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Part I

Framework

Chapter 1

Overarching Framework

But come, you suitors, since here is a prize set out before you; for I shall bring you the great bow of godlike Odysseus. And the one who takes the bow in his hand, strings it with the greatest ease, and sends an arrow clean through all the twelve axes, shall be the one I go away with . . .

—Penelope promising marriage to the best archer
The Odyssey of Homer XXI, 73–77
(translated by R. Lattimore)

We begin by describing the overarching framework for analyzing the economics of information technology systems, around which this book is structured. The starting point is to develop a clear understanding of the objective used to distinguish attractive systems from those that are not.

■ 1.1 OBJECTIVE

The objective of information technology systems development in business is to increase the wealth of shareholders by adding to the growth premium of their stock. Ideally, the increase achieved should be the maximum obtainable. Maximizing shareholder wealth consists of maximizing the value of the cash flow stream generated by operations, specifically those cash flows that are generated by a future investment in an information technology system (see Figure 1.1). This is

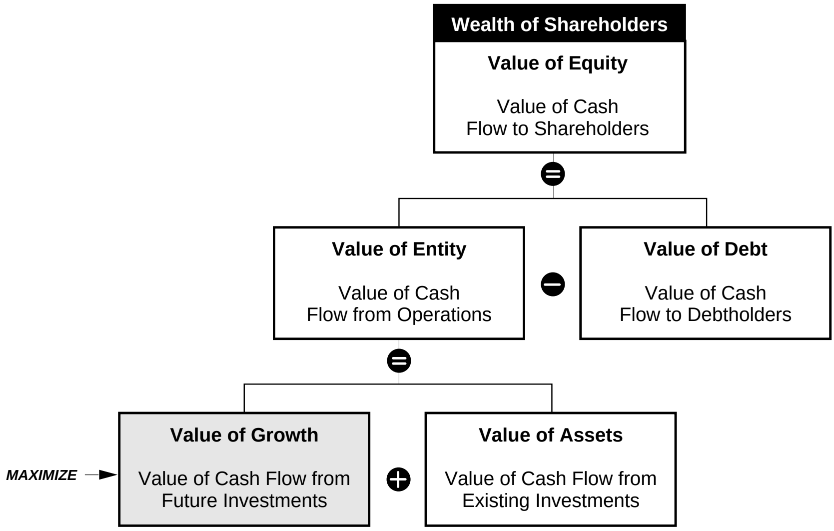

Figure 1.1 Strategic Objective: Maximize Value of Growth.

the objective that is used here as the basis for determining whether an information technology system has attractive economics.

■ 1.2 ANALYTICAL FRAMEWORK

Conceptually, the framework for analyzing the economics of information technology systems is simple. The first step is to identify the target customer opportunity. The second step is to align the information technology system to cost-effectively provide the features customers want. The third and final step is to accurately measure the economic value that can be captured (see Figure 1.2). An analogy can be drawn between this process and archery: picking the target, aiming the bow and arrow at the most vital point, and gauging the spoils before shooting.

The practical application of this analytical framework, however, is complex. It requires taking a quantitative approach

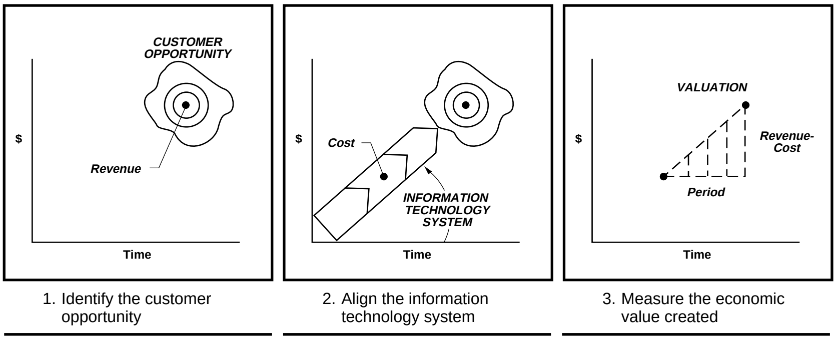

Figure 1.2 Analytical Framework.

at each step, with the level of accuracy obtained proportional to the amount of rigor in the analysis. The result is the quantification of the shareholder value created by an information technology system.

