The Implication of Complexity Theory on Real Option Analysis in IT Portfolio Management

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Keywords: IT Portfolio Management, Real Options Analysis, Complexity Theory

Background

One problem that continually faces CIO’s and IT managers is how to select and prioritize IT projects that become available to the organization. Our research team at the University of Illinois at Urbana-Champaign is currently working with several industry partners to develop a comprehensive process to manage their IT project portfolios (Shaw et al., 2007). This process is divided into three basic parts; (1) aligning IT strategy with organizational strategy using strategy maps (Kaplan and Norton, 2002), (2) balancing technological maturity vs. criticality using aggregate project maps, and finally (3) ranking candidate projects for investment.

As part of this third step IT projects can be ranked using a variety of techniques including Discounted Cash Flows (DCF), which attempts to put a quantitative value on these investments. However, one weakness of this technique is that it ignores management’s ability to adapt to changing situations. As an alternative, Real Option Analysis (ROA) can be used to place a monetary value on this managerial flexibility. As such ROA can be defined as:

\[ ROA = \text{Net Present Value} + \text{Value of Managerial Flexibility} \]

Accordingly, a project’s Net Present Value (NPV) generally undervalues its true value because NPV does not take into account a manager’s ability to affect outcomes. For example, a manager can kill a project that is going poorly, or expand a project that is going well. The options typically associated with IT projects are shown in Table 1 below (Benaroch, 2002).

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
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<tr>
<td>Defer</td>
<td>The option to delay investment until more information can be learned about the project, such as costs, prices, demand etc.</td>
</tr>
<tr>
<td>Stage</td>
<td>The option to build a project in stages, where investment can be delayed or even killed if the environment changes.</td>
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<tr>
<td>Explore</td>
<td>The option to use a pilot program to better learn about a project before initiating it on a full-scale basis.</td>
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<tr>
<td>Scale</td>
<td>The option to increase or decrease the scale of a project depending upon its success.</td>
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<td>Abandon</td>
<td>The option to kill a project if it goes badly.</td>
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<tr>
<td>Outsource</td>
<td>The option to subcontract a project or part of a project to shift some downside risks to a third party.</td>
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<tr>
<td>Lease</td>
<td>The option to lease some resources to shift some downside risks to a third party.</td>
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<tr>
<td>Growth</td>
<td>A set of projects where the value of earlier projects depends largely on investments in additional projects, i.e. an infrastructure investment that assumes follow-on investments will be made using that infrastructure.</td>
</tr>
<tr>
<td>Compound</td>
<td>A combination of the above options in one project.</td>
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The Problem

While our team was investigating the IT project portfolios of several large IT departments of Fortune 500 companies in the Mid-West, we hypothesized and later determined that not only did the number of projects vary inversely with the
System Development Life Cycle (SDLC), which is to be expected, but that it closely followed a pattern suggested by complexity theory. That is, the number of projects considered for investment dropped dramatically early on, and the number of projects that the firms were actually able to bring to fruition was only a small fraction of the initial possibilities.

This finding is consistent with the idea of limited firm resources being available for IT investment, while the need for IT resources increases dramatically as projects progress through SDLC phases. An example of this relationship from one of the participant firms is presented in the graph below (Figure 1). This trend was also consistent across several organizations, in different industries.

![Figure 1: Number of Projects by Phase](image)

The implications of the above relationship are especially important for real option analysis, IT portfolio management, and outsourcing, as it appears that a firm’s IT resources are quite constrained. Several questions that arise are:

- Are staged, scale up, and especially growth options that depend on projects being finished fairly valued in ROA analysis? Should they even be included in ROA?
- Does the slope of the curve change by sector/industry? Can this curve be used as an indication of the efficiency of a firm’s IT portfolio management/ development?
- Do firms that mainly outsource face similar constraints?

The curve plotted above follows the simple model of Ln(y) = βx + c, where y = Number of projects at that phase, and x is SDLC project phase, assuming a Poisson distribution consistent with Agresti (1996, pg. 71-102).

**Theoretical Framework and Research Design**

The primary frameworks used in this part of my dissertation will be, IT portfolio Analysis, Real Option Analysis, and issues surrounding complexity theory such as self-organized criticality, emergent systems, and complex adaptive systems.
Participants: The participants are large organizations with IT project portfolios. At the present our team is working with three Fortune 500 companies and is pursuing several others. In addition we have public archival data available from several U.S. government agencies.

Data gathering: The data is in the form of primary documents provided by the IT portfolio management teams of the organization in question. The documents provide information regarding the projects within their IT project portfolios.

Methodologies used: Our team is using a variety of methodologies, including the statistical analysis of case study documents, some field research, and potentially qualitative interviews as the research progresses.

Research Plan

The initial investigation of the target companies is ongoing. Our research team has been working closely with our industry partners on developing a methodology for their use. The next phase will be consulting with their management teams on our initial findings, including the results mentioned above. Following their input, data from a variety of firms' IT project portfolios will be sought out to check the generalizability of the model across industries.

Important Literature

In order to facilitate the proper placement of this abstract within the consortium, the following literature has been particularly important in developing this part of my dissertation.


