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IT Portfolio Management: A Case Study

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ABSTRACT

IT Portfolio Management is increasingly becoming an important topic of research in IS/IT. The number of IT projects in a company can number in the hundreds, and it is difficult for upper level executives to manage this portfolio effectively without using some guiding methodology. This paper focuses on one such methodology that is being developed by a Fortune 100 company. Although many excellent papers have discussed using Real Options in the valuation of IT, there has been relatively little work in using Real Options in the IT Portfolio management context. Furthermore, most of the papers in the main IS journals have used relatively simple option models to evaluate (1) a single investment decision (2) assuming independence between projects. The focus of this paper is on a company that is actually managing IT portfolios of projects, and on some issues that may make exotic option models and more appropriate valuation tools.

Keywords (Required)

IT Portfolio Management, Real Option Analysis, Complexity Theory

INTRODUCTION

Over the past ten years there have been numerous papers in the main IS literature that have explored the use of real options analysis in the valuation of IT projects. There have been several different focuses within these works. One early focus was on developing the usefulness and appropriateness of using Real Option Analysis (ROA) in managing IT projects both through logical argument and case studies (Benaroch and Kaufman, 1999, 2000; Taudes, Feurstein, and Mild, 2000).

A second focus was on developing the idea of actively managing IT projects in order to embed real options within them by design, rather than just passively assuming real options would occur naturally (Benaroch 2001, 2002; Benaroch,, Lichtenstein, and Robinson, 2006). Finally, the idea of using option models beyond the basic Black Scholes or Binomial models (Schwartz and Zozaya-Gorostiza, 2003), and reasons for actively managing a company in a way to maximize the option value of its IT portfolio have been proposed (Fichman, 2004).

One gap within this literature is that the studies usually assume that the investments are done in isolation. Although it is often recognized that interactions can exist within projects, the case studies presented usually focus on the option value generated from one business decision. In our investigation of a Fortune 100 company, (Organization A), meeting with divisional CIO's and other managers, we were exposed to the entire IT portfolio management process. Additionally, we are involved in the ongoing development of an IT Portfolio management methodology as the firm struggles to come to grips with the enormous complexity of managing a real world IT portfolio. This case specifically deals with how a Fortune 500 company manages a portfolio of projects, and attempts to inform the reader regarding this gap in the literature by showing how IT portfolios are managed. Although it was not designed as such, this case study is particularly well framed in the context of Fichman (2004).

The rest of this paper proceeds as follows. First, an overview of the IT portfolio management (ITPM) process is given. Second, each phase of the ITPM process is examined both from a strategic perspective, and from its real world context. This is done both by tying the ITPM process to the related academic literature, and by examining Organization A's real world practices. Third, certain implications of the real world practices are presented based on analysis done using Complexity Theory. Finally, implications for ROA and suggestions for further research are given.

THE IT PORTFOLIO MANAGEMENT PROCESS

The project portfolio management process can be broken down to a series of phases similar to the process of financial portfolio management (Brach, 2001).

1. Opportunity Identification
2. Allocation of Resources
3. Selection of Investments
4. Performance Monitoring

This is conceptually similar to a financial planner (1) identifying the long term goals of his/her client (e.g. long term growth vs. safety), (2) splitting up the client's funds into different classes of investments (e.g. real estate, growth stocks, and/or international assets), (3) identifying individual investments to purchase (e.g. buying shares in Google, T-Bills, and/or gold bullion), and (4) finally monitoring the entire portfolio's performance.

Stage 1: Opportunity Identification

According to Penrose (1959), one of the most important factors for the success and growth of an organization is its internal resources. These resources may be tangible or intangible and are limited; particularly so for managerial talent. It is the combination of these resources that drive the production possibilities of a firm. In developing corporate strategy, managers must balance the current resources of the firm with the firm's future needs. Building on this proposition, two important ideas have come out of the strategy literature, the Resource Based View (RBV) (Wernerfelt, 1984), and strategic alignment.