Often a first analysis will show that what customers desire is not technically achievable or economically attractive. Multiple iterations of an analysis may be required to resolve the tension between segment-specific desires and time-dependent technology and economics. As in archery, a target may be beyond the reach of the bow and arrow (not technically achievable) or a target may not be worth expending an arrow on (not economically attractive). In this way, wild ideas can be separated from those that truly have promise, based on their bottom line impact.

■ 1.3 SCOPE

To avoid possible confusion, the range of information technology systems encompassed and the limits of applicability of the framework need to be spelled out.

An information technology system is defined as a means for automating data, voice, video, or multimedia information flows. This definition is broader than the classical datacentric view to reflect that a digital signal of adequate bandwidth can carry any of these types of information, leading to the convergence of industries that once separately handled data, voice, and video. Simultaneously, it includes the traditional analog approaches of the past that are still with us today. *Data,* as used here, includes all alphanumeric and graphical information (e.g., text, spreadsheets, graphics). *Voice* includes all audio information (e.g., speech and music). *Video* includes all image information (e.g., still-frame and full-motion). *Multimedia* is any combination of the preceding.

➤ Range of Systems Encompassed

Any information system that can be specified in a quantitative way can be analyzed with this framework. The range of systems encompassed is, therefore, quite general. Essentially, any "black box" where information is input, processed, and output falls within our capability for analysis. The information system does not need to be built to be analyzed.

To illustrate (see Figure 1.3), at the highest level the *information* represented can be video, voice, and data separately or in combination. The signal used to represent the information can be digital or analog. The *system* can be networked or stand-alone. If networked, communication can be one-to-one (switched) or one-to-many (broadcast). Transmission can be interactive (2-way) or passive (1-way). Additional choices of distance (e.g., local or long-distance), medium (e.g., wired or wireless), and detailed implementation approach can be made. Thus, the entire range of computer system structures, from large-scale networks to small-scale palmtops, can be analyzed successfully. In addition, analog system structures, such as television, the phonograph, and microfilm can be analyzed.

➤ Limits of Applicability

The output of the analysis is a valuation of the cash flow stream generated by an information technology system. The

