weil (2000). Although the accounting books may use MACRS, depreciation for ROI analysis is most often incorporated using 3- or 5-year straight line depreciation. Straight line is a conservative compromise, because it weights the expense equally in each year, whereas accelerated depreciation weights the capital expense more in the first few years than in the last. Once the system is operational, ongoing costs such as maintenance and professional service support can be expensed when they occur.

Off balance sheet and lease financing options are usually not incorporated into the cash flow statements for the ROI analysis with a new project. For capital budgeting, the base case and the case with the new project should be objectively compared, independent of how the project is financed. Leasing and off balance sheet financing can artificially improve the ROI, because the cost of the project is spread over time by the lease payments. A more conservative estimate is to assume the costs of the project are incurred up front, or at the same time as the costs are anticipated to actually occur. Once the project is accepted for funding the best method of financing should be chosen.

To calculate the free cash flow with the new project, the last step is to add back the depreciation expense to the net income after tax. The depreciation expense was included in the calculation of net income in order to correctly include the tax advantage of this expense. However, for the final free cash flows the total depreciation is added back to the net income, because depreciation is not a "real" expense that actually impacts the cash flows, other than for tax reasons.

Incremental Cash Flows and IRR

Once the pro forma base case and new-project free cash flows have been calculated, the calculation of IRR is straightforward. The base case cash flows are subtracted from the cash flows with the new Web project; these are the incremental cash flows. See Figure 5c. The incremental cash flows are the net positive or negative cash in each time period that occurs in addition to the base case. The IRR is calculated from these incremental cash flows.

Using spreadsheet software, the NPV and IRR of the project are calculated by applying Equations (3) and (7), respectively, to the incremental cash flows. For the parameters given in this example, the NPV is $941,000 and the IRR is 22%, with a $5 M initial investment. Assuming the assumptions are correct, the IRR being greater than the firm's discount rate (WACC) suggests that this is a project the firm should consider funding.

Another factor to consider is the payback period. The payback for this project is calculated in Figure 5c from the incremental cash flows and occurs early in the third year (the beginning of the third month). The payback is anticipated to be just over 2 years, which is potentially a little long, so one possibility is to consider adjusting the total project expenses to enable earlier payback.

The reader should note that if the major project expenses occur up front, and the net cash flows in later time periods are increasing and positive, the IRR will increase if the time period of the analysis is extended. For this case example, if the assumptions were extended into years 4 and 5, the 5-year IRR would be 46%, compared to 22% IRR for 3 years. This is because we have extended the time over which the cash benefits can be included in the calculation from 3 years to 5, for the same up-front implementation cost.

Because the Web-portal projects may produce benefits over a long time period into the future an important question is, "what time period should be taken for a particular IRR calculation?" The time period for the analysis should match the time period used to calculate IRRs for similar investments in the firm. Often the 1-, 2-, and 3-year IRR numbers are calculated for an investment decision, and depending upon the firm, management decides which one to use for comparisons with other projects. For the Web-portal project example, 36 months was chosen as the length of time for the analysis. For e-business projects IRRs for time periods longer than 3 years are usually not considered when projects are compared, even though the project may have benefits in additional years.

Note that the 22% IRR calculated in this example does not include additional benefits such as: fewer errors in processing transactions, reduced time to process orders, improved information on customers, and improved customer satisfaction because customers can place orders 24/7 and have access to up-to-date product data. One can attempt to quantify these benefits and include them in the model; however, soft benefits such as improved customer satisfaction and better information are extremely difficult to accurately quantify. The approach most often used is to realize that the calculated IRR does not include these benefits, and hence the actual IRR of the project should be somewhat higher.

In addition, the case example does not include the strategic value of the initiative. Specifically, the Web-portal may be a "table stake"—an investment that is required to stay in business in a particular industry. Hence, even if the IRR is less than the hurdle rate for the company, management must invest in the project, or risk losing market share to competitors who have the technology.

The complete ROI analysis for the case example e-business project is summarized in Figures 5a–5d. This spreadsheet can be used as a basic template and starting point for any technology ROI calculation.

UNCERTAINTY, RISK, AND ROI

As with any ROI analysis, the 3-year IRR calculated at 22% in Figure 5c is only as good as the assumptions that are the foundation for the model. In this section we discuss how the assumptions and potential risk impacts of the project are essential factors to examine so that the ROI analysis supports the best possible management decision. The major uncertainties will come from the business assumptions and the risks of the technology project. We first focus on major uncertainties, business risks, and sensitivity analysis, and then on specific risks related to the technology. How to interpret ROI results and incorporate uncertainty and risk into the ROI analysis is also discussed.

