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Total Cost Management and Cloud Computing

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ABSTRACT

Purpose of this paper
This paper aims to contribute to the understanding of cloud computing, particularly from a benefit/cost point of view. While the qualitative benefits of cloud computing are pretty clear, it seems important to define a model to evaluate from a quantitative way the decision to adopt cloud computing.

Design/methodology/approach
We used the TCM methodology to tackle the subject and to arrive to a theoretical approach strongly skewed also to a practical usage.

Findings and value
This paper presents a model to evaluate a cloud computing solution versus on premise solutions. It has been found very useful in real life utilization.

Research limitations/implication
This paper presents an evaluation of cloud computing versus an on premise solution. It might be interesting to extend the model to consider also cloud computing versus the more traditional outsourcing or managed services model.

Practical implications
The method presented on this paper has many practical utilization and can support academicians as well as managers to approach the evaluation of moving to cloud computing.

Originality/value of paper
This paper approaches the problem using the TCM Total cost methodology. Based on our analysis, this method was not used in the past for cloud computing.

Conclusions
The paper presents a model for the evaluation of the costs/benefits connected with cloud computing useful to compare such a solution with on.-site premises

Keywords
Cloud Computing, Total Cost Management, Cloud Computing Life Cycle, Cost Benefit Analysis.

1 INTRODUCTION

One of the most interesting current trends in Information and Communication Technologies is represented by Cloud Computing.
This paper use a Total Cost Management (TCM) approach to assess the financial performance of a program of implementing cloud computing in a organization versus the use of internal ICT resources and then help in monitoring its implementation.
The potential move to cloud computing represents an important program for the organizations. It can include several projects, such as moving initially to hybrid cloud computing and later to Infrastructure as a Service and at the end to a full Software as a Service implementation. It is a strategic move not a tactical one, since cloud computing is not just a technology but a substantial innovation, involving services, processes, organizations and, in some cases, also business models.
Many papers talk about the intangible benefits connected with cloud computing, such as flexibility, use of professional skills, distributed utilization, and so on. Much less has been published in terms of evaluation of a generalized business model to compare the use of cloud computing versus an in-house solution.
A correct approach to cloud computing should be based on Total Cost Management (TCM) applying the skills and knowledge of cost engineering. Total Cost Management can allow mapping the process upstream of the launch of the program to move to cloud computing. TCM can also help to pick up the right form of Cloud Computing to use.
A unique element of the TCM process is that it integrates all the steps that an organization must take to define and later to deploy its business strategy for cloud computing. This includes monitoring and becoming aware of a performance issue with an asset in its asset portfolio, to completing a project and delivering a modified or new asset to the company's portfolio.
In the case of cloud computing, there is no huge investment in infrastructure by the client organization. One benefit of cloud computing is that it allows organizations to move costs from investments to variable costs. The application of TCM to cloud computing is also interesting from the point of view of applying TCM not to the cases of large capital investments in fixed capital assets through construction projects.

2 LITERATURE REVIEW

Armbrust, M. et al. (2009) argued that the construction and operation of extremely large-scale, commodity-computer datacenters at low cost locations was the key necessary enabler of Cloud Computing, for they uncovered the factors of 5 to 7 decrease in cost of electricity, network bandwidth, operations, software, and hardware available at these very large economies of scale. These factors, combined with statistical multiplexing to increase utilization compared a private cloud, meant that cloud computing could offer services below the costs of a medium-sized datacenter and yet still make a good profit. They ranked the list of critical obstacles to growth of Cloud Computing in Section 7. The first three concern adoption, the next five affect growth, and the last two are policy and business obstacles. Each obstacle is paired with an opportunity, ranging from product development to research projects, which can overcome that obstacle. They predicted that Cloud Computing will grow, so developers should take it into account. All levels should aim at horizontal scalability of virtual machines over the efficiency on a single VM.
Kondo D. et al. (2009) analyzed Cloud Computing. They noted that it has taken commercial computing by storm. However, adoption of cloud computing platforms and services by the scientific community is in its infancy as the performance and monetary cost-benefits for scientific applications are not perfectly clear. This is especially true for desktop grids (aka volunteer computing) applications. They compared and contrasted the performance and monetary cost-benefits of clouds for desktop grid applications, ranging in computational size and storage. We address the following questions: (i) What are the performance tradeoffs in using one platform over the other? (ii) What are the specific resource requirements and monetary costs of creating and deploying applications on each platform? (iii) In light of those monetary and performance cost-benefits, how do these platforms compare? (iv) Can cloud computing platforms be used in combination with desktop grids to improve cost-effectiveness even further? They examined those questions using performance measurements and monetary expenses of real desktop grids and the Amazon elastic compute cloud.
de Assunção, M. D. (2010) investigated the benefits that organizations can reap by using “Cloud Computing” providers to augment the computing capacity of their local infrastructure. They evaluate

