

Business Value - The Next Generation TCO/ROI

Given recent global economic developments IT professionals should be aware of and concerned with getting the most out of information technology investments over the short and long term!

In today's business world, companies are rethinking the way they determine investments in Information Technology. The block-budgeting style of allocating a yearly sum of money to the Information Technology department and expecting them to "buy what we need" is no longer appropriate. Today's Information Technology is a strategic part of the business; it has changed from a passive back room system to a strategic weapon to support business evolution. Because of this strategic link the rigor of a Total Cost of Ownership analysis is more important than ever, and it needs to be extended to assess the role of Information Technology in new business opportunities. TCO and its related ROI calculated for both existing and future business opportunities provide a true measure of the Business Value of Information Technology investments.

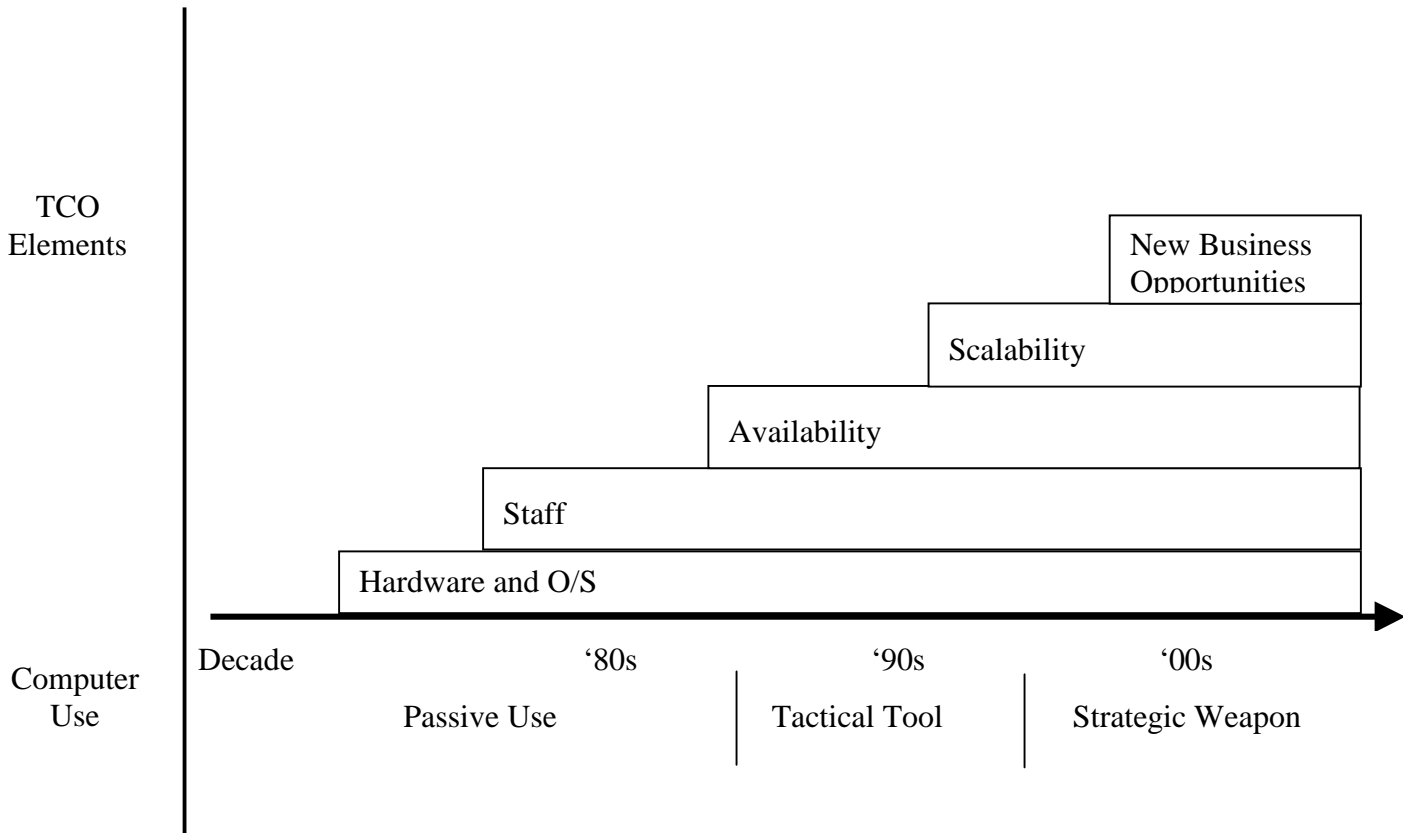
TCO Defined

Total Cost of Ownership is all of the direct costs such as hardware and software expenses, staff expenses, maintenance, overhead, to name a few, plus intangibles such as lost revenue and credibility due to security or system failures.