Uncertainty

For the case example described in this chapter we know one thing for sure: the 22% IRR calculated in Figure 5c will not be the actual IRR obtained by the project. How do we know this? There are many assumptions that went into the simple analytic model, and there are risks that may impact the project. It is therefore practically impossible that the assumptions will indeed be exactly correct. The important realization is that the ROI analysis of Figure 5 is only a point estimate. Management decisions based upon this single estimate will not be as informed as decisions based upon a range of possible outcomes.

In creating the ROI analysis, there are several important questions to ask, such as: What are the major assumptions in the model? Does the model capture the essential drivers uncovered in the business discovery? What are the ranges of possible outcomes for each major assumption?

For complex problems, a simple yet effective method is to estimate the best, the worst, and the most likely case for each of the major assumptions. Market research, the business discovery, industry experience, and project management experience should be used to define a reasonable range of possible outcomes. The expected value of the IRR can then be estimated from (Project Management Book of Knowledge [PMBOK], 2003)

$$\text{Expected Value} = \frac{\text{Best Case} + 4 \times \text{Most Likely Case} + \text{Worst Case}}{6}. \quad (8)$$

Equation (8) is equivalent to weighting the best and worst cases individually by the probability .167 and the expected case by the probability .67 (the probabilities for approximately plus or minus one standard deviation for a normal distribution). If similar projects have been undertaken in the past, it may be possible to assign empirical probabilities to the best, worst, and most likely cases.

The best and worst case ROI numbers are just as important for the management decision as the expected value. The expected value is a point estimate of the most likely outcome, and the worst case IRR is an indicator of the downside risk of the project. Even with a good potential upside, funding a project that has a large downside risk of a very low or negative ROI can be questionable. If there is a wide variation of the best and worst case IRRs from the expected value, this is an indicator that there is significant risk in the project.

Equation (8) is a simple estimating tool to define the expected value of the ROI given a range of possible outcomes and is used in project management (PMBOK, 2003) to estimate the expected value of the cost and time for an IT project. Spreadsheet software enables sensitivity analysis of ROI models. This is a powerful and more sophisticated tool to help understand which parameters in a model are most important, and how these parameters interact.

Sensitivity Analysis

For the case example, the major assumptions in Figure 5 are the following:

The increased transactions as a result of the Web-portal and the marketing campaign.

The fraction of existing customers who will migrate to use the Web-portal over time.

The reduced transaction cost with the Web-portal.

The cost of the project.

Two of these assumptions are particularly aggressive. First, we assume that when the Web portal becomes active 50% of the existing customer base will use the portal for transactions in the first year. The large number of users migrating to the system is the driver for the large cost savings. In practice the 50% migration may take longer than 1 year.

The second major assumption is that the number of transactions will jump by 20,000 in the first year, as a result of the global reach of the new Web portal, and that these transactions will then grow at a rate of 10% per year. This new revenue will not be possible without a significant and coordinated marketing campaign. Hence, this revenue generation assumption must be benchmarked against market research data and the experience of the marketing team.

Spreadsheet software (such as Microsoft Excel) enables one to dynamically change one or two variables in a model simultaneously and calculate the corresponding IRR. This analysis is surprisingly easy to do and provides a visual picture of the dependencies in any model. Figure 6a is the table of IRR output calculated by varying the total cost savings and the revenue generation. The “Auto Formatting” function enables color-coding of cells—gray was chosen for IRRs less than the hurdle rate of 12%, white for IRR greater than 12%. The gray cells correspond to cost saving and revenue generation amounts that would not be acceptable (negative NPV). The boundary, where the cells change from gray to white, is the minimum cost saving and revenue generation necessary so that the IRR approximately equals the hurdle rate (NPV = 0). These tables can be used as a tool to review the ranges of IRR in the context of the best, worst, and average cases expected for each input parameter.