the cost of seven scheduling strategies used by an organization that operates a cluster managed by virtual machine technology and seeks to use resources from a remote Infrastructure as a Service (IaaS) provider to reduce the response time of its user requests. Requests for virtual machines are submitted to the organization's cluster, but additional virtual machines are instantiated in the remote provider and added to the local cluster when there are insufficient resources to serve the users' requests. Naïve scheduling strategies can have a great impact on the amount paid by the organization for using the remote resources, potentially increasing the overall cost with the use of IaaS. Therefore, they investigated seven scheduling strategies that consider the use of resources from the "Cloud", to understand how these strategies achieve a balance between performance and usage cost, and how much they improve the requests' response times.
Chandra, D.G. et al (2012) described how in the current financial crisis and the growing need for quality education, the educational institutions are under increasing pressure to deliver more from less. Both public as well as private institutions can use the potential benefit of cloud computing to deliver better services even with fewer resources. Application of Cloud Computing in Education not only relieve the educational Institutions from the burden of handling the complex ICT Infrastructure management as well as maintenance activities but also lead to huge cost savings. They defined a cost benefit analysis of the use of cloud computing in education.
Maurer M. et al. (2011) presented a novel approach of adaptive SLA matching. Their approach adapts SLA templates based on SLA mappings of users. It allows Cloud users to define mappings between a public SLA template, which is available in the Cloud market, and their private SLA templates, which are used for various in-house business processes of the Cloud user. Besides showing how public SLA templates are adapted to the demand of Cloud users, they also analyzed the costs and benefits of this approach. Costs are incurred every time a user has to define a new SLA mapping to a public SLA template due to its adaptation. In particular, they investigated how the costs differ with respect to the public SLA template adaptation method. The simulation results showed that the use of heuristics within adaptation methods allows balancing the costs and benefits of the SLA mapping approach.
Khajeh-Hosseini, A.(2010) illustrated a case study showing the potential benefits and risks associated with the migration of an ICT system in the oil and gas industry from an in-house data center to Amazon EC2 from a broad variety of stakeholder perspectives across the enterprise, thus transcending the typical, yet narrow, financial and technical analysis offered by providers. Their results show that the system infrastructure in the case study would have cost 37% less over 5 years on EC2, and using cloud computing could have potentially eliminated 21% of the support calls for this system. These findings seem significant enough to call for a migration of the system to the cloud but their stakeholder impact analysis revealed that there are significant risks associated with this. Whilst the benefits of using the cloud are attractive, they argued that it is important that enterprise decision-makers consider the overall organizational implications of the changes brought about with cloud computing to avoid implementing local optimizations at the cost of organization-wide performance.

3 CLOUD COMPUTING

Gartner, the world's leading information technology research and advisory organization, defines cloud computing as "a style as a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies".
A well accepted definition of cloud computing is that provided by US National Institute of Standard and Technology (NIST): "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".