Return on Investment is the total of all benefits divided by the Total Cost of Ownership. Benefits, like costs, have both direct and soft number components.

Business Value is the sum of the Return on Investment calculated on today's business plus the ROI on tomorrow's new strategic initiatives.

Today TCO calculations have to embrace all factors both direct and intangibles. It has not always been that way. In the earlier days of Information Technology systems, hardware was expensive, staff relatively inexpensive, and applications limited to basic business functions, so TCO calculations were focused on hardware and used primarily to compare vendors. As hardware prices reduced, staff became more expensive and applications started to go on-line, TCO became a tool to understand the impact of unscheduled down time, and the true cost of Information Technology operations.



As Information Technology continues to evolve to applications that are real-time, and mainstream the need to understand all direct and indirect costs is greater than ever. TCO is no longer a tool to just compare vendors, but a means to optimize Information Technology investments to meet existing and near term business needs. As Information Technology becomes more mission critical the more important it is to understand the impact of outages, security breaches, catastrophic interruptions, and the entire supporting infrastructure. This much broader context results in the need to analyze many intangibles where numbers can only be derived from external examples and experience. This latter factor should not be the excuse to ignore TCO and ROI calculations. A rigorous TCO analysis forces a complete and detailed examination of all of the benefits and costs over the entire life cycle of systems. It is the discipline of this approach that assures that the investment in Information Technology is optimal for today's business and appropriate to support near term new business. This look ahead is very important as business cycles are becoming shorter than implementation cycles.

To meet this situation HRG has developed a methodology that can be used to assure effective TCO and ROI calculations. Hardware purchasing decisions are based on much more than price and performance. Since 1998, Harvard Research Group has performed more than 1500 interviews with IT professionals resulting in a rich understanding of factors critical to a TCO analysis. Recently HRG has done extensive secondary research and completed interviews with over 500 IT professionals in order to develop a methodology by which to calculate an accurate Total Cost of Ownership (TCO).

Procurement, installation, operations, and downtime all need to be included in a comprehensive TCO. Operational costs can represent from 50% to 80% of the TCO, depending on configuration size, complexity and planned system life span. For this reason, human resources, training, maintenance, and overhead costs are significant in controlling TCO.

The server and software market continue to change at a dizzying pace. In the process, server pricing will continue to become increasingly competitive. Processing power, availability, scalability, and customer service are critical elements in any server selection and purchase process.

The costs of running servers and clusters of servers can be reduced by well-planned operations and preventative maintenance. A vendor's major contribution is pricing, competence of support, availability, and the use of their broad knowledge of systems to assist the buyer in any way possible.

UNIX servers are increasingly the platform of choice for business critical applications by many of today's Fortune 2000 businesses as well as by the small to medium business (SMB) market. The current generation of UNIX servers provides automatic backup and other enhanced functionality to meet the demands of e-business and its related IT requirements. In order for IT professionals to understand the true price/performance of UNIX servers they must consider the cost of hardware, software, system configuration, staffing, training, downtime, security, and stand by resources.

To calculate an accurate Total Cost of Ownership (TCO), procurement, implementation, operations, and downtime costs all need to all be included. HRG has determined that the majority of systems related costs are operational and Human Resource related and therefore can in most cases be controlled in-house. This paper provides guidance on how to think through and implement a TCO analysis

Comparing costs on the basis of purchase price alone is meaningless when you consider all the money spent on a system over its typical 3-5 year lifetime. Other factors such as maintenance, human resources and downtime need to be considered. In defining the TCO, Harvard Research Group focused on procurement, installation, operations, and downtime related costs.

Procurement

Included in procurement is all up front purchasing costs: the cost of the servers themselves, any additional hardware needed, such as desktop computers, printers, scanners, disc arrays, and network interface cards (NICs), the operating system, utility software, applications needed to get a basic configuration up and running, and staff labor associated with determining system specifications.

