CLOUD COMPUTING: RETURN ON INVESTMENT
The Portuguese Higher Education Case Study

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Abstract: This work is about return on investment (ROI) estimation based on a set of scenarios related with *Cloud* services adoption by Portuguese higher education (HE) institutions. The adopted methodology required the development of a survey and its distribution among institutions. The collected data allowed us to evaluate a set of indicators and metrics in order to design ROI models. With such models it was possible to estimate the cost benefit of *Cloud Computing* paradigm in the context of Portuguese HE infrastructures and services.

1 INTRODUCTION

Cloud Computing is undoubtedly in vogue. The promise of productivity increase and cost reductions is leading to a growing interest in assessing *Cloud* services. However, much work is still to be done until useful evaluation tools and methodologies are agreed upon. Up to now, studies addressing the return on *Cloud Computing* investments are inconclusive, revealing that this research is still in its infancy. Nonetheless, we found several studies that are valuable contributions, namely (Harms, 2010), (Linthicum, 2011), (Mayo, 2009), (Misra, 2011) and (The Open Group, 2010).

This paper describes a case study on the assessment of *Cloud Computing* return on investment (ROI) in the context of the Portuguese higher education system. The proposed methodology is based on the development of a survey distributed among a sample of Portuguese higher education institutions (HEI). The survey results were assembled to identify a set of indicators and metrics that are relevant to the quantification of benefits and costs associated with the use of this paradigm.

Cloud Computing assessment is not only about direct economic advantages, but also about intangible benefits. Traditionally such benefits are not quantifiable; nevertheless they reflect added value to business. Therefore, *Cloud* ROI analysis was split into financial and non-financial.

Financial benefits are those that are measurable. These were categorized into five major groups: Hardware, Software, "Human Resources", "Energy Consumption" and "Data Center Space". Non-financial benefits include a large and diverse set of aspects for which it is difficult to establish the principle of "direct causality." Such factors are evaluated differently depending on the agent subjective appreciation. These factors were grouped here under Productivity and "Systems Administration." Finally, there is the "Automatic Provision" area. This area doesn't fit in either ROIs, but has impacts in both of them.

2 SURVEY

The survey was developed aiming the evaluation of a latent variable, in this case the return on investment. The term "latent variable" is used to represent a variable that cannot be observed or measured directly, but can be inferred from a coherent set of other variables, which can be observed or measured. To this end, a Goggle Docs questionnaire of 20 to 26 (depending on the answers given) closed ended questions was distributed among institutions' network and information systems managers.

The sequence of questions guides the respondent through three major groups (scope) of subjects. The first group relates with the characterization of the institutions from the ICT point of view. It contains questions like "the number of ICT staff" and "the number of servers installed in the data center." The

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second group concerns the knowledge about *Cloud Computing* and its associated technologies: "do you make use of virtualization?" and "do you use an external webmail service like Gmail?" The third group is about the way people are using *Cloud*. This group is further classified into three sub-groups, reflecting the degree of *Cloud* adoption. Examples of questions in this group are: "why was this paradigm adopted?" and "what were your fears?"

3 POPULATION AND SAMPLE

The target population was the set of all the 410 institutions of the Portuguese higher education system. Taking into consideration such high number of institutions, their geographical location and the lack of resources of this research, conducting a census was not a viable option. It was decided to work with a sample of institutions statistically representative ($n \geq 30$) to allow statistical inferences about the population. Therefore, a sample of 43 institutions, 10.5% of the population, providing a maximum error (ε) of 11%, was built based on the concept of stratified sampling. This sampling technique is a probability method such that sub-populations are included in a balanced way. Four levels of stratification were used based on the following criteria: geographical location, education subsystem, size and fields of studies. Completed the stratification process, a simple random sample technique was applied to each group.

4 SURVEY RESULTS

According to this study the percentage of the Portuguese HEIs that use *Cloud* services is 18.6% (only 8 of the 43 surveyed institutions). The majority of these institutions are using private *Cloud* model from the provider point of view (i.e., supporting institutions' services). Based on this result, it is inferred, with a 95% confidence interval, that 7.6% to 29.6% of the whole Portuguese HEI population are using *Cloud Computing*.

The remaining 35 surveyed institutions do not use *Cloud* services. Most of these institutions are interested in the hybrid *Cloud* model either from the consumer or provider points of view. This subset was asked about this *Cloud* adoption in the future, which 42.9% said "yes." In another words, 15 of these 35 institutions are considering the *Cloud Computing* adoption. However, based on that result it is not possible to infer about the Portuguese HEIs (whole population) that are evaluating the use of *Cloud* services. The statistical analysis made, namely the binomial test, was inconclusive.