The cloud computing model is usually composed of:

- five essential characteristics
- three service models
- four deployment models

The NIST defined essential characteristics are:

- On-demand self-service
  Characteristics: defined environments can be ordered from a catalog – provisioning of ICT resources are rapidly provisioned or de-provisioned on demand without requiring human interaction with the service vendor

Benefits: consumer concerns are abstracted from provider concerns through service interfaces – automation reduces ICT cycle time (real-time provisioning) and management cost

- Broad network access
  Characteristics: vendors deliver ICT resources over standard networks (Internet) – ICT resources are accessed through standard mechanism, including a number of devices (workstations, laptops, smartphones, and similar devices)
  Benefits: access anywhere, anytime
- Resource pooling
  Characteristics: ICT resources can be shared between many applications – ICT resources serve all clients using a multitenant model – different physical and virtual resources are dynamically assigned and re-assigned according to client demand
  Benefits: more efficient utilization of ICT resources – hardware cost reduction through economy of scale
- Rapid elasticity
  Characteristics: ICT environments scale down and up by large factors as the need changes – to the client, the capabilities available for provisioning might appear to be infinite, as they can potentially be purchased in any quantity and at any time
  Benefits: ICT resources optimization – flexibility increase
- Measured service
  Characteristics: resources utilization is measured for each application and for each tenant for public cloud billing or private cloud chargeback – cloud systems automatically control and optimize resource usage by leveraging a metering capability – resource consumption can be monitored and reported, providing visibility for both the vendor and the client of the services used
  Benefits: more flexible pricing schemes – multiple payment models – cost transparency

Before mentioning the cloud service models, SaaS evolved and established itself. This is useful in order to set the context for itemising the other cloud service models. The shift in business model toward SaaS took over the software industry around the turn of the century. Before it was called SaaS, it was an application rented from an Application Service Provider (ASP); here, the traditional enterprise license model was turned on its head, and you purchased in a pay-as-you-go (or on-demand) manner, with costs scaling with usage instead of having a large upfront capital investment. You didn't need to provision hardware and software; instead, the services were turned on when needed. After this approach was renamed SaaS, it evolved into several new kinds of offerings. Nowadays cloud service models are described generically as "XaaS". XaaS stands for "Everything as a Service" where X can take on values such as IT, Infrastructure, Platform, Software, Business Process, Desktop, Application, Database, Storage, Network, … The acronym XaaS refers to an increasing number of cloud services that can be delivered over the Internet rather than provided on-site.
The NIST defined service models are:

- Software as a Service (SaaS)
  This is the layer where applications run and cloud services are provided by vendor to the user on demand. There are hundreds of SaaS service offerings available today, ranging from general purpose applications (horizontal applications) to specialized applications for specific industries (vertical applications).
- Platform as a Service (PaaS)
  This is the layer for the development and deployment of applications. The vendor platforms typically includes database, middleware, and development tools.
- Infrastructure as a Service (IaaS)
  The infrastructure layer focuses on enabling technologies through the provision of physical assets like servers, storage capabilities, network devices and similar devices. This makes sense, since more and more ICT infrastructures are becoming a commodity. The infrastructure hardware is often virtualized.

The NIST defined deployment models are:

- Private cloud
  A dedicated cloud environment is usually maintained in-house by a single organization. There are however additional variations to this previous deployment definition. For instance, the dedicated on premises cloud environment, owned and used by a single organization, may be managed by a third party (Managed Private Cloud). Besides, somebody talks about Hosted Private Cloud (or Virtual Private Cloud) when an organization uses an external vendor with a bespoke ICT system, fully managed by the vendor.
- Community cloud
  The cloud environment is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns. It may be owned, managed, and operated by one or

more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.

- Public cloud
  The cloud environment is available to general public. It exists on the premises of the cloud provider and is operated by the provider too. Security and privacy is of utmost concern in this type of deployment.
- Hybrid cloud
  The cloud environment is a mix of private, community, or public clouds, that are bound together by standardized or proprietary technology that enables data and application portability. Often the cloud provider maintains the underlying infrastructure using public clouds and the client may interface with the public cloud using his own private cloud.