Installation

Installation includes all costs directly related to installing and configuring hardware and software. This also must account for the payment of third party consultants as well as staff training for the new system.

Operations

Operations includes all ongoing costs related to system management: maintenance contracts for hardware and software, all human resources required such as administrative, support and programming staff, and some percentage added for general overhead related to staff.

Downtime

A significant and frequently overlooked cost is downtime. Downtime includes lost productivity by all users on the system: staff, suppliers, resellers etc. Also, where appropriate, downtime costs include lost revenue due to availability issues. HRG calculates downtime by accounting for unplanned occurrences and the need for scheduled routine work on the system. Some of the more typical reasons for unplanned downtime are:

- Malfunction of hardware
- Malfunction of software
- Power outages
- Human error.

The critical nature of an application running on the system and whether it can deliver goods and services has a significant impact on the cost of downtime. HRG's model uses the HRG Availability Environment Classifications to adjust the impact of planned and unplanned downtime on final TCO calculation. HRG has defined Availability Environments (AE) by the impact of an outage on both the business and the end user or consumer. Each successive level incorporates all the functionality of the previous level.

Availability Environment Classifications (AEC)

HRG has defined availability in terms of the impact of an outage on the activity of the business and consumer (end user) of the service. The five Availability Environments (AE) listed below define availability in terms of the impact on both the business and the end user or consumer. Each successive level incorporates all the functionality of the previous level. When a failure and subsequent system recovery response has occurred, the system is assumed to not be at its original Availability Environment Classification until the failure has been corrected and any failed components have been replaced or repaired. In some cases, there may be system redundancies that support fail over capabilities in the event of an additional failure. The minimum requirement for a system to be considered highly available is that there is a backup copy of data available on a redundant disk and a log-based or journal file system exists for identification and recovery of incomplete transactions -- this represents the AE 1 Availability Environment Classification.

- **AE4** – Business functions that demand continuous computing and where any failure is transparent to the user. This means no interruption of work; no transactions lost; no degradation in performance; and continuous 24x7 operation.
- **AE3** – Business functions that require uninterrupted computing services, either during essential time periods, or during most hours of the day and most days of the week throughout the year. This means that the user stays on-line. However, the current transaction may need restarting and users may experience some performance degradation.
- **AE2** - Business functions that allow minimally interrupted computing services, either during essential time periods, or during most hours of the day and most days of the week throughout the year. This means the user will be interrupted but can quickly re-log on. However, they may have to rerun some transactions from journal files and they may experience some performance degradation.
- **AE1** – Business functions that can be interrupted as long as the availability of the data is insured. To the user, work stops and an uncontrolled shutdown occurs. However, data availability is ensured. A backup copy of data is available on a redundant disk and a log-based or journal file system is being used for identification and recovery of incomplete transactions.
- **AE-0** – Business functions that can be interrupted and where the availability of the data is not essential. To the user work stops and uncontrolled shutdown occurs. Data may be lost or corrupted.
- **Disaster Recovery** capability is a horizontal availability feature that is applicable to any of the Availability Environments (AEs). It provides for remote backup of the information system and makes it safe from disasters such as an earthquake, fire, flood, hurricane, power failure, vandalism, or an act of terrorism.

Other Factors

HRG considered all factors that comprise a comprehensive TCO calculation. However, the level of detail and time necessary to collect all possible data is not always useful in a real-world situation involving real dollars. This paper focuses on the most significant factors.

Who we spoke to

Harvard Research Group interviewed IT professionals who manage their companies' UNIX servers. All interviews were conducted randomly and comprise the following industries:

- Manufacturing,
- Education,
- Insurance,
- Healthcare,
- Government
- Telecommunications
- Utilities
- Software
- Wholesale / retail
- Financial services
- Software
- Services

Respondents within these industries run a mix of business critical applications including:

- ERP Software
- E-commerce
- Data mart / Data Warehouse
- Internet / Intranet Applications
- Collaborative Work Group
- OLTP

Of the respondents interviewed, 39% used IBM as their primary hardware vendor, 25% used HP, 21% used Compaq, and 15% used Sun. Both Intel-based and RISC-based servers were used. In terms of availability levels, 30% of clusters were used for low availability applications (AE0-2), 39% were used for mid-range availability applications (AE3), and 31% were used for high availability applications (AE4).

