This overview document of Applied Information Economics is targeted toward executives who make decisions about approving IT projects. The issues covered are the nature of the current IT decision problem, how AIE solves them and how AIE is different from other methods.

Applied Information Economics

A Powerful Method for Quantifying IT Value

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Critical Reviews for Applied Information Economics:

"The strengths of the AIE included a process that clarified the ambiguous benefits of increased security, techniques that quantified uncertain costs and even more uncertain benefits, and methods that determined the usefulness of each performance measure…. It also estimated risk in a meaningful way, included it in the decision, and identified means to reduce it."
The Federal CIO Council - in a report assessing the use of AIE in federal IT decisions

"The AIE process was a real eye-opener. It not only provided us with tools to measure observable outcomes, it also provided a means to look more introspectively at how people make observations and calculations."
Greg Maciag, President, ACORD – the standards organization for the insurance industry

"AIE's unique strengths are its processes for clarifying and quantifying 'unmeasureable' benefits, costs and risks and their presentation in a probabilistic model based on a range of estimates (versus single-point estimates)."
Research Note, The Gartner Group

"AIE's strength lies in its ability to conduct a true risk/return analysis based on proven methods that have a known statistical validity."
Research Note, Forrester Research, Inc.

"The theory of Applied Information Economics is right on target. People that don't use these methods will be missing a lot of opportunities."
Dr. Marshall Van Alstyne, MIT Sloan School of Business

"Ask about ROI numbers for an IT project and you often hear that the benefits are great, but too soft, too intangible to be measured. Doug Hubbard begs to differ…. Hubbard has made a career of finding ways to measure things that other folks thought were immeasurable."
Editorial, ComputerWorld

Table of Contents

I. The Risks & Opportunities for IT Decision-Makers

What is the single most important decision any decision maker faces? It is how to make decisions. Decisions analysis methods should show measurable improvements in decisions as opposed to simply making management more confident in decisions. And when the stakes are high, as they often are in IT, the need for real improvements in decision analysis is critical.

Making "economically rational" decisions about information technology (IT) investments is becoming both more important and more difficult. The difference between the "right" decision and the "wrong" decision is as dramatic as it is uncertain. There are plenty of great success stories: organizations that gain strategic advantages by leveraging IT into new levels of customer service, enhanced quality control and reduced administrative costs.

However, for every success story there is a story of runaway development costs, cancellations after a huge investment, practically unmanageable maintenance, or unrealized expectations. In the worst-case scenarios, a bad IT investment has net costs above the loss of the direct investment.[1] There are cases where dysfunctional IT systems have interfered with the business operations and cause the loss of customers and revenue. Most managers may not experience the high profile failures of the ACA website, Hershey's ERP implementation, Amazon's cloud outage or Target's security breach, but even less public failures can still cost organizations dearly.

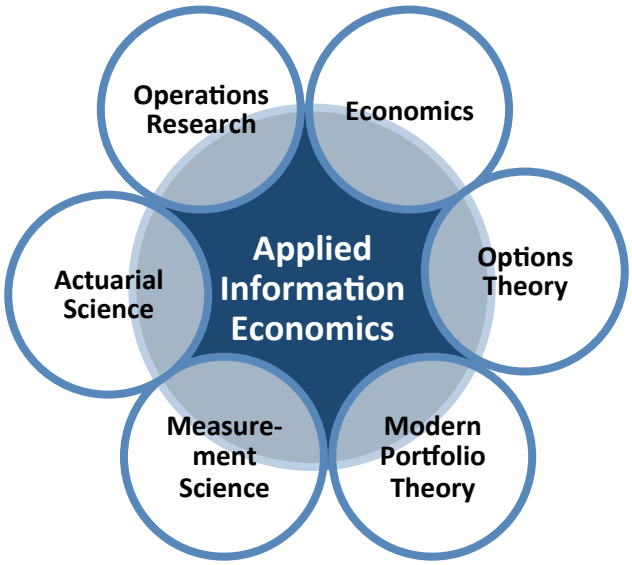
However, even with extreme differences in returns on IT investments, most decision makers find it difficult to determine which investments will be a phenomenal success and which will be a crippling failure. And some decision analysis methods may seem to help but actually produce a kind of "analysis placebo" where decision makers feel more confident in decisions without actually improving decisions.[2] The decision-maker is confronted with many seemingly abstract and intractable questions.