4 CLOUD COMPUTING LIFECYCLE

From a technical point of view the ICT transformation roadmap towards the cloud computing model occurs typically by steps such as virtualization, standardization, automation, orchestration.
In addition to these technical aspects, which do not investigate further here, we propose other considerations.
The first question should be to define if the cloud makes sense in the specific situation. We can find several criteria. Among these we can mention: applications needed for a short period of time; applications that involve workload peaks or volatility; and applications not strategic to the core business (application development included). Conversely, legacy applications, real-time applications, applications dealing with highly sensitive or confidential data should be carefully surveyed before their cloud on-boarding.
The cloud affinity of existing applications depends on multiple factors:

- compliance and cross-border issues
- site-dependency (for performance or data size)
- application specific benefits of migration, and the ease and cost of migration

New application types (mobile, social, collaboration) are practically begging to be deployed in a cloud.

Organizations need to do a due diligence on a number of points before even considering a move to the cloud. Some of the following are key points that need to be thought of and addressed:

- Do an investment appraisal (capital budgeting) exercise without taking anything for granted.
- Experiment on a low scale application which is non-critical and determine the hassles involved and substantiate the effort and cost involved.
- Prioritize the pieces of the portfolio and determine what all pieces need to sit on the cloud and what all should remain in-house or on the private cloud. Security and data privacy drive these aspects.
- Institute solid governance. There should be clarity and consensus on who will be responsible and accountable for decisions taken for the smooth functioning of the cloud infrastructure and functioning.
- Establish Service Level Agreement (SLA) with the cloud service provider and also chalk out a contingency plan for business continuity if the cloud should fail at any point in time.
- Determine how to measure the quantitative and qualitative benefits of the cloud for planning and growth.
- Choose the cloud service provider carefully, depending on current capabilities and potential of the provider. While choosing the service provider, future potential also should be thought of to grow business and expand operations and customer base.
- Create a mechanism to evaluate the cloud service provider.

Before considering a move to the cloud, sometime it is developed a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis in order to identify and analyze the internal and external factors that can have an impact on the viability of the cloud project. E.g., for a public cloud the SWOT analysis could have the following:

- Strengths: pay-per-use pricing model; fast deployment; business agility (the power to change rapidly and effectively); business continuity (24x7)
- Weaknesses: security issues
- Opportunities: location independence; maintenance / versioning optimization

- Threats: limited customization option; loss of control; legal and compliance constraints; potential vendor lock-in

How the cloud will evolve? It is difficult to make predictions, especially about the future!. According to many analysts, organizations will probably move to a hybrid cloud environment in time. This approach would mix and combine the private, public, and community cloud approaches together with existing systems. It would provide the correct functionality that meets each organization's specific needs. In the more distant future, organizations will move more and more applications to the public clouds (Mateos et al. 2011).
The expectation is that quite a bit usage of the cloud computing by organizations will come from Business Processes as a Service (BPaaS). More and more organizations will delegate externally operations. They will start by moving to public clouds back office operations and slowly moving the middle and front office applications. The comparison would be with what manufacturing has done with operations and back office.

5 TOTAL COST MANAGEMENT FRAMEWORK

In the AICE website (see References) the Total Cost Management (TCM) is defined as the application of technical and professional competences to planning, managing and controlling resources, costs, profitability and risks. It is a systematic approach to cost management and control of any investment or business activity during its life cycle.
A unique element of TCM is that it integrates some essential steps that an organization must take to deploy its business strategy. The costs refer to any investment of resources in the enterprise's strategic assets. Resources may include time, monetary, human, and physical resources.

In 2006, AACE International (an ICEC founding member) published their "Total Cost Management Framework – An Integrated Methodology for Portfolio, Program and Project Management". With reference to this framework, there are two levels of the TCM process. They are referred to respectively as:

- Strategic Asset Management refers to the TCM process of managing the total life cycle cost investment of the enterprise's strategic asset portfolio. The portfolio will contain many assets in various stages of their life cycles (including those assets that are nothing more than ideas). Although investments are made in an asset through the performance of a project or program, Strategic Asset Management is not concerned with day-to-day project tasks. To paraphrase an old saying, it is more concerned with doing the right projects than with doing the projects right.
- Project Control refers to the TCM process as applied at an individual project level. It is applied to a project to ensure a desired asset investment result.