Comparing "Apples to Apples"

To get a fair picture of each vendor's TCO, HRG chose three levels of server performance: Low, Medium and High. Within each level, systems were priced with the same amount of memory, CPU power, and storage. Prices do not reflect vendor or channel discounts.

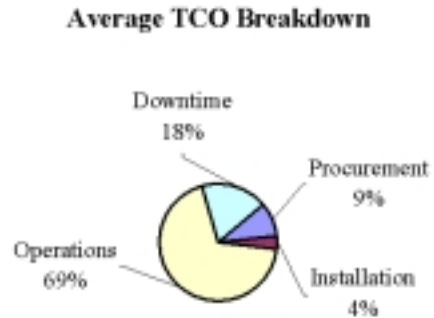
Comparing costs across Intel and RISC architectures proved to be problematic. On one hand, all systems run some version of the UNIX operating system. On the other hand RISC-based systems

typically cost 2 to 4 times more than comparable Intel systems (anywhere from \$35,000 to \$260,000 more.) The difference in price can partially be justified by lower downtimes for RISC machines. In its underlying analysis HRG therefore separated RISC from Intel-based machines in order to provide a more fair comparison.

Primary Research Results

HRG has aggregated and analyzed all relevant costs across all phases: procurement, installation, operations, and downtime.

What emerges is that operations are the most significant costs in calculating the TCO. In the mid-range and high-end clusters, the significance of operations can reach over 80% of the total costs! Typically vendors have little impact on operational spending (20-30%), but the vendor who makes an effort to reduce operating costs will help reduce the overall TCO. What this really means is how a company manages staff, provides effective training, and controls overhead etc., are the most significant factors in keeping costs down for clustered server configurations.



Downtime, procurement, and installation make up the balance of the TCO component costs.

How to Calculate a Meaningful TCO

What follows are some important concepts that can help you calculate a meaningful and accurate TCO.

Take the Time

In order to get the most out of any TCO analysis it is best to take the time to collect as much real financial data as possible. Each situation is unique in terms of discounts, availability levels, volume of transactions, etc. A rigorous data collection process can take some time, but will greatly enhance the accuracy of your TCO analysis.

Hidden Costs

In thinking about how to reduce your Total Cost of Ownership it is important to understand what costs are truly vendor dependant and which are under internal company control. Most operational costs are not vendor dependant, but there are many ways in which the vendor does affect costs that may not be apparent at first. What follows are some questions you should ask vendors:

- Will you help assess company needs to speed up the process of designing solutions?
- Can you provide tools that can help speed up the installation process?
- Do you provide useful scripts and support for the applications that I want to run?
- Will I need to pay for third party consultants during installation and/or during operations?
- Will you provide timely and effective customer service?

Understand the Cost of Downtime

With the competitive landscape of e-business challenging companies 24 hours a day, the cost of having a critical application “down,” can be considerable. Average losses are approximately \$70,000/hour with some industries citing \$1 Million or more. These costs are determined by factoring in lost sales, lost employee productivity, and/or a slow down in manufacturing. Further costs may be incurred from a loss of data in which staff may need to restore what was lost. Unplanned downtime does not always imply lost revenue, an example being delayed invoices. Revenue that is retrievable after the system is back up should not be calculated into downtime costs. Other downtime costs worth considering are repairs needed by hardware and software, any need for outside consultants or special training due to unscheduled downtime, and overhead rates applied to all staff that experiences a loss in productivity.

Often the cost of downtime is difficult to assess due to a lack of relevant data. The first step to truly understanding downtime costs is to determine your system’s Availability Environment Classification. The higher the AE number the higher the cost of downtime.

Key Factors

There are two key factors of TCO that are not conducive to quick calculations. One is Life Cycle, the other is Soft Numbers. The word “total” in TCO means that the life cycle should be from pre-specification to retirement, with each phase being analyzed in detail to document assumptions, evaluate alternatives, and define related business scenarios. This requires homework so the life cycle is often defined around those phases that are easier to quantify.

Soft Numbers

The second factor - Soft Numbers – are even more elusive than life cycle phases, and are often the reason that TCO and related ROI calculations do not cover the entire scope of a business solution or a system’s application.

Today’s business environment requires full consideration of these two factors without any simplification for meaningful ROI and TCO calculations, and the business spectrum covered by TCO has to include not only today’s business but also tomorrow’s. In today’s market environment the investment in Information Technology (IT) is strategic so thinking, planning, and operations have to be reviewed relative to both today’s business and tomorrow’s new opportunities. In this broader scope ROI becomes Business Value.