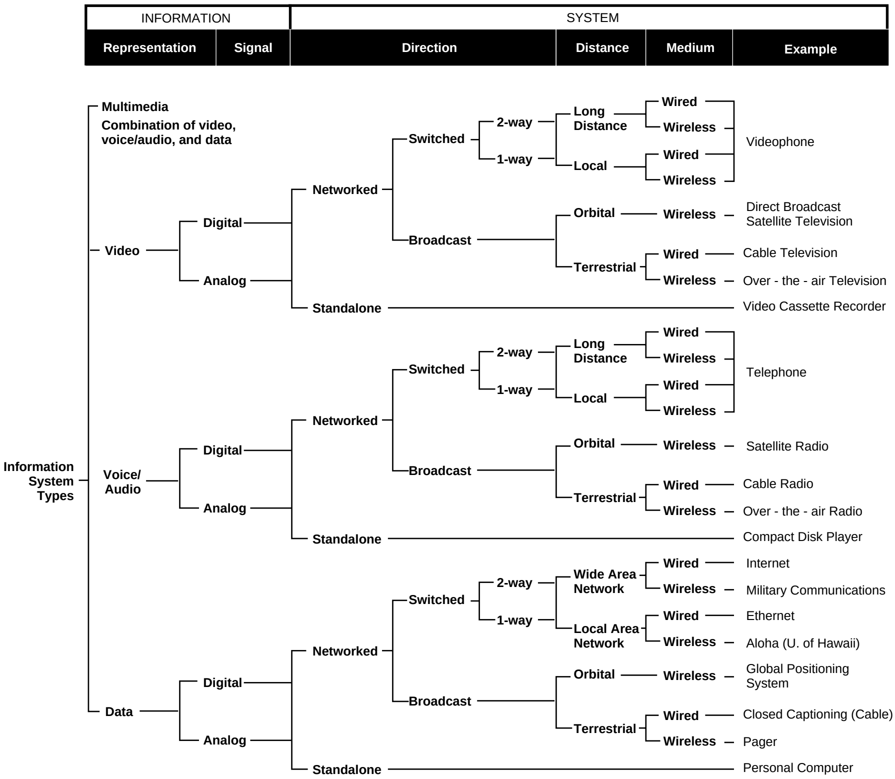

Figure 1.3 Range of Systems Encompassed.

limits of its applicability emerge, therefore, under those circumstances in which a well-defined valuation cannot be calculated. The circumstances that characterize this danger zone are:

➤ The use of the system cannot be clearly described or understood by customers. This can make it extremely difficult to assess the revenues from new services or estimate the cost savings that can be achieved.

➤ The capacity and performance requirements of the system cannot be determined. This can create a situation where the type of system that should be built is unknown.

➤ The system design has technical problems that have never been solved before, creating large uncertainties in function, performance, schedule, and cost estimates.

➤ Costs are not well understood. For example, potential cost variations are large and unpredictable. This can create a situation where establishing a reasonable cost estimate is prone to substantial error.

These circumstances often arise when one is dealing with "bleeding" edge technology, highly complex projects, and far-out time horizons. In the 1950s, estimating the demand for computers was difficult because potential customers (or vendors for that matter) could not envisage its uses. In the early years of computer networking, nobody knew whether the traffic would consist of mostly short or long, frequent or infrequent messages—a consideration with major implications for network capacity and performance. The developers of supercomputers planned to use revolutionary wafer-scale integrated circuits, until they encountered insurmountable heat dissipation problems. Last, improperly sized application software development efforts have often led to large, unpredicted cost overruns.

Two approaches for handling the analysis can provide useful results (see Figure 1.4), should you find yourself in this danger zone. The first applies when the accuracy of the valuation falls just below the minimum acceptable level (see Figure 1.5) and involves performing a "scenario assessment." In this case, scenarios should be developed that can be translated into variations of inputs, and a range of valuations obtained to bracket the results and gauge the amount of uncertainty and risk. The second approach applies when the error in the valuation is extreme, and can be used to set system development targets. Here, a domain of valuations should be obtained by parameterizing the inputs and deriving the combinations of input levels that yield acceptable valuations. These input level combinations can then be set as system development targets.

The *minimum acceptable accuracy level* is a function of the magnitude of the financial impact and the degree to which the business case either for or against is compelling (see Figure 1.5). The magnitude of the financial impact can a

Region	Situation	What to Do	Example Use
Safety	**Well Defined Valuation** Understanding of inputs is good enough that the accuracy of the valuation is above the minimum acceptable level.	A valuation should be calculated and sensitivities or breakevens run.	Standard information technology system valuation. (e.g., developing a website)
"Danger Zone"	**Poorly Defined Valuation** Understanding of inputs is poor enough that the accuracy of the valuation falls below the minimum acceptable level.	**Bracket Valuation:** A range of valuations should be obtained under different scenarios by varying the inputs.	Scenario assessment. (e.g., the effect of to-be-established regulations on encryption)
	Understanding of inputs is so poor it creates a situation where the error in the valuation could be extreme.	**Parameterize Valuation:** A domain of valuations should be obtained by parameterizing the inputs and running simulations to derive the combinations of input levels that yield acceptable valuations.	Setting system development targets. (e.g., the cost of an optical computer)

