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Organisational sustainability modelling—An emerging service and analytics model for evaluating Cloud Computing adoption with two case studies

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ABSTRACT

Cloud Computing is an emerging technology which promises to bring with it great benefits to all types of computing activities including business support. However, the full commitment to Cloud Computing necessary to gain the full benefit is a major project for any organisation, since it necessitates adoption of new business processes and attitudes to computing services in addition to the immediately obvious systems changes. Hence the evaluation of a Cloud Computing project needs to consider the balance of benefits and risks to the organisation in the full context of the environment in which it operates; it is not sufficient or appropriate to examine technical considerations alone.

In this paper, we consider the application of CAPM, a well established approach used for the analysis of risks and benefits of commercial projects to Cloud adoption projects and propose a revised and improved technique, OSM. To support the validity of OSM, two full case studies are presented. In the first, we describe an application of the approach to the iSolutions Group at University of Southampton, which focuses on evaluations of Cloud Computing service improvement. We then illustrate the use of OSM for measuring learning satisfaction of two cohort groups at the University of Greenwich. The results confirm the advantages of using OSM. We conclude that OSM can analyse the risk and return status of Cloud Computing services and help organisations that adopt Cloud Computing to evaluate and review their Cloud Computing projects and services. OSM is an emerging service and analytics model supported by several case studies.

1. Introduction

Cloud Computing promises to revolutionise the provision of major computing services, bringing with it benefits for all types of users. These benefits vary from simplified administration for systems programmers to ready access to massive processing power on demand for desktop users. However, to gain the full benefits, a full commitment to Cloud Computing is necessary and this brings with it a requirement for users to revise business processes and attitudes to computing services in addition to the immediately obvious systems changes (Chang, 2015a; Khajeh-Hosseini, Greenwood, & Sommerville, 2010; Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011). Therefore evaluation of a Cloud Computing project must consider the balance of benefits and risks to the organisation in the context of its environment in addition to technical considerations. This is particularly important for Emerging Services and Analytics to provide the organisations that adopt Cloud Computing the ability to complete their tasks faster and better and ensure all the stakeholders and customers involved are happy with the level of services on offer.

One of the recognised methods available to analyse investments is Capital Asset Price Modelling (CAPM) which is able classify risks into uncontrolled or managed types (Sharpe, 1964, 1992). CAPM takes proper account the risks associated with an investment and the context in which it is made. However, Cloud Computing projects present some particular challenges which are not well addressed by CAPM because it was developed as a generic technique for evaluating investments and business projects. We therefore propose Organisational sustainability modelling (OSM), a data analysis and processing method derived from CAPM but developed to meet the specific needs of an organisation evaluating a Cloud Computing project. This paper presents OSM as the better model together

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with case studies to support relevant to Emerging Service and Analytics in Cloud Computing. The breakdown of this paper is as follows. Section 2 presents models for analysing project return and risk, focusing on CAPM. Section 2.2 discusses the limitations of CAPM. Section 3 describes the OSM, including the key inputs and outputs and performance comparison between OSM and CAPM. Sections 4 and 5 describe two case studies to support the validity and effectiveness of using OSM for organisations that adopt Cloud Computing. Section 6 presents topics for discussion and Section 7 concludes with a summary of this paper.

2. Methods for analysing project return and risk

It is important for organisations to understand that adoption of Cloud Computing is not just a technical challenge but is also an enterprise challenge which includes costs, users and organisational issues (Chang, 2015a; Khajeh-Hosseini et al., 2010; Marston et al., 2011). Hence it is appropriate for an evaluation of a Cloud adoption project to consider more than the technical aspects. With an increasing number of organisations investing more in Cloud technologies, deployment and services, extensive work has been done investigating business models empowered by Cloud technologies (Kagermann, Österle, & Jordan, 2011; Madhavapeddy, Mortier, Crowcroft, & Hand, 2010; Molen, 2010). This work has continued during the economic downturn, particularly in Green IT and data centre consolidation (Chang, 2015b; Hammond, Hawtin, Gillam, & Oppenheim, 2010; Minoli, 2010).

Existing literature such as Service Level Agreements is not entirely concerned with the analysis of risk and return status for the organisations that adopt Cloud. There are other research methods that aim to bridge the gap between the technical and business requirements and attempt to use the established economic models for Cloud Computing.