The role of Information Technology has changed over the years as shown in slide 2. Up to the mid-80s IT was passive used for tasks such as accounting, and billing. In the following ten years IT was used as a tactical business tool with tasks going on-line, and applications spanning multiple company functions. Today IT has become a strategic weapon. Knowledge can and is being disseminated throughout the company, customers are on-line, and mass customization is being used to build customer loyalty.

Times have changed, but that doesn’t mean we throw out TCO and ROI. It means that they have to be calculated for today’s business and tomorrow’s opportunities and combined to see true Value. In this paper we will examine TCO both in terms of today’s business, and in terms of its use to determine Value. The common ground to using TCO to calculate ROI in today’s business

and for future business opportunities is the art of estimating the intangibles. These estimates often referred to, as soft numbers are essential to understanding the total cost and benefit picture.

Before going too far let's define the terms we are using. Total Cost of Ownership is all of the direct costs such as hardware and software expenses, staff expenses, maintenance, overhead, to name a few, plus intangibles such as lost revenue and credibility due to security or system failures.

Return on Investment is the total of all benefits divided by the Total Cost of Ownership. Benefits, like costs, have both a direct and soft numbers component.

Business Value is the sum of the Return on Investment calculated on today's business plus the ROI on tomorrow's new strategic initiatives.

The definitions are simple, but the calculations are more involved because of the task to derive the soft numbers. There are three categories of soft numbers, those that are part of the benefit, those that are part of the costs and those that are part of the evaluation of the next business opportunity. All are intangible, and some are more difficult to determine than others. Deriving the soft numbers means careful thought, in-depth analysis, and understanding all business processes, existing and future. It is not a back of the envelope exercise, but not too difficult, and certainly essential, otherwise the spending on IT could be too much, and waste capital, or too little and limit growth and profitability. Clearly assessing benefits and costs of future business opportunities is more difficult than calculating ROI and TCO for today's business, and I will come back to discuss that.

Since soft numbers are so important to estimating benefits and costs let's spend a few minutes on soft numbers.

Soft numbers are with us everywhere. Michelin Tires ran advertisements showing people traveling with their babies in their cars in order to stress that there is more at stake than just the price of the tires: the value of loved ones. Although we all hope that accidents won't occur, the reality is that they do, and the potential and probability of an accident and its range of consequences are all part of the Total Cost of Ownership of a car. Since the chances of an accident and the severity of that accident are unknowns they must be estimated, hence soft numbers. Depending on the variables, there are usually statistics and data to help us estimate, for example, crash test results, tire safety margin data, geographic risk assessments, driver history, accident statistics, and even the laws of physics.

In the real world of computer applications, applicable information is available as in the car example, and mixed with experience can be used to derive meaningful soft numbers.

Time does not permit to explore in broad detail all of the soft number areas throughout the entire life cycle, but I have chosen one situation to review to show the concepts of how to deal with soft numbers.

The Scenario

- Full service on-line point of sale cash registers at a 24-hour retailer with 50 locations
- An unscheduled two-hour down time at 8 PM on the second Tuesday in July.
- At that time of day there are four checkout stations open at each of the 50 locations.

It is often best to derive estimates by calculating the two extremes; best case and worse case scenarios, and then determine where the operation is between the two extremes. Here the best-case situation is that the down time is totally transparent to customers, so there is no impact. In the worse case scenario we retain all of the operating costs while every customer goes to different stores, so we lose all revenue from the 100 shopping hours forever. Additional revenue would also be lost as word goes around that store “X” is temporarily closed, which creates an indeterminate period of time before shoppers will return to the store. In order to find the cost of the worse case scenario we should begin with the operating costs and historical revenue statistics for the two highest revenue hours in a year for each of the locations. The more difficult to estimate is the secondary impact of shoppers not coming to the store because they have heard that the store is effectively closed. A reasonable estimate for this might be to assume that even if the system were back up by 10PM the revenue impact would last for at least another 2 hours.

At this point we have an estimate for the two extreme cases. Next, to calculate the TCO we need to decide where we fall between the two extremes. Based on our level of system back up, redundancy, and alternate customer service options, we can estimate our exposure between the two extremes. From this estimate and the costs of the two extremes we can estimate the cost of such a system interruption.