In the RBV, a firm's advantage comes from the development of resources that are valuable, rare, imperfectly imitable, and non-substitutable (Barney, 1986, 1991). Unlike in neo-classical economics, in the RBV firms are not considered homogeneous. Firms can and do build core competencies and competitive advantages through unique assets, unique employees, and unique skill sets. This relates to portfolio analysis in that some projects that might fit well in one organization may be completely wrong for another. This building of core competencies in IT tends to be a dynamic process largely because most technologies become stale or commoditized relatively quickly in the IS field (Mata, Fuerst, and Barney, 1995).

The idea of strategic alignment is related in that in order to create *future* value for its stakeholders; firms need to constantly invest in the *correct*, often new technologies based upon the resources they already possess or need. Furthermore, these investments must be able to overcome the diversification discount that occurs when unrelated assets are simply combined arbitrarily (Berger and Ofek, 1996). One way that has been proposed to focus a firm's energy on only those areas that will maximize firm value is through the use of Strategy Maps (Kaplan and Norton, 2002, 2004). Strategy Maps are a top down approach to managing that begins with the firm's Mission Statement and Vision, and proceed to identify those areas of investment that are needed to support the organization's overall goals. Strategy Maps also have the added value of communicating the direction of the firm to all employees so that different divisions do not work against one another.

Strategic Alignment at Organization A

Decisions of the goals of the firm were generally made above the CIO level, and thus beyond the scope of our study. The corporate CIO was mandated to support decisions made by division presidents. However, Organization A clearly had a well defined focus on driving profit growth. This overall company goal was repeatedly mentioned in discussions with members of the management team. In keeping with this goal, the CIO of the entire firm also had a goal that no more than 20% of the firm's IT projects would be used to enhance existing operating margins. Instead, the focus of IT investment was to be either on new technologies or on major upgrades of existing projects in order to maximize long-term profit growth.

Stage 2: Allocation of Resources

Once the overall goals of the firm have been identified, areas of investment must be decided upon. In the larger corporate sense, decisions need to be made on what businesses to invest in, based on corporate goals and considerations such as Porter's five forces. From the IT portfolio management perspective, decisions also need to be made about the proportion of resources dedicated radical new technologies versus the proportion of resources dedicated to current and legacy systems.

Organizational Learning

Developing IT assets is an on-going process. Firms are typically unable to immediately adopt new technologies unless they purchase the necessary skills or services from others. Instead firms usually need to build competencies over time in selected technologies (Cyert and March, 1963; Nelson and Winter, 1982). Particularly in the volatile field of IT skills need to be constantly updated. Christensen (2000) identifies three ways firms can mismanage this change.

First, successful firms may fail to invest in new disruptive technologies because these technologies initially tend to be peripheral to their main lines of business. By the time the technology becomes popular, the firm may be far behind in the technology compared to newer competitors much like Borders and Barnes and Noble lost much of their market to Amazon. Second, managers can focus too heavily on proven technologies, becoming too path dependent on what is familiar. When new technologies appear firms that are too set in their ways can miss windows of opportunity, even if they have invested heavily. IBM is an example of a company that was instrumental in personal computing, but lost to Microsoft and others because it was unwilling to embrace changes in the way people used computers. Third, firms can develop too fast, adding cost and features to their products that their customers don't need or want. Current cell phone companies may fall into this category developing feature laden phones that some people can't understand or afford.

Management Frameworks

To help manage the allocation of resources, different frameworks have been developed to help prioritize investments. The McKinsey and Company Matrix measures industry attractiveness on the x-axis and the current strength of individual divisions on the y-axis. The Boston Consulting Group Matrix measures growth rate on the y-axis and market position on the x-axis. Finally, the A.D. Little Strategic Condition Matrix measures market strength on the y-axis and technological maturity on the x-axis (Patel and Younger, 1978). While these frameworks have usually been used at the corporate level, the principle can also be used at the project level to inform managers about the allocation process and to link overall firm strategy to innovation using Aggregate Project Maps (Christensen, 2000).