4.1 Institutions that use *Cloud Computing*

Two main reasons were reported for *Cloud* adoption: the expectation of cost reductions (75% of the institutions of this subset), and the flexibility of sharing resources (50%). In regard to concerns, 75% of the institutions said their biggest fear came from provider lock-in. This concern relates to the difficulty in migrating between service providers due to many barriers, namely the lack of information portability. Security problems and dependence on an external service provider appeared in second place for 50% of the Portuguese HEIs of this group.

The 8 Portuguese HEIs that are using *Cloud* services were asked about the impact that such adoption had on their ICT investment profile: 35.7% answered that it decreased by 10%. But, similar number of respondents said that no significant variation occurred. One should note that 25% of the answers indicate an investment growth. This might reveal that institutions have on site both kinds of infrastructures: traditional ICT and *Cloud*.

When asked about cost reductions attained in a number of key areas, like staff training, systems administrators and server consolidation, the majority of the surveyed institutions reported revenues as low as 10%. Based on the answers given it was possible to identify, by a modal scores analysis, a set of indicators ("Server consolidation", "Electricity consumption reduction", "Operating systems licenses reduction" and "Data center footprint reduction") that will be used to estimate the financial ROI. The average cost reductions reported by these indicators were between 2.5 and 12.5%. A similar analysis was made to identify the set of indicators ("Increase productivity and efficiency" and "Increase use of resources") for the non-financial ROI evaluation. Again, the gains of these indicators vary between 2.5 and 15%. Finally, in the area of automated provision these institutions reported an average gain of 5% associated with the decrease of provision time.

4.2 Institutions that are Evaluating *Cloud Computing* Adoption

The 15 institutions, which do not use *Cloud* services, but are evaluating its adoption, were questioned about the benefits associated with the use of *Cloud*

Computing. Most of the institutions (66.7%) are expecting to reduce costs of ICT investment. However, 60% of the choices fall on the availability and ubiquity of the service. Note that the maintenance responsibility transfer from site to the service providers is not among the benefits that the institutions mostly associate with this paradigm.

When asked about their greatest concerns, 73.3% reported security problems as the main barrier to adopt *Cloud* services. Also, 60% of the institutions of this group are reluctant to become dependent on a single service provider (external) and 46.7% report the lack of control over the resources as a drawback in its adoption. The lack of interoperability between service providers is not a top concern of these institutions, meeting only 13.3% of indications.

In regard to the expectations on ICT cost reductions after *Cloud Computing* adoption, one third of the institutions reported a reduction expectation between 10 and 30%. The same number of respondents expects a greater gain, between 30 and 50%. On the contrary, 20% of the respondents do not expect any cost reductions. To attain more detailed information concerning this issue, it was further asked to specify the expected investment reduction for the same set of key areas as the previous group (Section 4.1). In this case the institutions reveal higher expectations as they report cost reductions for almost all areas between 10 and 40%. A single area was left out: the training area.

5 ROI FORMULATION

Return on investment (ROI) is a financial measurement used to evaluate the efficiency of an investment. ROI is a popular metric because of its versatility and ease of use. A common formulation for ROI is given by (1), where "*Gain from investment*" refers to the profit obtained from the investment made. Based on this definition if an investment does not have a positive ROI then it should not be undertaken.

$$ROI = \frac{(Gain\ from\ Investment - Cost\ of\ Investment)}{Cost\ of\ Investment} \quad (1)$$

Given the nature of the surveyed organizations the concept of gain, from an ICT investment, does not have a straight forward interpretation: It is not within the HEI purpose the trading of ICT services, but these services are required as they allow institutions to pursue their goals. In this context, and taking into consideration that the selected indicators (both financial and non-financial) reflect investment cost reductions due to *Cloud Computing* adoption, (1) must be rewritten.

We start by expressing ICT ROI (2) and *Cloud Computing* ROI (3) using (1). Assuming that *Cloud Computing* investment gain relates to the investment gain of a non-cloud ICT scenario through a linear relationship (4) parameterized by α and β, where α reveals the relative evolution of the two gains over time, and β reveals the added value of adopting *Cloud Computing*, both ROIs can be related as described by (5).

$$ROI_{ICT} = \frac{g_{ICT}^{inv} - c_{ICT}^{inv}}{c_{ICT}^{inv}} \quad (2)$$

$$ROI_{CC} = \frac{g_{CC}^{inv} - c_{CC}^{inv}}{c_{CC}^{inv}} \quad (3)$$

$$g_{CC}^{inv} = g_{ICT}^{inv} \times \alpha + \beta \quad (4)$$

$$ROI_{CC} = \frac{(ROI_{ICT} + 1) \times c_{ICT}^{inv} \times \alpha + \beta}{c_{CC}^{inv}} - 1 \quad (5)$$

Considering that the variation of investment gain is given by (6) and a somewhat conservative approach of the *Cloud Computing* gain is adopted, as no gains are associated with its adoption (the gain is the same as for the ICT use case, i.e. $\alpha = 1$ and $\beta = 0$), only costs reduction contributions, then it is possible to express *Cloud Computing* ROI based on the ICT ROI (prior to *Cloud* support) and the investment cost reduction (7).