From this example we can see that not only can a TCO analysis tell us the costs associated with what we have, but it can also be a useful tool to decide what we should do. Let’s say that the difference between worse case and best case in this scenario is \$ 10 million and we estimate that if it happened we would be halfway between the two extremes, and that the probability of this happening is once per year.

From the TCO analysis we know how much we spent on the total system and that we run the risk of a \$5 million loss of revenue once per year. We can then determine the additional costs to bring our system and customers service options up to the standards needed to achieve best case. If that showed that the \$5 million revenue risk and the related non-recoverable operational costs could be eliminated for an appropriate expense then that would be the thing to do. Conversely we could also do a TCO for the worse case where we assume that we eliminate all of the system and customer service options so hypothetically set ourselves up for the worst case. If the calculation showed the cost reduction to be greater than the risk, then the system is overkill. [An editorial side bar. “I have never found this to be the case.”] Completing these three sets of TCO calculations for the best, worse, and probable case is an excellent way to determine if the right decisions have been made, and it makes it possible to see the spectrum of costs and related benefits for various levels of infrastructure, computing resources, availability, and scalability.

Each soft number area will be different than the example, but hopefully the example showed the concept of the thought process that can be used. Even though the thought process for each soft number area will be different, the concept is fairly universal.

Life-Cycle

Switching gears from soft numbers to another key aspect of TCO and ROI - life cycle.

Determining the intangibles is essential, but it is more than numbers, it is the discipline required to think through the whole life cycle, to understand all of the factors involved in each phase that can provide insight into the operations. The analysis of the entire life cycle must be from the instant someone thinks about a new application, replacement, upgrade, etc., through specification, procurement, installation, operations, and eventually retirement. It is never as simple as the case where the salesperson said to the buyer, "If you buy my system it will eliminate half of all your work." "In that case," said the buyer, "I'll take two." If buying, selling, and measuring results were only that easy.

Often it is assumed that the costs of some phases are so low that they need not be included in the TCO and corresponding ROI calculations. In such cases, the advantages of the TCO calculation are missed and they no longer identify true costs, or work as a tool to compare vendors. It is best not to omit phases of the life cycle whose costs might appear on the surface to be inconsequential. For example, we know that operating and downtime costs can be of the order of millions of dollars, so it might seem unimportant to include the costs of five people spending six weeks writing the specification. Yet even though the direct costs of this phase may be small, it is here where the questions begin: who should develop the specification? Who defines the functionality requirements? Do we do interviews? Do we need a focus group? Where are our peers and competitors on this? How will this integrate with our other applications? Etc. The business and operational costs of the answers to these questions are an integral part of the TCO calculation, and the exercise of defining and answering these questions can not only turn up hidden costs, but also can also eliminate errors, and help pinpoint specific goals.

True Story

After much time and millions of dollars had already been spent on development an unsuspecting vendor representative was brought into the following situation. Unfortunately, from the get-go everyone involved was confident that they knew all of the requirements and trade-offs, and they completed an ROI analysis based on those assumptions. A complete TCO analysis had not been done so the only considerations were standard assumptions: they had not gone through a disciplined process of reviewing the scope and breadth of the application's life cycle. It was a billing system for a wireless phone company, and when it was ready for field test a cross section of dealers were brought in for a review. By the end of the day the dealers had come up with over 50 shortcomings in the new application--obviously a review that should have been done at the specification stage and not at the start of the field test. A complete TCO analysis of the application at the specification stage would have raised these issues, and made it clear that too little was known to begin development without input from all groups within the user community.

We don't want to give you the impression that TCO is only relevant at the beginning of a project, or that if a project is already underway it is worthless to go back and look at TCO. In fact, it is applicable at any time. Most of the cost of ownership is incurred in the operational phase, and it is during this period that upgrades and enhancements are made in order to improve functionality and performance. Understanding all of the factors involved in those decisions are just as important as for new projects.

It should now be clear that in order to gain the benefits possible using TCO calculations, the analysis must cover the full breadth and scope of the applications and systems, from the very beginning of the life-cycle, what I like to call the "thought" phase, all the way through to retirement. By not leaving out any part of the life cycle you are guaranteed a better overall cost-analysis, and an accurate means to survey and compare architectures, trade-offs, operations, and vendors.