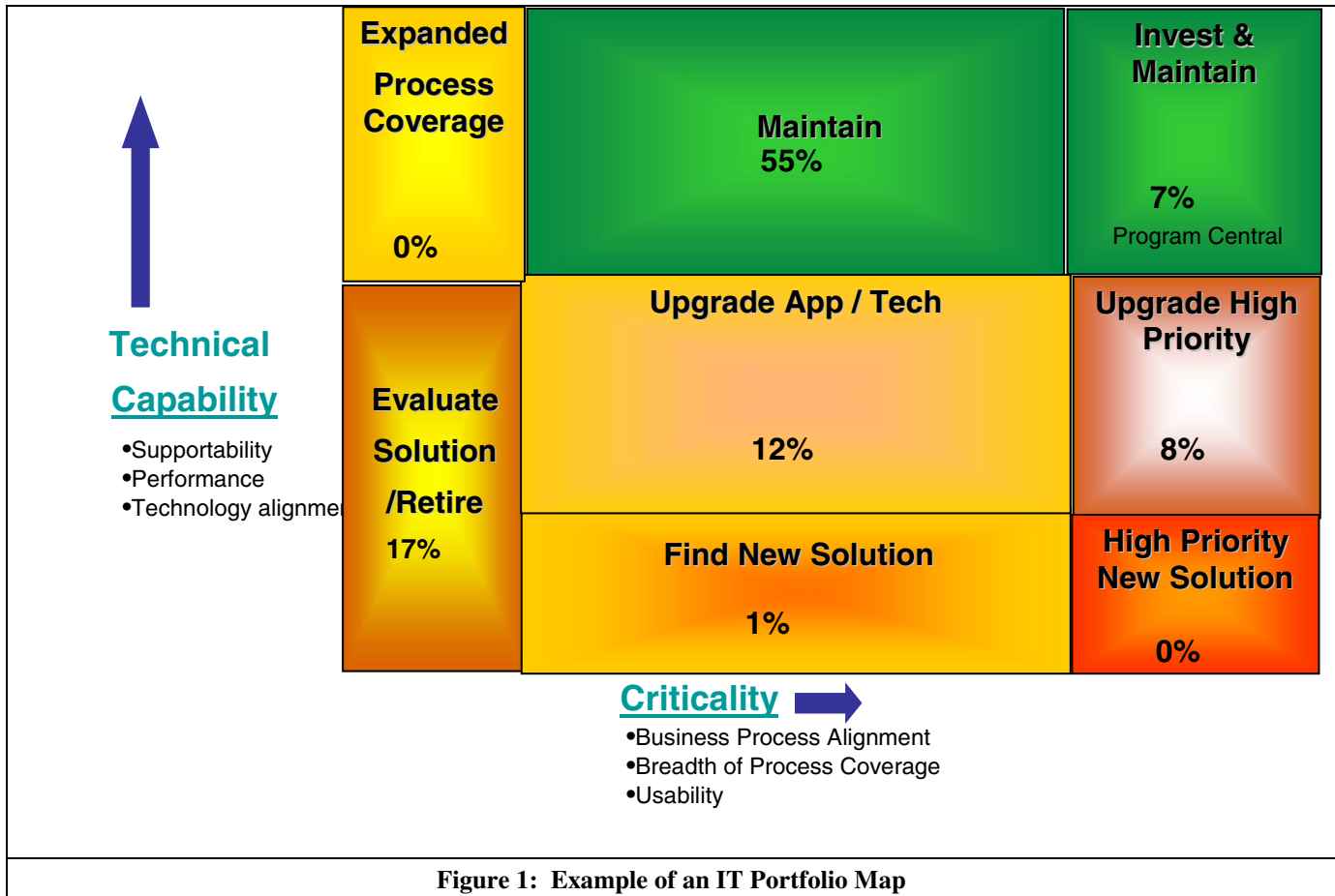
Asset Allocation at Organization A

The firm in question is made up of numerous divisions and the corporate CIO has a dozen divisional CIO's reporting to him. These CIO's propose projects based upon their divisional needs, and divide projects up into three broad categories; "Must Do" projects, long term projects, and operating margin projects. "Must do" projects are IT projects related to contractual or regulatory compliance issues. Long-term projects refer to IT projects that will create long term profits for the company, and operating margin projects are IT projects that will incrementally upgrade a current asset or process, but will not ensure long term profit growth. The corporate CIO has mandated that no more than 20% of the projects started will be in this category.