So Total Cost Management primarily maps the process upstream of project management. Traditionally, the field of project management begins with the "initiation" of a project. There are several standards defining methodologies for project management models. However, these standards do not address what happens before a project is initiated; that is how does a project starts, how is the project identified and prioritized among other operating, maintenance, or investment options available to an enterprise.
TCM process is industry generic. It is finding wider use in Information and Communication Technology (ICT) management, software and other companies.
When one examines the program of the implementation or transformation to Cloud Computing, there are several processes that it is necessary to consider connected with the change:

- ICT
  - Infrastructure
  - Platform
  - Standardization (this is particularly important in the case of SaaS, since it makes sense to standardize as much as possible before migrating)
  - Integration
- Organization
  - Change in processes, their improvement and leaning, human resources and competencies
- Procurement
  - Changes in procurement, now focused on services rather than products and systems
- Marketing

- Definition of new possible products/services with Cloud Computing (for instance mobility becomes much easier)

An investment appraisal is used to determine whether an organization's long term investments, major capital, or expenditures are worth pursuing. Cloud Computing project is no exception.
This paper contribution is to identify a model to define an approach in order to perform the economic evaluation and the decision analysis of a cloud implementation or transformation project with its investment options. These options may be related to the different sourcing models (in-house, outsourcing, cloud); the several cloud service models (IaaS, PaaS, SaaS); the several cloud deployment models (private, public, hybrid); the vendor, industry and solution choices.
This is a capital budgeting exercise, that an exercise to analyze investment alternatives and determine whether they are worth pursuing. This paper will consider the case of a cloud project.
The investment appraisal criteria we can adopt are typically based on:

- Metrics derived from income statement (ROE Return On Equity, ROI Return On Investment, PBP PayBack Period)
- Metrics derived from cash flow statement (NPV Net Present Value, IRR Internal Rate of Return)

In order to build the economic evaluation it is necessary to adopt some assumptions (solution type, facilities costs, maintenance costs, staff costs, and so on). There are however items more difficult to assess. For not all these issues there are still no definite answers up to date.

6 THE BUSINESS CASE FOR CLOUD COMPUTING

This section makes some observations about Cloud Computing economic models using the TCM framework:

- In deciding whether hosting a service in the cloud makes sense over the long term. The Cloud Computing model not only potentially reduces costs. It especially offers the elasticity and helps in transferring risks to the vendors.
- As well, although hardware resource costs continue to decline, they do so at variable rates; for example, computing and storage costs are falling faster than WAN costs. Cloud Computing can track these changes—and potentially pass them through to the client—more effectively than what is possible with an in house data center, resulting in a closer match of expenditure to actual resource usage.
- In making the decision about whether to move an existing service to the cloud, one must additionally examine the expected average and peak resource utilization, especially if the application may have highly variable spikes in resource demand; the practical limits on real-world utilization of purchased equipment; and various operational costs that vary depending on the type of cloud environment being considered.

The main benefits of cloud computing with regard to the information systems are scalability and flexibility, access to information resources in any place, in continuity and professionalism of being able to use the resources of the provider shared with other clients (resource pooling).
From the ecological point of view, finally, is not negligible in the commitment of the major suppliers in drastically reducing the environmental impact of data centers, including using alternative energy.