- How do I estimate the value of an information system (including "intangible" benefits)?
- How do I deal with extreme uncertainties in the estimates of IT costs and benefits?
- How do I know whether one IT investment is "better" than another (IT or otherwise)?
- How do I know when to stop analyzing, accept some risk, and make a decision?
- How do I know whether my decision analysis methods are working at all or are just feeding unjustified confidence?

II. The Solution: Applied Information Economics

Definition: Applied Information Economics (AIE) is the practical application of mathematical models and scientific measurements in order to optimize decisions in uncertain investment environments.

Hubbard Decision Research (HDR) specializes in Applied Information Economics (AIE) - a quantitative decision-making methodology specially designed for the challenges of IT decisions, but now applied in a variety of other areas.

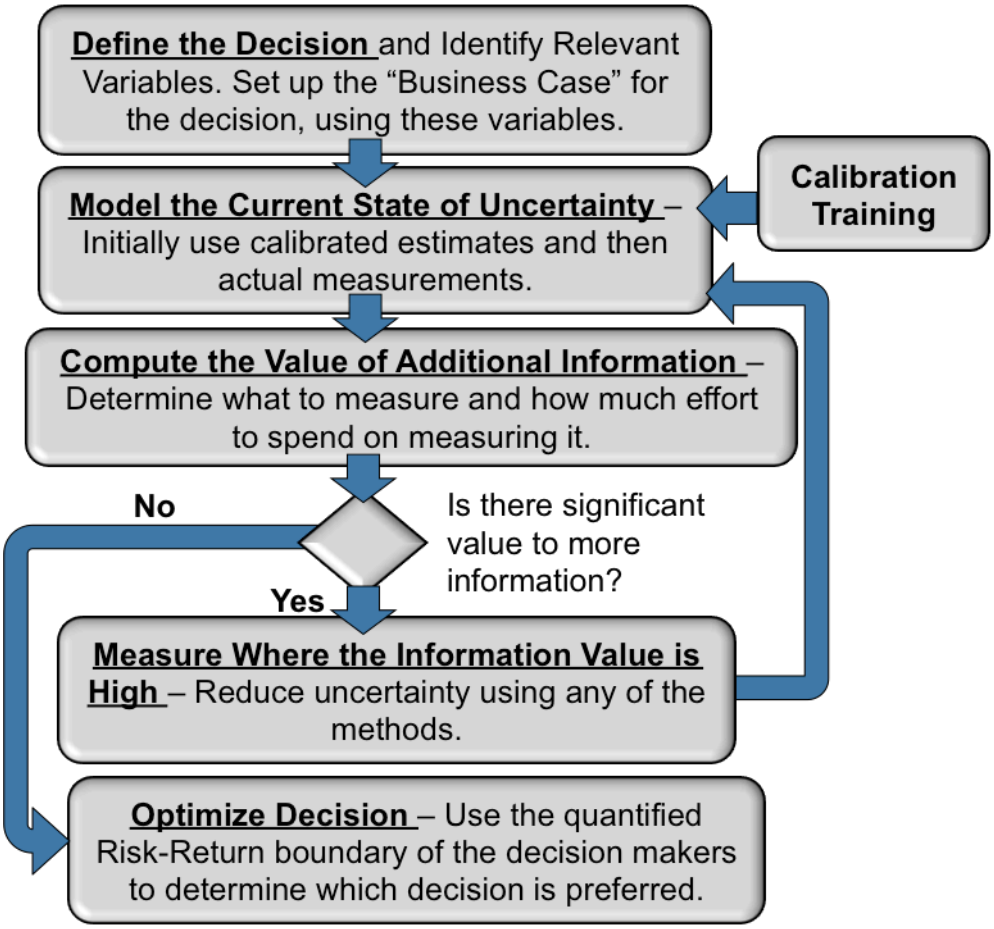


AIE is a synthesis of techniques from a variety of scientific and mathematical fields. The tools of economics, financial theory, and statistics are all major contributors to AIE. But in addition to these more familiar fields, AIE includes *Decision Theory* - the formulation of decisions into a mathematical framework; *and Information Theory* - the mathematical modeling of transmitting and receiving information.