(a)

Revenues (US $ thousands)	Cost Savings (US $ thousands)						
	1,700	1,800	2,000	2,200	2,400	2,600	2,800
39,250	-26.3%	-25.8%	-24.7%	-23.7%	-22.6%	-21.5%	-20.3%
39,500	-20.3%	-19.7%	-18.7%	-17.6%	-16.4%	-15.3%	-14.1%
39,750	-14.6%	-14.0%	-12.9%	-11.8%	-10.7%	-9.5%	-8.3%
40,000	-9.2%	-8.6%	-7.5%	-6.3%	-5.2%	-4.0%	-2.7%
40,250	-4.0%	-3.4%	-2.3%	-1.1%	0.1%	1.3%	2.6%
40,500	1.0%	1.6%	2.8%	4.0%	5.2%	6.4%	7.7%
40,750	5.8%	6.4%	7.6%	8.9%	10.1%	11.4%	12.7%
41,000	10.5%	11.1%	12.4%	13.6%	14.9%	16.2%	17.5%
41,250	15.1%	15.7%	17.0%	18.3%	19.5%	20.8%	22.2%
41,500	19.6%	20.2%	21.5%	22.8%	24.1%	25.4%	26.8%
41,750	24.0%	24.6%	25.9%	27.2%	28.6%	29.9%	31.2%
42,000	28.3%	29.0%	30.3%	31.6%	32.9%	34.3%	35.7%
42,250	32.6%	33.2%	34.5%	35.9%	37.2%	38.6%	40.0%
42,500	36.8%	37.4%	38.8%	40.1%	41.5%	42.9%	44.3%

(b)

% of total customers migrating to the new Internet channel	Lift in Transactions due to the Web Portal Initiative						
	4,000	6,750	9,500	12,250	15,000	17,750	20,500
25%	-17.0%	-13.5%	-10.1%	-6.9%	-3.7%	-0.6%	2.4%
29%	-13.5%	-10.1%	-6.7%	-3.5%	-0.3%	2.8%	5.8%
33%	-10.1%	-6.7%	-3.4%	-0.2%	3.0%	6.0%	9.1%
37%	-6.8%	-3.5%	-0.2%	3.0%	6.2%	9.3%	12.3%
41%	-3.6%	-0.3%	3.0%	6.2%	9.3%	12.4%	15.4%
45%	-0.5%	2.9%	6.1%	9.3%	12.4%	15.5%	18.6%
49%	2.6%	5.9%	9.2%	12.4%	15.5%	18.6%	21.6%
53%	5.6%	8.9%	12.2%	15.4%	18.5%	21.6%	24.7%
57%	8.6%	11.9%	15.1%	18.4%	21.5%	24.6%	27.7%
61%	11.5%	14.8%	18.1%	21.3%	24.4%	27.6%	30.6%
65%	14.4%	17.7%	21.0%	24.2%	27.3%	30.5%	33.6%
69%	17.2%	20.5%	23.8%	27.0%	30.2%	33.4%	36.5%
73%	20.0%	23.3%	26.6%	29.9%	33.1%	36.2%	39.4%
77%	22.7%	26.1%	29.4%	32.7%	35.9%	39.1%	42.2%

Figure 6: Case example of sensitivity analysis of the ROI model: (a) Cost savings versus revenues, and (b) percentage of customers shifting to the new Internet channel versus Year 1 transaction lift due to the Web-portal initiative. Grey cells have IRR less than the 12% hurdle rate for the firm.

Figure 6b calculates the IRR as a function of two key drivers in the model: the number of new transactions and the fraction of customers using the new Web-portal channel. The boundary clearly shows the importance of migrating customers to the new channel to reduce transaction costs. Sensitivity analysis using the built-in functions in spreadsheet software (such as the Table function in Microsoft Excel) is a powerful tool to analyze the dependencies between variables in any ROI model.

Project and Technology Risks

A theme for this chapter is that the business drivers, rather than the specific technology, are often most important for any ROI analysis. However, risks of a technology implementation project can also have a significant impact on ROI. As discussed in the section on the productivity paradox, the majority of large IT projects fail to deliver on time and on budget (see Davenport, 1998; Rigby et al., 2002). The technology implementation project enters into the ROI analysis through the cost of the project and delays in realizing the revenue benefits, so that risk events often increase the cost and time of the project, decreasing the overall ROI. Risks for Internet projects and strategies to mitigate these risks are discussed in another chapter. Here we focus on specific risks that may impact the overall ROI of an e-business or IT project.