The corporate CIO allows each of the divisional CIO's to fight for resources among themselves, and does not generally intervene in the process. This creates a competitive atmosphere where individual divisions must fight for resources based on predicted profits. Once a CIO has committed to a specified IRR on a project, they are held to that target, "or else". CIO's that do not meet their targets can be removed fairly quickly, however on questioning this statement there did not seem to be a stated policy for what "or else" meant.

In order to further inform the allocation process and visually monitor each division, a modified version of the Aggregate Project Map suggested by Christensen (2000) is used by the firm. An example of this IT Portfolio Map is shown in Figure 1. In this case, the technical capability of the firm to finish the project successfully, as determined by the CIO of the division, is plotted on the Y-axis, and the criticality of the project is shown on the X-axis. The different regions of the map were named by the divisional CIO's within Organization A. Each division submits its own IT Portfolio Map to visually show their compliance with the CIO's mandate of investing in only high priority projects.

Although the CIO's wish to monitor the Asset Allocation Process more closely, the firm has actually been slow to monitor changes over time. The company as a whole is well known for being metric oriented, and is a leader in such areas as Six Sigma in their engineering projects, but has been slow to adopt metrics in the area of IT Portfolio management. One stated goal of the managers the authors deal with is to formalize this process, including the use of metrics, such as those used in Balanced Scorecards (Kaplan and Norton, 1992, 2002).



Stage 3: Selection of Investments

Limitations of Discounted Cash Flow Analysis

Once the allocation of resources based on need and corporate goals has been made, specific projects need to be selected. Traditional Discounted Cash Flow (DCF) analysis suggests that any investment that has a positive Net Present Value (NPV) should be pursued and those that have a negative NPV should be forgone. However, this approach fails in several key respects.

First, it fails to link investments to the strategic needs of the firm. In fact, managers are typically very aware of their business environment and make investments accordingly. Second, DCF gives no weight to the value of managerial flexibility. When NPVs are calculated, they are discounted at a rate that is generally higher for projects that are considered risky. However, this approach blindly assumes that management will continue to invest in a failing project. In reality, IT projects are often abandoned, or scaled up/down, and pilot projects are used to investigate uncertain technologies. Third, and perhaps most importantly, DCF ignores the possibility that certain investments may be either synergistic or disadvantageous when taken together (Kulatilaka, 1995; Trigeorgis, 1993).

Background Literature: Real Options Analysis

Real Options are similar to financial options in that they are the right but not the obligation to make or divest an investment, or take some other action in the future. However, a real option differs from financial options in several important respects (Brach, 2003):

- They are created by managerial design.
- The options are constrained by the resources of the organization.

- Real options are usually not tradable.
- Real options often have interactions with other real options
- Time to maturity does not necessarily increase real option values

Real options offer an advantage over traditional DCF or NPV analysis. Traditional DCF analysis discounts potential investments according to their risk level. However, such techniques neglect to take into account that returns on IT investments are often asymmetric. That is, if an IT project is not going well a manager can decide to abandon the project and thus limit downside risk, while if a project is going well management can expand or build on promising technology. It is this asymmetry that is the source of option value. Many different types of options exist. Some of the more common types of real options are shown in Table 1 (Benaroch, 2002). Conceptually a projects value can be thought of as:

$$Project\ Value = Traditional\ Net\ Present\ Value + The\ Value\ of\ Options\ on\ that\ Project$$

Finally, the valuation of options, which started with the Black-Scholes’s model (1973), depends greatly on the uncertainty involved in the investment. Uncertainty may be either endogenous or exogenous. In the case of IT, endogenous uncertainty often involves the uncertainty of not being able to implement the technology successfully. Such uncertainty is only resolved through actually investing, perhaps through pilot programs. Exogenous uncertainty is related to issues beyond the control of the firm, such as input costs or future demand for the product. This kind of uncertainty is only resolved through waiting. Therefore, projects that have a lot of technological uncertainty are prime candidates for investment whereas projects that have a lot of exogenous uncertainty are candidates for deferment (Pindyck, 1993).

