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A Real Option based Six Sigma project evaluation and selection model

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Abstract

Identification and selection of Six Sigma projects are one of the most frequently discussed issues in the Six Sigma literatures today. In this paper a two-stage methodology has been proposed based on (i) Real Option Analysis for evaluating the value of the project to improve the managerial flexibility (ii) a zero–one integer linear programming model for selecting and scheduling an optimal project portfolio, based on the organization's objectives and constraints. The methodology is illustrated through a case study from petrochemical industry carried out during 2007. The study contributes to managerial practices by identifying a new way of valuing the Six Sigma projects through Real Option Analysis by considering various kinds of risks. Resource-constrained environment has been chosen to test the proposed approach of selection of project portfolio and the model is validated with a detailed discussion.

Keywords: Six Sigma; Project evaluation and selection; Real option; Project portfolio

1. Introduction

Businesses today are challenged by continually changing business environment. To remain competitive in the global business, organizations need to continuously upgrade their technologies and processes, comply with the changing statutory provisions besides keeping their expenses under control. Under such competitive and constrained situations, organizations have no choice, but to undertake transformational initiatives which can facilitate implementation of new business strategies. Six Sigma has emerged as the most effective business transformational initiative in recent times. Most of the researches on successful implementation of Six Sigma point to "selection of right projects" as one of the key success factors. Kwak and Anbari (2006) suggested that among several key factors, the project selection plays a very vital role in effective introduction and implementation of Six Sigma. Pande et al. (2000) opined that good project selection is itself a process and if properly carried out, the potential benefits of Six Sigma can improve substantially. As companies become more mature in their Six Sigma programs, they start expecting more benefits using fewer resources. Hence it appears that the success of six sigma program lies in, the ability of management to select the right mix of Six Sigma projects that maximize business impact with fewer resources allocated to them. That apart, the process of identification of a subset from a set of projects i.e. portfolio of projects, which can successfully achieve the multiple objectives under constrained resource conditions is also yet another critical decision for any organization to make.

At macro level the investments in Six Sigma projects can be viewed as capital investment projects. Capital investments share three common important characteristics; i.e. (1) they can be partially or completely irreversible, (2) there is uncertainty over the future rewards from the investment, and (3) the managers have some leeway about timing of the investment (Dixit and Pindyck, 1993). Traditional financial theory suggests that firms should use Discounted Cash Flow (DCF) approach to analyze capital allocation requests for projects. Estimated cash flows from an investment are discounted to their present value at a discount rate commensurate with the project risk. However, the assumptions made in calculating the value of investments are known to have some drawbacks. According to Miller and Park (2002), these methods require the assumption of certainty of project cash flows, but fail, when used to evaluate strategic

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investments where payoff is uncertain or at risk. That apart, DCF technique ignores the need for flexibility to modify decisions during the course of the project, as and when new information arrives. These passive methods may be appropriate in deterministic situation, but might not be so under conditions of uncertainty. Another limitation in Six Sigma project is that the existing literature is silent about the risks associated with project. The expected payoffs of the projects may fluctuate owing to the risks related both to the project and market. Since, typical Six Sigma project investments could be exposed to more than one source of risks, it is necessary to find ways to model and evaluate such investment vis-à-vis the related risks. It is also very imperative to impart flexibility in managerial decisions, by identifying the various options embedded in the project.

A review of literature strongly points towards the Real Option Analysis as a competent approach to overcome the above demerits. Copeland and Antikarov (2001) have formally defined real option as: "A real option is the right, but not the obligation, to take an action at a predetermined cost called the exercise price, for a predetermined period of time". Real Option Analysis presents an attractive alternative to the existing valuation methods as it explicitly accounts for the value of future flexibility in decision-making (Trigeorgis, 1996). Hence the option values of the projects not only act as a real value of the project, but also augment the flexibility in decision making. Keeping in view the above challenges, the study aims at testing yet another approach for improved and flexible decision making by the managers under constrained resource conditions and associated risks. This paper tries to explore the following questions:

- How to evaluate Six Sigma project investments, especially when it is exposed to multiple sources of risks
- What are the options embedded in Six Sigma projects and how it can enhance the managerial flexibility in decision-making and add value to the Six Sigma projects
- How to select and schedule a portfolio of projects based on organization's objectives and resource constraints to provide maximum value to the Organization

This paper deals with the application of real option approach to evaluate and prioritize a portfolio of Six Sigma projects. The main contribution of this paper is a model developed through the application of methods from operation research and financial engineering. Implementing this project selection method will put the Six Sigma program on a sound financial basis, to ensure that it continues to be the approach for Organizations, far into the future. The proposed model provides a better understanding of the Six Sigma project valuation in light of various risks and offers provisions of flexibility in managerial decision making and in terms of its investment and payoff potential.

In the next section we discuss related works, which include work on real options, first on project and then on various approaches on project selection. In the section that follows we present our methodology, which includes real option approach and portfolio optimization steps. Our approach has then been tested through a case study, carried out in a petrochemical industry. The last section comprises of the summary of results, limitations of the study and conclusion besides throwing light on the scope for future studies.

2. Review of literature

In this section the works of various authors have been reviewed under two major heads viz. application of real options on projects and project portfolio optimization.

2.1. Application of real options on projects

First coined by Meyers in 1977, the real option framework facilitates decision makers with the options to invest, grow or abandon a project contingent upon the arrival of new information. The literature available on real options is quite exhaustive. A review of literature reveals that a lot of research work has still date been carried out on applications of real options on Research & Development (R&D) and Information Technology (IT) projects. The most recent ones being the application of real options to R&D projects by Schneider et al., 2008; and Eckhause et al., 2009; while Schwartz and Zozaya-Gorostiza, 2003; Kumar, 2002 in IT projects. Costa and Paixao (2010) has applied real option techniques such as contingent claim analysis and dynamic programming for project evaluation when the project develops stochastically over time and the decision to invest into this project can be postponed. Similarly Helga et al. (2001) have proposed a simple capital budgeting model for finding the portfolio of options that has maximum value and fulfills the capital expenditure constraints. However these approaches have some shortcomings regarding its applicability in traditional budgeting situations. Though there are many applications of real options to various types of projects, studies pertaining to application of real options on Six Sigma projects are conspicuously limited. Mawby (2007) suggested that real option application on Six Sigma projects will give more dynamicity to the selection of portfolio of Six Sigma projects. Recently Tkac and Lyocsa (2009) proposed a new model based on real options approach for evaluating Six Sigma projects, which involves the stochastic nature of project outcomes, cost and uncertainty regarding future payoffs and managerial options. However the usefulness of this model in practice may be perceived as limited due to its computational complexity and difficulty to use in real life situation.

2.2. Project portfolio optimization

Project selection is the process of evaluating individual projects or groups of projects, followed by making a choice to implement a sub set of them, so that the objectives of the organization will be achieved. However from a project selection aspect, the large majority of published literature relates to the R&D project selection area (Hu et al., 2008). Six Sigma projects apparently differ from typical R&D project in various aspects. Six Sigma projects focus more on application and orientation towards results, shorter time of project execution, more deterministic nature of