Keil and co-workers (Keil, Cule, Lyytinen, & Schmidt, 1998) conducted a research study of three panels of expert technology project managers in Finland, Hong Kong, and the U.S. The three panels listed the common risk factors for any technology project in order of importance; see Figure 7.

What is so surprising about the list in Figure 7 is that managers across continents and in very different cultures perceive the same major project risks in order of importance. It is also interesting to note that technology is mentioned only once in this list—"Introduction of new technology" is third from the bottom.

1. Lack of top management commitment to the project
2. Failure to gain user commitment
3. Misunderstanding the requirements
4. Lack of adequate user involvement
5. Failure to manage user expectations
6. Changing scope/objectives
7. Lack of required knowledge/skills in the project personnel
8. Lack of frozen requirements
9. Introduction of new technology
10. Insufficient/inappropriate staffing
11. Conflict between user departments

Figure 7: Risk factors identified by three independent panels of technology project managers listed in order of importance. Adapted from Keil et al. (1998).

In the early and mid-1990s Internet technology was new and many new Internet technology projects of that time period were "bleeding edge". These new Internet solutions were much more complex than previous IT systems. In addition, the Internet mania and infusion of vast amounts of venture capital pushed product development to "Internet time" in order to grab market share (Iansiti & MacCormack, 1999). These time pressures resulted in buggy code releases, and beta versions abounded. ROI for such new technology, where costs and benefits were relatively unknown, was very difficult to define.

However, in 2003 and beyond, with Internet technology entering the mainstream and distributed architectures becoming more the norm than the exception, practically all technology investments are required to demonstrate a good ROI. Fairly good and systematic cost estimates for e-business systems are available today. The business benefits of these systems, although still difficult to quantify, are easier to estimate than when the technology was first introduced.

From Figure 7, the primary project risk factors are therefore not technological but organizational. For example, the top two risks in the list Figure 7 are "lack of top management commitment" and "failure to gain user commitment." These risk factors involve the people who will support and use the project and are risk factors that a project manger has little or no control over. Organizational issues are an essential consideration for the success of any technology project. Figure 7 is a simple tool one can use to assess the major risks of a project that may impact the ROI. If any of these risk factors are present, they should be included at least qualitatively in the management decision. In addition, a risk management strategy can be invaluable for planning contingencies for mitigating various risk events (Karolak, 1996).

Monte Carlo Analysis Applied to ROI

Sensitivity analysis using spreadsheet software is a useful tool for visualizing the interrelationships between parameters in an ROI model. However, this method has the limitation that one can vary at most two parameters simultaneously. Even for the relatively simple model given as a case example in this chapter, several parameters combine to give the ROI. The variation of multiple parameters simultaneously can be included using Monte Carlo methods.

The idea of a Monte Carlo simulation is to generate a set of random numbers for key variables in the model. The random numbers for a specific variable are defined by a statistical distribution. Similarly to defining the best, worst, and expected case for each input parameter in a sensitivity analysis, the shape of the distribution and spread (mean and standard deviation) are best defined by the management team. Past experience, market research, and the judgment of the management team are all factors to consider when defining the statistics of the input variables.

The random numbers are then put into the analysis spreadsheet and the output (the IRR and NPV) is calculated. A new set of random numbers is then generated based upon the statistical functions defined for each input variable, and the output is recalculated. If this process is repeated a large number of times statistics can be generated on the output of the model. Intuitively, one Monte Carlo cycle is a possible outcome of the model with one particular set of variations in the inputs. By running thousands of cycles, one is effectively averaging what might happen for thousands of identical projects given many different variations of input parameters.

Relatively low-cost packaged software is available that can perform Monte Carlo simulations in spreadsheet software (Crystal Ball 2003, Palisades @Risk 2003). This software is easy to use—the user selects specific cells and specifies distribution functions for the variables. The software then varies the values of the cells with random numbers. The output, in this case the IRR or NPV, is automatically calculated for a large number of cycles and statistics of the possible outcomes are generated.

Figure 8 is an example of the Monte Carlo output for the case example of Figure 5. The project cost, increase in number of transactions, and percentage of users migrating to the Web channel were varied simultaneously. The distribution functions chosen for the inputs were all normal distributions with standard deviations $1 M, 15,000, and 25%, respectively. The average IRR, or expected value, is 22%, with standard deviation 17.5%.