It is important to emphasize, however, that even though AIE is a theoretically well-founded set of techniques, it is a practical approach that has been applied to over 80 major investment decisions in a variety of industries. Every proper application of AIE keeps the bottom line squarely in mind, and the output from the AIE project supports practical business objectives.

Some of the basic techniques that make AIE a powerful set of tools are a method for clarifying decisions and defining variables in a quantitative way, calculation methods for the value of information, methods for modeling uncertainty as estimates, measurement methods, and treating the IT investment as a type of investment portfolio. These methods are part of a fully documented formal procedure.

The Five-Step AIE Process



This powerful process helps clarify, measure, and provide optimal recommendations for a variety of situations. AIE can be applied across an enterprise to solve some of its most perplexing problems, including the following:

- Investment decisions at all levels of IT (using probabilistic analysis)
- Insuring that the implementation of IT decisions are effective (with financially based quality assurance measurements)
- Developing a strategic plan for information systems based on identifying the best opportunities for economic contribution by information systems

Defining the Decision

Most IT investment arguments include some costs or benefits, which are treated as "intangibles" or factors that cannot be measured. Some common examples include "strategic alignment," "customer satisfaction," or "employee empowerment." In most of these cases, the factors only seem to be immeasurable because they are ambiguously defined. AIE removes this type of ambiguity by focusing on definitions that can be expressed in units of measure.

For example, an argument for a new Project Management System may claim that, among other things, it increases "employee empowerment." Does this mean that certain types of decisions can be made better and faster because the information to make decisions is available to more people? If so, how frequently do situations arise that require such decisions and what is the economic impact of a timely decision that is more likely to be correct? Does "employee empowerment" mean that management overhead per employee is reduced because less supervision is required? Does it mean that employee turnover is reduced (along with recruiting and training costs). Or does it mean all of the above? By asking specific questions tied to observables, we can turn our "intangibles" into the known and measurable.

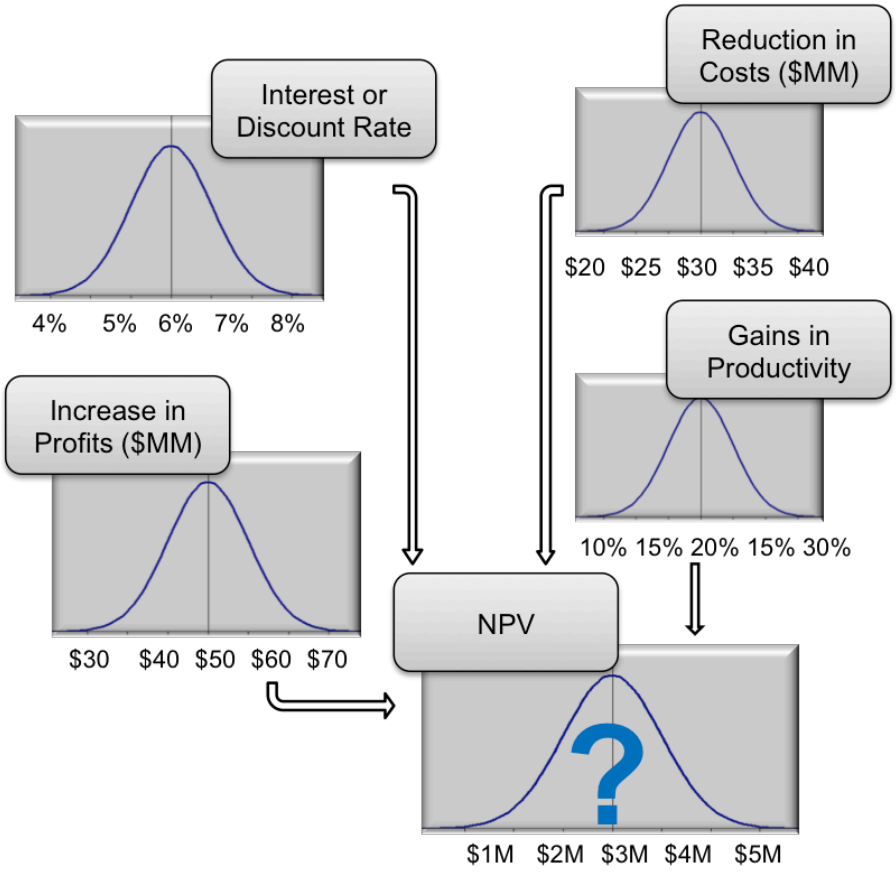
Analyzing Uncertainty Quantitatively

Rational investment decisions must always take both the risk and return of a given project into account. The ability to quantify the risk of a given IT investment, and compare its risk-return with other non-IT investments, is one of the many things that sets AIE apart.