To summarize the life cycle, let's review each of the key phases. In each phase there are direct costs, and costs associated with trade-off decisions.

In Harvard Research Group's TCO model the first phase is procurement. This phase has three sub phases: - thought, specification, and purchase.

Thought Phase

The life cycle begins as soon as an objective is stated, such as "let's review whether it is time to upgrade our supply chain." In this first phase we develop the plan of how we are going to plan, and this is where the criteria for analyzing costs and benefits are established.

Specification Phase

Once we have our basic criteria in place, the next task involves the development of detailed plans and specifications. In many ways this is the most important part of the life cycle, and it is often where far too many corners are cut. I remember a cartoon where the head of the development team said to the rest of the staff, "Start programming while I go upstairs and find out what they want." It is tempting to get things started with "ready, fire, aim!" but we have all seen or experienced the disastrous consequences of inadequate planning. Although the planning costs will be higher if done properly, they have a much higher return on investment than any other phase. I was once involved in a project where the specification, design, and implementation phases cost \$10 million, and the operational phase cost \$75 million. By analyzing all of the cost components, we concluded that the next time we did the project we needed to spend more in the early phases. The second time around we spent \$14 million in the thought and specification phases, and the operational costs reduced to \$57 million. So \$4 million more in planning and benchmarking saved \$18 million in the operations phase. Without the discipline of a Total Cost of Ownership approach, we never would have seen this net gain of \$14 million.

Procurement Phase

Buying anything takes time, and time is money, so there are obvious procurement costs, but what is less obvious and falls into the soft numbers category is the impact a seller's ease of doing business with has on costs.

Installation Phase

This is the shortest phase of the life cycle, and the easiest to cost, as most costs in this phase are hard numbers.

Operations Phase

This is the longest, most costly, and hardest phase to compute because of the many soft numbers. Examples of these soft numbers are:

- Costs and revenue impact associated with unscheduled downtime
- The same, except for scheduled downtime
- User satisfaction
- Productivity Improvement
- Operational and Revenue benefits as related to system architectures
- Inflation
- Training and Learning Curves
-

Allowance for unforeseen changes brought about either internally, or through external technological and business factors

Retirement Phase

Often overlooked in this phase are costs associated with retraining, and parallel operations.

Business Opportunities

Next let's look at the need for including new business opportunities in the calculations. The ROI and TCO calculations discussed above are typical, but can lead to the wrong conclusions unless the business case is expended to look at future needs. Let's look at our point of sale example. In that scenario the trade-offs between systems and downtime risks were analyzed within the operations of the business unit and the systems needed to support it. To often corporate strategies are not linked to operations so unknown during the time of the analysis was the intent to establish an on-line order entry system, and for the first year divert some store inventory for those sales. Missing the change in corporate strategy would lead the analysis to the wrong conclusion. The key here is that in a world where often business and technology changes are faster than implementation cycles, the analysis has to look at today and tomorrow.

Conceptually the task of determining the benefits and calculating the total cost of ownership for the new business opportunity are the same as our scenario, but they are made more difficult because there is little quantifiable data to support the new business assumptions.

The discipline and rigor of deriving the soft numbers for both the current and new business opportunity, and assessing the needs of the present and new business opportunities will lead to the right trade-offs. To emphasize the importance of looking at the complete picture of both existing and new businesses we should think of the task as not calculating ROI and TCO but TBV – True Business Value.

Summary

ROI and TCO - both require deriving soft numbers. But don't simplify the calculations to accommodate easy estimates. Putting the discipline in place to derive the soft numbers from data and experience will make ROI and TCO calculations much more meaningful.

TCO - consider every phase of the TCO from "thought" to retirement. We all know the operational phase has the highest cost but don't use that as the reason to ignore the other phases. The thought process of what is needed and what can go wrong in every phase will lead to a much more meaningful analysis.

TBV - True Business Value - The scope of TCO and ROI has to be extended to consider how future business opportunities can affect even the decisions for today's business.

Harvard Research Group is an information technology market research and consulting company. The company offers highly focused market research and consulting services to vendors and users of computer hardware, software, and services. For more information contact Harvard Research Group as follows:

Harvard Research Group™
Box 297
Harvard, MA 01451 USA
Tel. (978) 263-3399
Fax (978) 263-0033

E-mail hrg@hrgresearch.com
<http://www.hrgresearch.com>