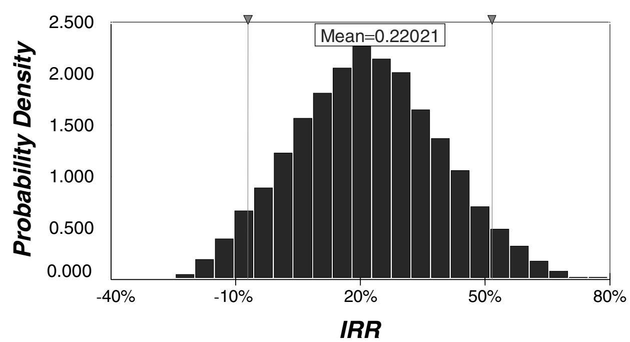

Figure 8: Distribution of 3-year IRR calculated from 10,000 Monte Carlo iterations.

The Monte Carlo analysis shows that the model has considerable spread in the IRR with these parameters. Specifically, there is a 28% probability that the project will have an IRR less than the hurdle rate for the company. Given this information, the management team can consider whether they will fund the project as is, kill the project, or revise the scope and assumptions to reduce the downside risk.

EXECUTIVE INSIGHTS

This chapter has developed the tools necessary for calculating ROI for an e-business or IT project. This section provides a "big picture" framework for how ROI is used for technology investment decisions and what questions to ask when reviewing an ROI analysis. We also look "beyond ROI" at trends for the future.

The Important Questions to Ask When Reviewing an ROI Analysis

This chapter has discussed the major issues concerning ROI analysis and factors to consider in developing an analytic financial model for technology projects. The following set of questions summarizes the issues that were discussed. These questions may be useful to consider when reviewing an ROI analysis:

1. What are the main assumptions in the model?
2. Was there a business discovery to define the assumptions?
3. Are all the major uncertainties and risks adequately accounted for?
4. Are the assumptions realistic and are they expressed as a range of possible inputs?
5. Is the calculated IRR expressed as a range with an expected value and approximate probabilities?
6. Is there a sensitivity analysis and how is it interpreted?
7. What is the downside risk (worst case) and is there a plan to mitigate this risk?
8. Will the project have senior management and end user support, are the requirements well defined, and will an experienced project manager run the project?
9. What is the strategic value of the project to the firm in addition to the benefits incorporated in the model?
10. How important are other factors, such as soft benefits, that were not included in the analysis?
11. Does the project contain any option value that should be factored into the decision?

As described in detail in the section *Risk, Uncertainty, and ROI*, the analysis is only as good as the underlying assumptions. The first four questions are designed to probe if the assumptions incorporate the important issues, how they were obtained, and if the uncertainty in the assumptions is understood. Assumptions are critical to the validity of the ROI model. An effective method is for the management team to collectively define the assumptions based upon their experience and market research. If the assumptions are all based upon conservative estimates, and the management team collectively agrees on the assumptions, the ROI analysis is ultimately more believable.

Questions 5 through 7 probe if the range of possible outcomes is understood and if there is a plan to deal with the worst case. Question 8 asks if the primary organizational risks have been thought through. In addition to Question 8 the list in Figure 7 can be used as a checklist for additional potential risks that may impact the project and Karolak (1996) gives a complete software project risk management checklist. Finally, questions 9 through 11 probe for additional value that may not have been captured in the ROI analysis and that should be considered for the funding decision.

The last question, 11, is concerned with the potential option value of the project—from the survey of Fortune 1000 CIOs 20% of respondents report that they qualitatively consider option value in funding IT projects (Jeffery & Leliveld, 2002). What is the option value of a technology project? An e-business or IT project has option value if, as a result of the project, the firm has the opportunity to implement additional projects in the future, and these projects would not have been possible without the initial project investment. Option value can be an important component of added value and is especially important for infrastructure investments.

For example, an enterprise data warehouse (EDW) is a very large IT infrastructure investment that, from a cost containment perspective, may be difficult to justify. However, once this infrastructure is put in place, the firm can leverage it for a variety of potential applications: Analytic CRM, improved supply chain management (SCM), and improved demand chain management (DCM) are a few of these applications. Hence, implementing the EDW is equivalent to buying options for CRM, improved SCM, improved DCM, and a variety of other strategic initiatives. Analytic methods exist for calculating financial option values and these methods have been applied to technology projects (McGrath & MacMillan, 2000). Qualitatively at least, the option value of a technology project should be considered when making an investment decision.