In reality, there is uncertainty about nearly any estimate we would use in a cost-benefit analysis and there is often a good deal of uncertainty in the relationship between (previous) intangibles and their now tangible terms. Instead of choosing some arbitrary number as a point estimate, AIE focuses on determining the range of possible values for a given variable and ascribing probabilities to them. Decades of research prove that this is a skill that managers and technology experts alike can be taught in a way that is reliable and demonstrates measurable improvement.[3, 4, 5, 6, 7]

The ranges of values assigned to variables in a decision model can be used to determine a "probability distribution" of the net benefit of a particular IT investment. AIE uses the "Monte Carlo" method - the generating of thousands of random scenarios on a computer (also used in statistics, actuarial science and game theory) - to develop a profile of the likelihood of each possible outcome. Usually, this method will show that there is at least some risk of a negative outcome – and this risk will be measured.

Monte Carlo: How to Model Uncertainty in Decisions



Calculating the Economic Value of Information

Contrary to popular belief, the value of information can be calculated as a dollar value. Although the term "information" is often used in an ambiguous manner, it can also be used as an unambiguous unit of measure with a well-defined value calculation. This mathematical procedure can be paraphrased as follows:

1. Information Reduces Uncertainty
2. Less Uncertainty Improves Decisions
3. Better Decisions Result in More Effective Actions
4. Effective Actions Improve Profit

These four steps can be stated in an equation that has been in use since the late 1940's. From this the "elusive" value of information can be determined precisely. While the equation has been in use for many decades, it is not widely used which can result in a focus being placed on low economic value variables. In fact, this observation has been so ubiquitous that we have given it a name: the "measurement inversion."[8]

Examples of Measurement Inversions

Some investments considered by HDR clients	What they would have measured	What needed to be measured (sampling methods designed by HDR)
Document management systems for legal discovery	Reduced printing and handling costs	Percent of relevant documents not introduced to a case
Infrastructure upgrades	Downtime and IT labor costs	How work processes are affected by downtime
New procurement system for government	Detailed "time and motion" study of procurement process	Price savings from using reverse auctions
IT security	People who attended training, external threats	Internal theft incidents

Measuring What Matters Most

Measures for ROI in IT business cases have historically focused on minor cost reductions such as printing, internal IT costs, attendance to training, and similar items. However, the more valuable measures are more often related to behavior and especially behaviors outside of IT.

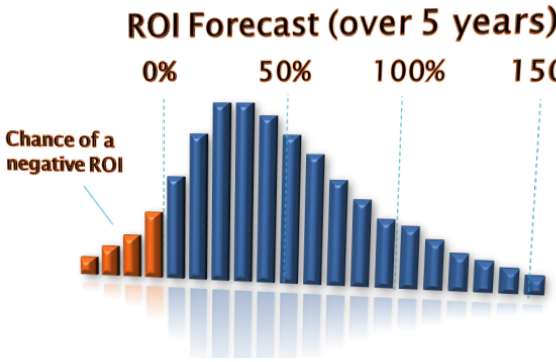
If something matters to a decision, it must have some detectable consequences, which are observable in some amount, and which are therefore measurable. But decision makers often worry that they don't have sufficient data and, even if they had enough, statistical measurement methods are impractical for some reason. These are myths.

The value of information points us toward measuring quantities with high uncertainty. This is exactly the situation where gathering a small amount of data has surprising and positive results. In this situation, most people consistently underestimate the mathematical uncertainty reduction derived from even a small amount of data. HDR has proven this by using statistical measurement methods of many kinds on a variety of practical decisions for two decades.

Making the Best Bet

The last step in applying AIE to IT is a method from Modern Portfolio Theory; this step treats the set of IT investments in a firm as another type of investment portfolio. Each investment is analyzed on a risk-return basis for its contribution to the portfolio.