3.1 Elasticity: Shifting the Risk

The economic benefit of Cloud Computing is connected with “converting capital expenses to operating expenses” (CapEx to OpEx). The absence of up-front capital expense allows capital to be redirected to core business investment. As a matter of fact, the benefits with cloud computing are connected also with the possibility of “pay as you go”. There is a substantial benefit of paying not on the capacity but on the usage even if it is more. This benefit is connected with the possibility on the side of the vendor to offer the service to more than one user and hence to reduce the buffer to take into account of the variable loading; in the networking community, this way of selling bandwidth is already known as *usage-based pricing.*
Byrd, T.A. (2000) defined elasticity in the case of ICT as: ICT infrastructure is the shared ICT resources consisting of a technical physical base of hardware, software, communications technologies, data, and core applications and a human component of skills, expertise, competencies, commitments, values, norms, and knowledge that combine to create ICT services that are typically unique to an organization. These ICT services provide a foundation for communications interchange across the

entire organization and for the development and implementation of present and future business applications.
The key observation is that Cloud Computing's ability to add *or remove* resources at a fine grain (one server at a time with EC2) and with a lead time of minutes rather than weeks allows matching resources to workload much more closely. Real world estimates of server utilization in datacenters range from 5% to 20% Few users deliberately provision for *less* than the expected peak, since in case they reach the peak of utilization, they might have severe problems in terms of response time or even time outs.
Armbrust, M. et al. (2009) proposed the following simple equation that generalizes all of cases to compute the benefits as:

$UserHoursc_{loud}$ x (revenue − Costcloud) ≥ $UserHoursd_{atacenter}$ x (revenue − $\frac{Costdatacenter}{Utilization}$)

The left-hand side multiplies the net revenue per user-hour (revenue realized per user-hour minus cost of paying Cloud Computing per user-hour) by the number of user-hours, giving the expected profit from using Cloud Computing. The right-hand side performs the same calculation for a fixed-capacity datacenter by factoring in the average utilization, including nonpeak workloads. Whichever side is greater represents the opportunity for higher profit.
If Utilization = 1.0 (the datacenter equipment is 100% utilized), the two sides of the equation look the same. However, based on queuing theory as utilization approaches 1.0, system response time approaches infinity. In practice, the *usable* capacity of a datacenter (without compromising service) is typically 0.6 to 0.8. Whereas a datacenter must necessarily overprovision to account for this "overhead," the cloud vendor can simply factor it into Costcloud. (This overhead explains why we use the phrase "pay-as-you-go" rather than rent or lease for utility computing.
Finally, there are two additional benefits to the Cloud Computing user that result from being able to change their resource usage on the scale of hours rather than years. First, unexpectedly scaling down (disposing of temporarily-underutilized equipment)—for example, due to a business slowdown, or ironically due to improved software efficiency— normally carries a financial penalty.
Second, technology trends suggest that over the useful lifetime of some purchased equipment, hardware costs will fall and new hardware and software technologies will become available.

There are substantial reductions in risks with Cloud Computing:
- Reduced oversupplying
- Management of security by professionals
- Technology updates and upgrades
- Loss of critical employees
- The risk of not correctly estimating workload shifts from the service operator to the cloud vendor. The cloud vendor may charge a premium (reflected as a higher use cost per server-hour compared to the 3-year purchase cost) for assuming this risk.

3.2 Comparing the Costs of Moving to Cloud Computing

Whereas the previous section tried to quantify the economic value of specific Cloud Computing benefits such as elasticity, this section tackles an equally important but larger question: Is it more economical to move my existing datacenter-hosted service to the cloud, or to keep it in a datacenter?
With the above caveats in mind, here is a simple example of deciding whether to move a service into the cloud.
The costs with an internal Data Center (in the case of SaaS) are:
- Architectural costs
- Procurement (sourcing, transportation, and installation) of hardware (servers, storage)
- Procurement of application and platform license and maintenance
- Customization and Configuration
- Operational costs
- Physical and logical security
- Site Disaster Recovery
- Costs replication between data centers for the business continuity plan
- Upgrades and patches
- Support to the end user
- Data Center support and maintenance

- Power, cooling and space
- Costs of the network (Lan, Wan)
- Resources for physical and logical security.