A Framework for Synchronizing e-Business Investments With Corporate Strategy

A major challenge for executive managers is how to decide which new e-business and IT projects to fund. This is a complex decision, because for a large firm the annual IT budget may be several hundred million dollars or more and often there can be many new projects that must be considered for investment. For example in the 1990s a major worldwide banking institution, which was representative of other industry leaders, had an annual IT budget of $1.3 billion and had over 800 projects running simultaneously.

The process of managing the portfolio of technology investments of a firm is called IT portfolio management. This process is similar to managing other portfolios in the firm such as financial assets, new products, and marketing initiatives. IT portfolio management includes important factors such as the strategy of the firm and the risk and return of investments. This idea is not new and was first discussed by McFarlan (1981).

- Define the firm-wide strategic intent and business objectives
- Understand the strategic context of the firm. This context defines the focus of the technology investments
  - *Corporate strategy: operational excellence, customer focus, innovation*
  - *IT focus: Cost reduction, defined by strategy, strategy enabler*
- Develop e-business and IT objectives matched to the corporate strategic objectives
- Develop an appropriate portfolio of e-business and IT investments to support the strategic business objectives
  - *Make risk and return (ROI) tradeoffs on investments*
- Update as necessary
  - *Requires a continual dialogue of cross functional executives and technology managers*

Figure 9: Linking strategy to IT portfolio investments: a framework for managing IT by business objectives. Adapted from Weill and Broadbent 1998.

As discussed in the *Introduction* and throughout this chapter, ROI analysis is only one component of a technology investment decision. A general framework for investing in technology is given in Figure 9. This top-down approach (Weill & Broadbent, 1998; Weill, Mani, & Broadbent, 2002) starts with executive managers defining the strategic objectives of the firm. From the corporate strategy the key business objectives are defined. For example, these objectives may include increasing revenues in core markets, growing revenue in specific new markets, or cutting costs internally.

When defining the strategic initiatives, it is important to understand the strategic context of the firm within a given industry. The major focuses of corporate strategy can be grouped approximately into three categories: operational excellence, customer focus, or innovation. Treacy and Wiersema (1997) conducted a research study of thousands of firms and found that market-leading firms were often exceptional in one or two of these three categories, but none were exceptional in all three. One example is Dell Computer: Dell excels at operational excellence and customer service, but does not produce particularly innovative products. Another example is IDEO, a design company that has won countless awards for product innovation focused on what customers need.

In 2000 and beyond, the line between the three focuses of operational excellence, customer focus, and innovation is blurring. Increasingly, all firms must exhibit some level of customer focus excellence to remain competitive. However, understanding the core drivers of a firm's business is an essential first step to ensure that investment dollars are optimally allocated. The goal is to synchronize e-business and IT investments with the corporate strategy. The IT objectives for the firm must support the key business objectives (KBOs) derived from the corporate strategy in order to optimize the value of the portfolio of IT investments. Synchronization of IT with corporate strategy is simply not possible if the KBOs are not well defined.

Once the key IT objectives have been defined, the next step in the process in Figure 9 is to select an optimal portfolio of projects. This can be a challenging task, because often capital is limited and there may be many potential projects that could be funded. How do we select an optimal portfolio of e-business and IT investments? A rigorous IT portfolio management selection process can help capture the value of the project to the business and the risk of the project.

Kaplan and Norton (1992) have pioneered the use of scorecards to rate business performance. Scorecards are a powerful tool to objectively rank technology projects against one another. As an example, Figure 10 is the scorecard used by Kraft Foods to rank IT and e-business projects. Note that there are two dimensions of the scorecard: "Business Value Criteria" or value to the business, and "Likelihood of Success Criteria" or ability to succeed. Ability to succeed is related to the risk of the project. Also note that ROI, labeled as financial return, is just one component of the total score.

The categories on the scorecard and the category weights were defined by the Kraft Foods executive management team. A detailed grading rubric was developed

Likelihood of Success Criteria		Wt.	Score	**Business Value Criteria**		Wt.	Score
Technical Standards	X1:	10%		Financial Return	Y1:	30%	
Skills Capability & Training	X2:	10%		Customer & Consumer Focus	Y2:	20%	
Scope & Complexity	X3:	25%		Supply Chain Business Benefits	Y3:	15%	
Business Alignment	X4:	22%		Technology Efficiency	Y4	15%	
Risk Factors	X5:	21%		Knowledge Advantage	Y5:	10%	
Management Capability	X6:	12%		Work life Balance	Y6:	10%	
Dimension Total	X	100		Dimension Total	Y	100	

Figure 10: Kraft Foods score card used to rank new e-business and IT projects on the dimensions of ability to succeed and value to the business. Source: Steve Finnerty, CIO of Kraft Foods and President of the Society for Information Management, 2002.