Table 1: Common Types of Managerial Options	
Option	Description
Defer	The option to delay investment until more information can be learned about the project.
Stage	The option to build a project in stages, where investment can be delayed or killed if the environment changes.
Explore	The option to use a pilot program to better learn about a project.
Scale	The option to increase/decrease the scale of a project depending upon its success.
Abandon	The option to kill a failing project.
Outsource	The option to subcontract a project or part of a project to shift some downside risks to a third party.
Lease	The option to lease some resources to shift some downside risks to a third party.
Growth	A set of projects where the value of earlier projects depends on additional projects, i.e. an infrastructure investment that assumes follow-on investments will be made.
Compound	A combination of the above options in one project.
Table 1: Common Types of Managerial Options	

Selecting Projects at Organization A

One of the biggest problems in the Portfolio Management process at Organization A, is that project selection is not at all a well defined procedure. As mentioned above, the divisional CIO’s are allowed to “fight it out” for corporate resources.

Although the company recently adopted the IT Portfolio Map, (Fourth Quarter, 2007), to help codify the Asset Allocation process, there is not a set way to rank or select projects. The main criterion used for ranking a project is by its Internal Rate of Return (IRR). This of course has the typical problem of scale, i.e. a \$100K that has a IRR of 200% is considered better than a 1 million dollar project with an IRR of 100%.

The firm is currently investigating using ROA to deal with these problems. As proposed by Fichman (2004), firms that manage innovation can use the uncertainties inherent in new technologies to generate value. In short, high variances, particularly in market risk allows for high option values. The main difficulty in this process is two-fold. First, it is difficult to estimate variance in new projects. Second, the divisional CIO's do currently "game the system", by predicting IRR's that make projects seem more/less attractive than they actually are. The authors are working on this problem with the executives of Organization A.

Stage 4: Performance Monitoring

Performance Monitoring at Organization A

In order to manage any portfolio effectively, the ITPM process needs to be monitored, for example through the use of Balanced Scorecards (Kaplan and Norton, 1992, 2001). Although this makes common sense, Organization A does not formally monitor the process once the selection process is made. Each CIO is responsible for their own portfolios and much of the monitoring process is done by divisional presidents. If a project does not make the promised rate of return, the exception is noted, but nothing is currently proscribed. Also, other than yearly monitoring of projects through the IT Portfolio Maps, individual projects are not currently considered at the corporate level once the investment decision has been made. This policy is being reviewed in partnership with our team.

CHARACTERISTICS OF IT PORTFOLIOS

In the authors' investigations of the IT Portfolio Process, it has become clear that IT portfolios are not the same as financial portfolios in one additional critical way. IT portfolios are not well diversified. Whereas, financial portfolios depend on investments being uncorrelated or even negatively correlated, we found evidence that IT portfolios are highly correlated. IT projects were divided up in several different ways in the firms we investigated. Some firms divided the projects up by division, and other firms by type, i.e. infrastructure projects in one portfolio, mobile projects in another portfolio, etc. Still others divided projects up by technology, i.e. Oracle, SAP, Cisco etc. In all cases, we had strong reason to believe that the projects were strongly correlated and occasionally interacted. Usually this was from discussions with managers that told us there are key groups or individuals in the firm, but there was also some statistical evidence given in the way projects progressed through the System Development Life Cycle (SDLC) at each firm.

Complexity Theory

In order to test the hypotheses that the projects were highly related we used complexity theory to make predictions about the portfolio. Complexity theory although not commonly used in the MIS literature is well established in the hard sciences and is becoming more commonly used in the social sciences to predict how organizations will behave. In short, when a system is dynamic, such as in an IT organization where managers compete for resources, non-linear relationships become common. In the interest of space, for an introduction to complexity theory and its application to business see Kelly and Allison (1999) or for more technical but still accessible explanations of the theory itself Gribbin (2004) or Bak (1996). It was in this latter work, (Bak, 1996, pg. 54-55), that the authors first got the idea to apply complexity theory to ITPM, following a suggestion by Peter Grassberger.