Costs in the Cloud Computing are:

- Integration with applications that remain in the house
- Customization and Configuration
- Support to the end user
- Costs of the network (usually the Internet)
- You pay the resources that you actually consume: “Pay per use”.
- Vendor management
- Disposition of the existing resources (people, hardware, software, and so on)

The total cost reduction tends to be around 20-30%

On top of the previous costs there are the migration costs. A related issue is the software complexity and costs of (partial or full) migrating data from a legacy enterprise application into the Cloud. While migration is a one-time task, the amount of effort can be significant and it needs to be considered as a factor in deciding to use cloud computing. This task is already spawning new business opportunities for companies that provide data integration across public and private cloud computing.

Outsourcing leads to a potential change in the activities also in other areas of the client organization due essentially to the reduction in the number of suppliers dealt directly by the Client Organization (see Figure 1).

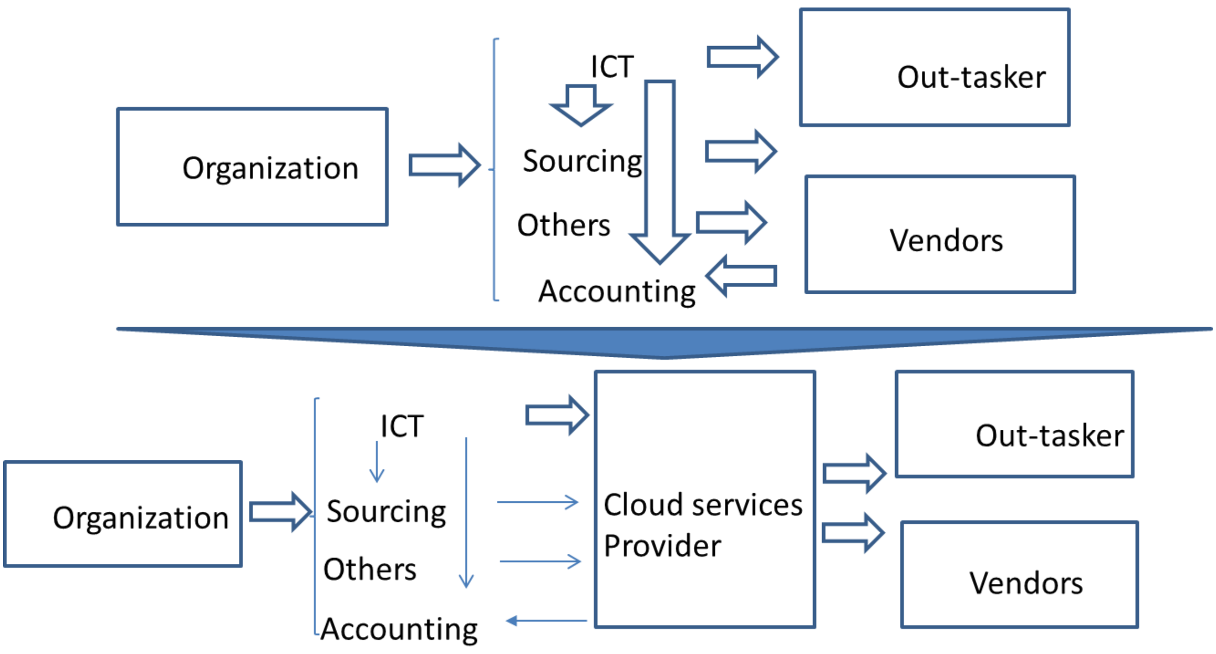

Figure 1 Changes in the organization with Cloud Computing

7 CONCLUSIONS

The cloud is a model for enabling, via the network, widespread access, and easy request on a shared set of configurable computing resources (for instance, networks, servers, storage, applications, and services). These resources can be acquired and released quickly and with minimal management effort or service provider interaction.