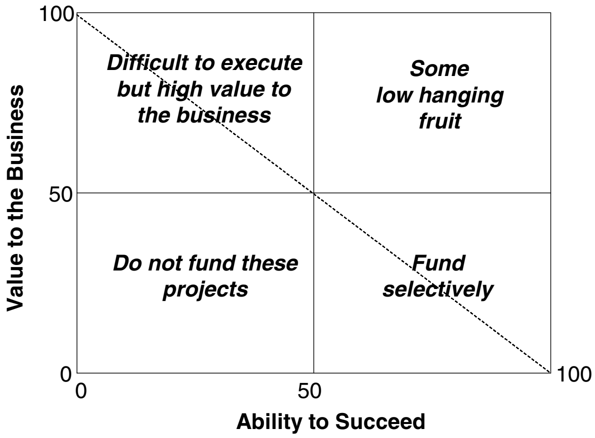

Figure 11: The portfolio application model.

so that each category could be objectively scored, and an independent review committee evaluated all projects and ensured consistency in scoring. All projects were then ranked by the business value criteria total score, and a line was drawn that corresponded to the total IT budget. The projects were also plotted on the portfolio application model matrix, Figure 11. The portfolio application model makes possible a schematic of the risk and return profiles for all of the IT projects. Based upon this information, the executive management team at Kraft Foods, which included the CFO and business unit sponsors, discussed which projects to fund and which to reject. The discussion enabled the CIO to increase the IT budget, with the CFO's approval, in order to fund additional projects that had high value to the business.

As a general example, if a KBO for a firm is to cut costs, a corresponding IT objective may be to increase electronic transaction processing. On the scorecard, projects that support electronic transactions will be weighted more than projects that do not. New e-business projects such as e-procurement are therefore more likely to be selected for funding through the IT portfolio management selection process. An e-procurement system may also be considered to have a relatively high ability to succeed, or equivalently a low risk.

Projects plotted on the matrix in Figure 11 fall into four categories. Projects in the upper right have high value to the business and ability to succeed. These projects should be funded. Small and medium-sized e-business projects such as e-procurement and customer self-service portals may fall into this category, and are often "low-hanging fruit," projects that will yield quick payback. Projects in the lower left corner have low value to the firm and have high risk—these projects clearly should not be funded.

Projects on the upper left in Figure 11 have high value to the company but are difficult to execute. Example projects may be ERP, CRM, or EDW and large strategic e-business initiatives. These projects may well be drivers for the long-term competitive advantage of the firm. Risk is clearly an issue with these projects, and a risk management plan can potentially significantly improve the ability-to-succeed score. In order to reduce the risk for a large project, the project may be broken into components or phases that each have a high ability to succeed. Projects that fall into the lower right corner in Figure 11 have low perceived value, but have a high ability to succeed. IT executives may choose to selectively fund projects in this category because they can be easy wins for the IT team.

A potential issue is that infrastructure investments may often be categorized as having low value to the business by non-IT business executives. The low value-to-the-business score may be due to the value not being accurately captured on the score card. Infrastructure is an important platform for future projects and may have significant option value. However, without a specific category for option value an infrastructure investment may receive a low value-to-the-business rating as perceived by executive managers. Future IT initiatives often depend on an infrastructure being in place. Therefore, for infrastructure projects the option value and future dependencies can be important considerations for the funding decision.

The IT portfolio management process gives executive managers a framework for optimal investment decision-making. Implementing this framework in practice gives managers objective information that can be used to make informed management decisions. Ultimately the management decision is made based upon executives' experience and must weigh subjective issues that are not quantified by the process. In addition, executives should also consider the dependencies between projects and the optimal order for execution. Kraft Foods exemplifies how a cross-functional executive team discussed the available information and reached consensus on the funding decision.