By using techniques from Modern Portfolio Theory, we can determine whether the uncertainties inherent in a given IT investment decision are acceptable given the "risk-return boundary" for the firm. Executives are guided through a process to determine their risk-return boundary, if this hasn't already been done internally. One of the primary benefits of having an explicit risk-return boundary is that it improves the consistency of investment decisions. By removing environmental biases, the risk tolerance of the executives and the company can be applied consistently.



III. What is Different about Applied Information Economics?

The methods and results of AIE are an improvement on predecessors and represent an opportunity as they would still be new to almost any IT decision-making committee. Previous attempts to improve the ability of firms to invest in IT more effectively could be put into two categories: traditional cost-benefit analysis and weighted scoring methods.

Traditional Cost-Benefit Analysis

For firms that are making no formal attempt to quantify the value of information systems, traditional cost-benefit analysis (CBA) is a great improvement. The decision criteria used by CBA include Net Present Value (NPV), Return on Investment (ROI), Economic Value Added (EVA) and a few others. Since CBA speaks the language of budgets and finance, it is usually understood by the individuals tasked with making budget decisions. Furthermore, the basic principles it attempts to apply (NPV, ROI, etc.) are sound financial tools.

The weakness of a CBA is that traditionally it depends on point estimates (exact numbers instead of ranges) for every relevant factor in the costs and benefits of an information system. The point estimates are not usually justified by methods of measurement but are entirely based on the judgment of individuals. Sometimes, the only attempt to differentiate between different levels of uncertainty is an ambiguous "hard" vs. "soft" distinction. Often a benefit that is identified as "soft" is left out of the calculation altogether. This tends to systematically ignore some of the largest benefits of information systems. Consequently, the result of most CBAs is a number that leaves out any risk of loss and cannot be meaningfully compared to alternative uses of the budget.

Weighted Scoring Methods

Many managers have resorted to a much simpler method which seems to emulate quantitative analysis by assigning "scores" on some scale (e.g., 1 to 5). These methods ask IT investment decision makers to rate a proposed project in categories such as "Strategic Alignment," "Organizational Risk," and so on. The scores in each of these categories may then be multiplied by a weighting factor, which is meant to account for the relative importance of each category.

While there may be a perceived benefit to this method, there is little evidence that it results in any measurable improvements in decisions. It is important to note that these methods are not based on any kind of formal, accepted economic model and that they cannot truly be called "economics" at all. The total score that is generated for a proposed system maps poorly to

reality in financial terms. In fact, these methods have been shown by some researchers to actually make decisions worse by adding a level of ambiguity to the analysis.

Comparison of Methods

	Weighted Scoring Methods (NO IMPROVEMENT)	Traditional Cost-Benefit Analysis (BETTER)	Applied Information Economics (BEST)
Basic Financial Tools	Not specifically included or altogether ignored; produces a "score"; not financially meaningful	NPV, ROI, EVA (sound financial tools)	NPV, ROI, EVA (sound financial tools)
Analyzing "Intangibles"	Attempts to evaluate without removing ambiguity; adds further ambiguity with scoring	Usually ignored because only "hard" benefits are given numbers	Focuses on removing the ambiguity of the identified intangible with "unit of measure" definitions
Uncertainty and Risk in the Estimates	No specific methods are discussed. Subjective scoring methods actually may add uncertainty	Uses point estimates, ignores differences in level of uncertainty except for ambiguous "hard/soft" distinctions	Employs sound mathematical methods already used in actuarial science, statistics, and financial management theory
Information Gathering Methods	Almost no focus on real measurement techniques of any kind	Systematic methods employed - but rarely; usually depends on individual judgment	Empirical, scientific methods based on calculated information values are used
Overall Assessment	Creates an illusion of objectivity and quantifying benefits; has demonstrated no measurable improvement in decisions	Better than nothing; has sound financial methods	The only method which provides scientifically and economically valid recommendations

Conclusion

Applied Information Economics has distinct advantages over other methods for assessing the value of information systems investments. It is the only method that has specific tools to deal with the uncertainty, intangibility, and ambiguity typical of IT investments in a way which is financially meaningful. Every component of AIE, from initial estimates and modeling uncertainty to computing information values and using empirical measurement methods, are based on quantitative methods that have been shown to measurably improve estimates in independent research. Applied Information Economics is and will continue to be at the forefront of methods to keep business prosperous in the growing information economy.

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