$$\Delta c_{\%}^{inv} = \frac{c_{ICT}^{inv} - c_{CC}^{inv}}{c_{ICT}^{inv}} \quad (6)$$

$$ROI_{CC} = \frac{ROI_{ICT} + \Delta c_{\%}^{inv}}{1 - \Delta c_{\%}^{inv}} \quad (7)$$

6 RESULTS REVIEW

Expression (7) limits this study to a single indicator analysis, meaning that the impact of each indicator was assessed individually. A multi-indicator analysis was not conducted due to the lack of mathematical models to describe such dependencies, although we have found evidences of such behavior between indicators.

Distinct financial evaluations were performed based on the answers received from the first two groups of institutions: those who already use *Cloud Computing* and those who are evaluating its use. In both cases the data collected represent investment cost reductions (6) for a set of financial indicators. A comparison between the evolutions of the expected

ROI for both groups of institutions shows a large discrepancy. While the institutions that are considering using *cloud* services reveal a significant cost savings expectation, the institutions that actually use such services argue that these reductions exist, but are moderate.

For the indicator “Reduction in the number of licenses for operating systems,” it was considered that there was a direct relation between the reduction in the number of licenses and its costs. However, we may have an additional gain due to variations in licenses’ costs. In order to explore such possibility, let’s consider N as the number of licenses prior to the adoption of *Cloud Computing* and c_{ICT}^{inv} the cost associated with those licenses. With the use of *Cloud* services the number of licenses is now M and its associated cost c_{CC}^{inv}/ρ. In a scenario of multiple operating systems, ρ measures the relative evolution of the two costs due to the different reductions achieved for each type of licenses. Thus, the new cost is given by (8).

$$c_{CC}^{inv} = \frac{\mathrm{M}}{\mathrm{N}} \times c_{ICT}^{inv} \times \rho \quad (8)$$

Assuming the variation in the number of licenses is given by (9), equation (8) can now be rewritten as (10).

$$\Delta_{\mathrm{N}}^{OS} = \frac{\mathrm{N} - \mathrm{M}}{\mathrm{N}} \quad (9)$$

$$c_{CC}^{inv} = (1 - \Delta_{\mathrm{N}}^{OS}) \times c_{ICT}^{inv} \times \rho \quad (10)$$

Using (6) we can now express $\Delta c_{\%}^{inv}$ as a function of Δ_{N}^{OS} and ρ (11). Finally, the *Cloud Computing* ROI is expressed, for this indicator, by equation (12).

$$\Delta c_{\%}^{inv} = 1 - \rho(1 - \Delta_{\mathrm{N}}^{OS}) \quad (11)$$

$$ROI_{CC} = \frac{ROI_{ICT} + 1 - \rho(1 - \Delta_{\mathrm{N}}^{OS})}{\rho(1 - \Delta c_{\mathrm{N}}^{OS})} \quad (12)$$

Expression (12) reveals a reduction of costs parameterized by ρ. Three scenarios can be envisaged based on the weight cost of the licenses fees that are no longer paid compared to the total. In the first scenario, such reduction is similar to just considering the reduction of the total number of licenses, i.e. the weight of the licenses that have been discontinued is not significant compared to the total (e.g. $\rho = 0.9$). In the second case, the reduction achieved is greater than the previous scenario because the weight of the fees is important to bear against the total (e.g. $\rho = 0.6$). In the third scenario, the most favorable towards *Cloud*, due to the significant weight of the cost of the licenses that are no longer paid (e.g. $\rho = 0.3$). A similar analysis applies to the “Systems Administrators” indicator.

7 CONCLUSIONS

A glimpse of the status of *Cloud* adoption by the Portuguese HEIs is provided by this work. Also, *Cloud* ROI models were elaborated to estimate, based on the collected data, the return on *Cloud* investment, but only for a single indicator analysis. Such data and results will be refined and compared with other sources as they are made available. Also, further ROI models will be developed to address *Cloud* lifecycle. Such work will target specific use cases, at different *Cloud* layers, focusing near-term versus long-term analysis.

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REFERENCES

Harms, R., Yamartino, M, 2010. The Economics of the Cloud. *Microsoft*.

Linthicum, D., 2011. ROI of the Cloud Part 1: PaaS and Part 2: IaaS. *Microsoft*.

Mayo, R., Perng, C., 2009. Cloud Computing Payback: An explanation of where the ROI comes from. *IBM.*

Misra, S., Mondal, A., 2011. Identification of a company’s suitability for the adoption of cloud computing and modelling its corresponding Return on Investment, Mathematical and Computer Modelling, Vol.53, Issues 3–4, pp 504-521. *Elselvier*.

The Open Group, 2010. Building Return on Investment from Cloud Computing. *Document No.: W104*