One prediction of complexity theory is that systems that have a lot of interactions will tend to follow a log-linear or log-log pattern in their distributions. Systems that are very independent will tend not to follow these patterns and will be more linear in nature. The projects in Organization A used a gated version of the SDLC, where projects progressed to the next phase only if the current phase was completed successfully. If the IT projects in a portfolio are independent, then it is somewhat logical that the number of projects in each phase would decrease in a linear fashion, however, if there are lots of interactions between projects, complexity theory predicts that this relationship will be log-linear:

$$\ln(y) = a + bx$$

where y = Number of projects at that phase, and x is SDLC project phase, and a is a constant

$$\ln(\text{number of projects}) = a + b(\text{project phase})$$

The data for the number of each project in each phase of the SDLC is shown in Tables 2 and 3, while the results of the regression done using the above equation is given in Table 4.

Phase: 2006 Data	Number of Projects
Pre-Initiate	398
Initiate & Requirements	121
Design	35
Build/Test	15
Deploy	6
Introduction	4
Table 2: 2006 Data Projects By Phase	

Phase: 2007 Data	Number of Projects
Pre-Initiate	342
Initiate & Requirements	160
Design	28
Build/Test	16
Deploy	12
Table 3: 2007 Data Projects By Phase	

	R ²	a	b
2006	0.97771658	6.6566337	-0.93886227
2007	0.92934381	6.6006549	- 0.90023933
Table 4: Results of the Regression Based on Complexity Theory			

As can be seen graphically in figure 2, and by the high R², the fit of the regression line is quite good. These results are consistent with what complexity theory predicts, and suggest that there is indeed a great deal of interaction between projects, if only because the same groups in the organization work on similar projects. For example, Organization A has a core SAP and a core Oracle team. Many projects that deal with these systems are built by IT personnel in these two core groups. If the people on these teams are very good, then all such projects can be expected to do well. If the teams are overworked, all such projects may suffer. If several key members of these teams are hired away by competitors at the same time, many of these projects can fail, etc. Simply put, the projects in an IT portfolio behave consistently with the way a complex system with lots of interactions and non-independent projects would be expected to behave as predicted by complexity theory. If this is true, then traditional Real Option models such as Black Scholes and the Binomial Option Models will incorrectly value the portfolio unless the interactions can also be evaluated.