Sharma, Thulasiram, Thulasiraman, Garg, & Buyya (2012) explain the use of Black Scholes model and how it can be adapted for predicting risks in Cloud adoption. However, their assumptions about the "risk-free rate" are not correct. It is not given by the service providers. Instead, the risk-free rate should be defined and measured by the users, because each business has different business requirements and uses Cloud Computing for different purposes. For example, consider one company which outsources all its data to the Cloud service providers and another which only uses Cloud Computing for experimenting with new product developments such as the penetrating tests of security products. Clearly the impact of loss of any data from the Cloud will have much more immediate and serious impact on the first company than the second and this should be reflected in the "risk-free rate". In addition, Sharma et al. (2012) do not classify risks as controlled or uncontrolled, which is important for risk assessment (Sharpe, 1964, 1992).

Qanbari, Li, Dustdar, & Dai (2014) attempt to develop an improved version of the economics model for Cloud Computing. They propose Cloud Asset Pricing Tree (CAPT) based on the Binomial Tree, a probability distribution theory. Although such attempts make sound contributions, there are two limitations. The first limitation is that they assume dependency of all risk and return factors when some risks are totally independent. They add up the value for the risk and return status. Returns such as profits can be presented by addition but risks are not a matter of addition and can combine in the form of multiplying effect (such as Bush fire, the more areas it affects, the damage is not an addition) or can be totally independent of each other. The second limitation is that they do not classify the type of risk into uncontrolled and managed risks (Sharpe, 1964, 1992).

The Capital Asset Pricing Model (CAPM) is a better choice than the methods described earlier because it classifies risks into uncontrolled and managed types which helps investors and stakeholders to identify the type of risks. This enables them to identify the best solutions for improving their Cloud services or business activities, or both.

2.1. Introduction to capital asset pricing model (CAPM)

Capital Asset Pricing Model (CAPM) is an approach to modelling costs and risk which was proposed independently by Treynor, Sharpe, Lintner and Mossin in the 1960s, based on Markowitz's work on diversification and modern portfolio theory (French, 2003; Lintner, 1965a, 1965b; Markowitz, 1952; Mossin, 1966; Sharpe, 1964, 1992). In its origins, it was developed to calculate investment risks and to determine expected returns on an investment. Underpinning the model is the observation that there is a relationship between returns on investments and the associated risk, and that investors who are prepared to accept more risk expect a greater return.

A key feature of CAPM is that it divides risks associated with an investment into two categories: those which can be controlled and managed, and those which cannot. For example, when considering risk in a stock market portfolio, risks associated with the relative fortunes of individual companies arising from the foresight and proficiency of their management may be managed and ameliorated by spreading an investment across a variety of different companies. However, a general trading downturn is an inherent characteristic of this type of investment which cannot be avoided.

The model produces an estimate of the return from an investment or project (r) from just three input values:

1) Expected rate of return from a notional risk free investment (r_f).
2) Expected rate of return from a typical investment in the market in which the organisation operates (r_m).
3) A value representing a measure of the uncontrolled risk associated with the market (β).

The essence of CAPM is usually described by the following equation:

$$r = r_f + \beta \left(r_m - r_f \right) \quad (1)$$

where r is the expected return on the cost of a project, r_f is the risk free rate, r_m is the expected return on the market and β is the measure of uncontrolled risk. The term $r_m - r_f$ is known as the market risk premium and represents the additional return demanded by the investor to invest in the market (rather than a risk free investment) and is usually considered implicitly rather than explicitly. For a stock market investment, the risk free and the market rates are estimated from analysis of the market as a whole. The risk free rate is the minimum rate of return the investor expects to achieve. This is generally taken to be the rate of return from an investment which is completely free of risk such as a Bank cash deposit or government bonds. The market rate is the typical rate of return achieved in the market; the rate of return associated with normal activity in stock market, a typical rate of return which an investor would expect from any investment in the market. It may be derived from an evaluation of the returns on investments in the stock market as a whole, but one of the major stock market indices is often used instead.

In practical use of CAPM, rather than using a single observation as in the example above, many observations are used to estimate beta (β) over a period of time. For example, monthly estimates of the input values over a period of five years will generate sixty points in a plot of actual return against risk premium (market return—risk-free rate). The beta value (β) is then given by the gradient of a line of