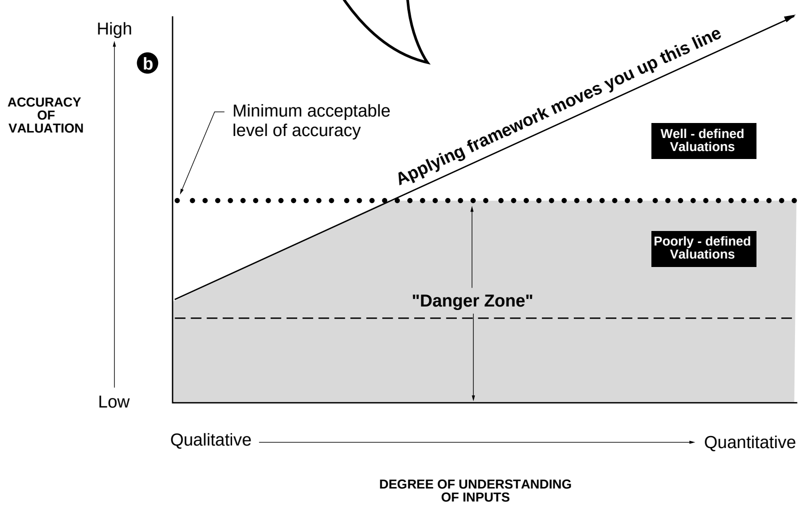

Figure 1.4 Limits of Applicability.

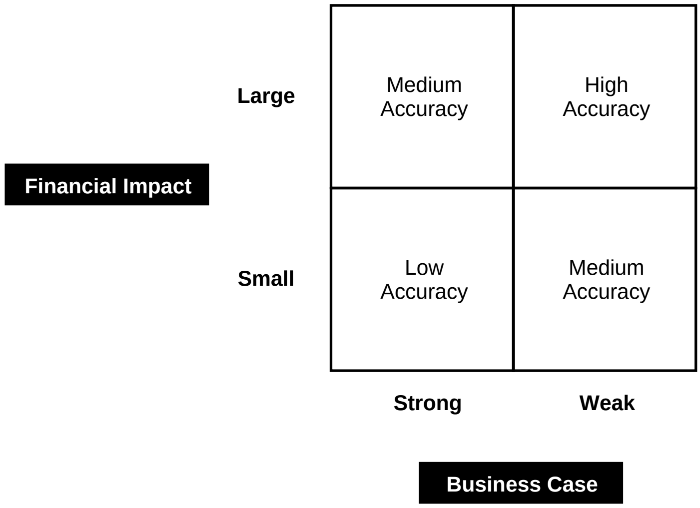

Figure 1.5 Minimum Acceptable Level of Accuracy of Valuation.

be assessed against capital budgets and income projections. The business case can be viewed as strong if the valuation is found to be large in either a positive (for) or negative (against) direction. It is weak if the valuation is close to zero.

■ PROBLEMS AND SOLUTIONS

Problem 1.1: Under what conditions is maximizing shareholder wealth (equity value) identical to maximizing the value of the cash flow stream generated by a system?

Solution: The value of equity equals the value of operations less the value of debt. The value of operations and debt is equal to the cash flow from operations and the cash flow to debtholders, respectively, discounted at the appropriate risk-adjusted rates. So the required conditions are the cash flow to debtholders must be held constant and the system project does not change the risk profile.

Problem 1.2: What are some ways the analytical framework could result in a finding that the economics of a system are unattractive?

Solution: The customer opportunity could be of insufficient size; the cost to address the opportunity may be too high; the window of opportunity may be too narrow or too distant in time; and the risk of failure may be too high.

Problem 1.3: What are some examples that fit the definition of an information technology system other than those listed in Figure 1.3?

Solution: High-definition television, amateur radio, and stereo systems.

Problem 1.4: Give some additional real-world examples of cases that fall outside the limit of applicability of the analytical framework.

Solution: Massively parallel processors, josephson junctions, optical computers (as of 1999).