Finally, to effectively synchronize strategy and IT investments the IT portfolio management process must be ongoing. Many firms in mature industries have fixed annual IT budget cycles, so that the IT portfolio management process is implemented for the funding decisions of each cycle. However, in order to optimize the return from IT investment dollars, firms in dynamically evolving industries should implement quarterly or more frequent IT portfolio reviews.

Beyond ROI: Trends for the Future

Following the bursting of the Internet bubble in 2000, the technology industry is undergoing a shakeout and consolidation, which may last several years. As we look forward in this environment, optimizing investments in e-business and information technology is increasing in importance as companies struggle to maintain competitive advantage. Calculating ROI is important for informed management decisions. However, as we have discussed, ROI is only one component of the decision-making process.

The method of calculating ROI for an e-business or IT project is in principle no different from the method for calculating ROI for a new manufacturing plant, marketing plan, or research and development project. However, e-business and IT projects can be incredibly complex, so that estimates and generalities that are good enough for a manufacturing project can potentially destroy an IT project if any element goes wrong. Building the ROI model on sound assumptions and developing a risk management strategy can therefore significantly impact the actual ROI realized for IT projects.

A trend for the future will be that firms will increasingly implement more sophisticated IT portfolio management processes and will incorporate ROI into these processes. Furthermore, we have discussed ROI in the context of new project selection. In order to maximize IT value one must realize that ROI analysis is an important on-going process. That is, the ROI of projects should be measured after the project is complete. This after action review enables feedback to the entire IT portfolio management process, and the firm can then calculate the realized ROI of the entire IT portfolio.

Similarly to a financial portfolio, it does not make sense to invest in a mutual fund or stock that is losing money year after year. E-business and IT projects are no different, and measuring the ROI of existing IT projects enables executives to weed out underperforming investments.

Some complex strategic e-business initiatives may have high cost, high risk, and huge potential payoffs. For these projects a management strategy is to break the project down into phases, where each phases is defined by ROI. Once a phase is complete it should demonstrate good ROI before the next phase is funded. This approach reduces the risk of the e-business investment and makes the project "self-funding," because new revenue or cost savings can fund the next phase of the initiative.

During the roaring 1990s Internet and e-business initiatives were viewed as too complex, or too innovative, for management investment decisions to be made using ROI. As we move into the next phase of the technology revolution powered by the microprocessor and networking technologies, e-business initiatives will be scrutinized and evaluated on the same basis as all other firm investments. IT management teams must therefore embrace the financial management techniques of ROI analysis and portfolio management that are used widely in other functional areas of the firm.

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GLOSSARY

COGS Cost of goods sold, equal to the beginning inventory plus the cost of goods purchased or manufactured minus the ending inventory. These costs are expensed because the firm sold the units.

DCF Discounted cash flow, equal to future cash flows divided by discount rate factors to obtain present value.

Depreciation The portion of an investment that can be deducted from taxable income. It is also the reduction in book market value of an asset.

Discount rate The rate used to calculate the present value of future cash flows.

Hurdle rate The minimum acceptable rate of return on a project.

Information technology portfolio management A methodology for managing information technology investments as a portfolio with different risks and returns. The process often involves using scorecards to rate projects on multiple dimensions, such as the alignment of the project with the strategic business objectives of the firm and the ability of the project to succeed.

IRR Internal rate of return, the discount rate at which the net present value of an investment is zero.

ITPM Information technology portfolio management.

MACRS Modified accelerated cost recovery system, the accepted US income tax accelerated depreciation method since 1986.

NPV Net present value, a project's net contribution to wealth—present value minus initial investment.

Payback The payback period of an investment, or the time taken to recoup the original investment with the new revenue and/or cost savings from the project.

PV Present value, the discounted value of future cash flows.

Real option A deferred business decision that is irreversible once made and whose eventual outcome is contingent upon the future evolution of the business environment.

Risk free rate The expected return for making a safe investment, usually equivalent to the rate of return from government bonds.

ROI Return on Investment, a generic term for the value of a project relative to the investment required. In practice the ROI for a project is calculated as the IRR for the project.

Table stake A technology investment that is necessary in order to remain competitive in a particular industry.

Time value of money The idea that cost savings or revenue received today is more valuable than the same cost savings or revenue received some time in the future.

WACC Weighted average cost of capital, the expected return on a portfolio of all the firm's securities. Used as the hurdle rate for capital investment.

CROSS REFERENCES

See *E-Business ROI Simulations; Electronic Commerce and Electronic Business; Internet Project Risk.*

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