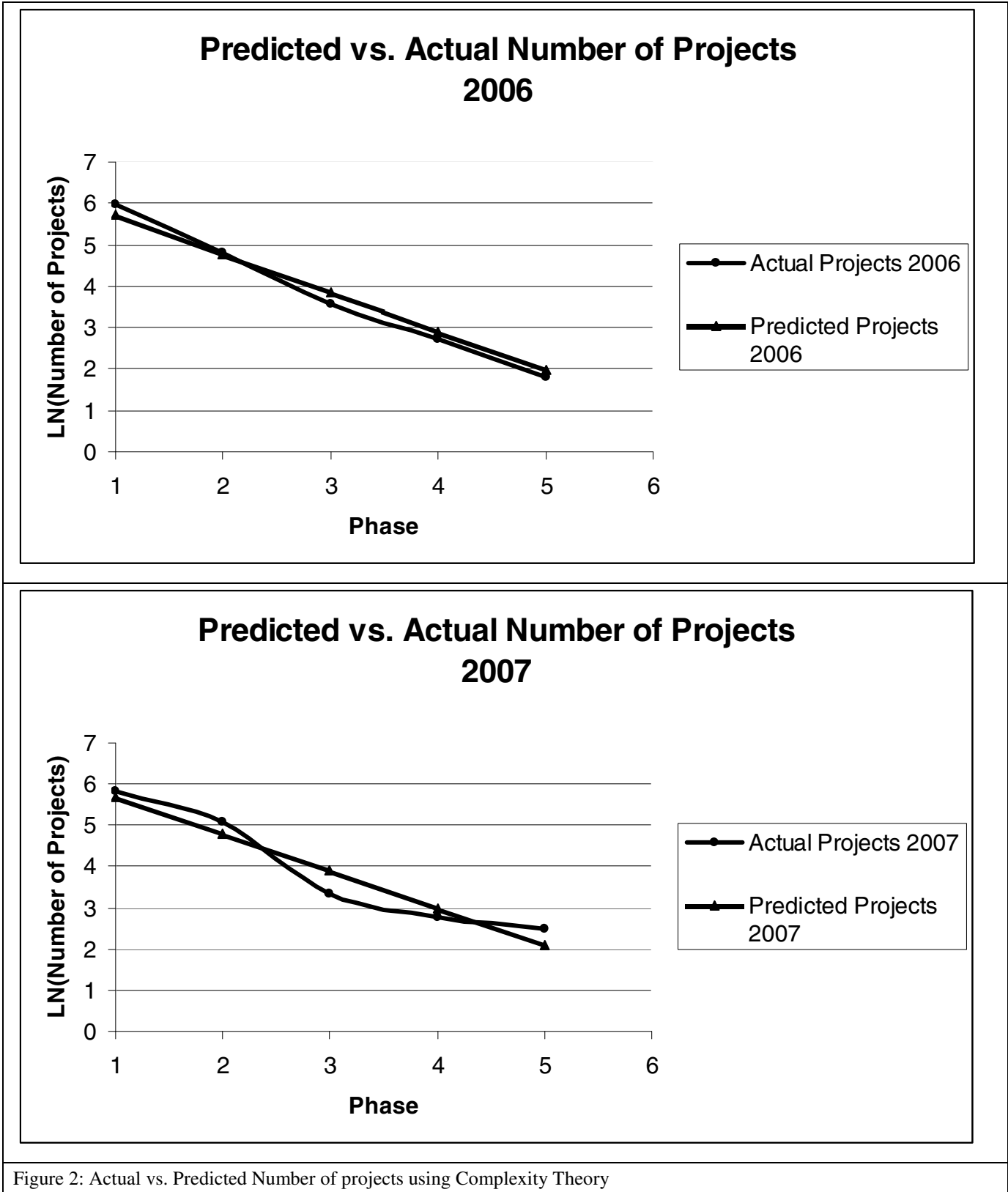


Figure 2: Actual vs. Predicted Number of projects using Complexity Theory

CONCLUSION AND AREAS FOR FURTHER RESEARCH

Exotic Real Option Models

Much of the research done in the main IS Journals on ROA assumes the use of either the Black Scholes Model or the Binomial Model. However, given the strong interactions that we suspect exist, IT portfolios might be better suited to so-called Exotic Option models. In particular, we are investigating the use of Up and In Barrier options, Chooser options, Margrabe options, and Monte Carlo option models.

Up and In Barrier options are particularly suited to situations where an investment must hit a predetermined level before the option has value. This is similar to a IT project needing to surpass a SDLC gate before it becomes valuable. Margrabe options and Monte Carlo options are good when a project has multiple variables, such as when both project costs and revenues may change. Margrabe options allow two for two variables to change, while Monte Carlo methods are needed for many variables or when there are many project interactions. Finally Chooser options are used in the situation when a firm is developing several different projects that will fulfill the same niche, and only one will be completed. This can happen when there are two or more competing technologies, and it is not clear which technology will become the standard.

The next step of our research will specifically address Monte Carlo modeling techniques in real options through the use of Copulas. Copulas allow joint probability distributions to be represented by their marginal distributions thus greatly simplifying the cognitive burden placed upon managers and decision makers. That is, by simply asking managers to estimate the marginal distributions associated with each project, and pair-wise correlations, a joint distribution can be constructed. One nice property of copulas is that they can be extended to represent non-linear correlations as well as linear correlations.

In this paper we are identifying and beginning to fill a gap in the literature by presenting an IT Portfolio Management methodology that is (1) fundamentally based on aligning a firm's IT investments to its corporate strategy, (2) that is actually being developed and implemented by a Fortune 100 company, and also by (3) describing the real world IT project management process that is currently being used in practice. In the near future we hope to start detailing how to mathematically model an IT Portfolio and its many interactions through the use of Copulas. While it may be surprising that such large companies are at a very primitive state in managing its IT assets, Organization A is actually not an exception. Having visited or investigated a half dozen or so Fortune 500 companies, none of them were much more advanced in their processes than the company reported on here, and several were much worse.

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