Cloud computing is flexible and can adapt to the needs of the business, you only pay for the resources that are actually using; does not require large investments, replacing them with operating costs over time; makes the ICT infrastructure redundant and fault tolerant.
The Cloud is suitable in situations where the processing requirements are variable because in these cases are exploited, and above all, paid resources only when needed.
Jeff Bezos, founder and CEO of Amazon claims that, just as it makes no sense that each produces all the electricity it consumes in a completely autonomous way, it is not efficient that predisposes the entire ICT infrastructure you need.
So how do we turn to an energy supplier, at the same way it is possible in a natural way to purchase hardware and software resources from specialist suppliers.
The factors that favor the adoption of cloud are the role of information systems more and more process-oriented rather than technology; the substantial savings possible with large data centers, the spread of broadband Internet access, and virtualization in computer application software more and more standard.
The client using cloud services just needs to terminals connected via the network, normally Internet, to its cloud service provider.
When the car was introduced, the initial expectations were only to have transportation without horses. In fact, the initial cars were very similar to chariots, made with woods and leather. In time, people discovered that the car was something different. The car started to differentiate. More technologies started to be used in car building: metallurgy, electronics, computers, etc. Not only the car changed in form, size, and so on, the car started to impact in a powerful way on the social and economic models of life and of doing business.
We expect that something similar will happen with cloud computing. It will be the merge of cloud computing with social, mobile, web, big data, and business intelligence, and so on to provide a new model to support the three Cs: clients, channels, and collaboration. In time, this will change also the social and economic models.
This Section cannot be completed without quoting a phrase attributed to Darwin: “It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change.”
The managers in any industry should take into account in any moment that if they do not move somebody else will. Cloud computing shifts the economics from fixed investments to variable costs (shift to right). This reduces the barrier to entry for new entrants. These technology aspects can combine with new regulations – such as the one which facilitate the entry to the so called Payment Institutions in the case of financial institutions and with the wider availability of network access. The impact of all these aspects could bring new entrants with advanced functionality.
Cloud computing is a disruptive innovation. In the long term, it could bring to a blurring of the productive organizations, technology providers, processors, and connectivity providers roles.
Organizations should concentrate in the short term to pilot immediately and use cloud technology at their best, taking into account the plus and deltas for each use. At the same time, they should also evaluate the long term scenarios. The future will bring risks, which the innovative and brave organization will be able to turn into opportunities.

7 REFERENCES

- Aice website http://www.aice-it.org/en/total-cost-management
- 2010, *The Business Case for Cloud Computing Services*, Seismic, MSP University

AICE, The Italian Association for Total Cost Management, *Body of Knowledge BoK*, http://www.aice-it.org/it/lingegneria-economica/body-of-knowledge

Anderson, C. 2008, *The Long Tail: Why the Future of Business is Selling Less of More*, edited by Hyperion, ISBN 978-1401309664

Armbrust, M. et al. 2009, *Above the Clouds: A Berkeley View of Cloud Computing*, Technical Report No. UCB/EECS-2009-28, http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28.html, Accessed 29 April 2014

Byrd, T.A., and Turner, D.E. 2000. Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct. *Journal of Management Information Systems*, 171, 167-208.

Carr, N. 2008, *The Big Switch: Rewiring the World, from Edison to Google*, edited by W. W. Northon and Co., ISBN 978-0393345223

Chandra, D. G., and Borah, M. D. 2012. *Cost benefit analysis of cloud computing in education.* In Computing, Communication and Applications ICCCA, 2012 International Conference on pp. 1-6. IEEE

Chong, F., and Carraro, G. 2006, *Architecture Strategies for Catching the Long Tail*, http://msdn.microsoft.com/en-us/library/aa479069.aspx

Cowan C. et al. 2012, *Finance in the Cloud*, A report published by Value Partners Management Consulting Ltd., London, UK

Damodaran, A. 2010, *Applied Corporate Finance*, edited by Wiley, ISBN 978-0470384640

de Assunção, M. D., di Costanzo, A., and Buyya, R. 2010. *A cost-benefit analysis of using cloud computing to extend the capacity of clusters*. Cluster Computing, *13*3, 335-347

Di Maio A. 2010, *Community Clouds from Governments to Banks Will Challenge Vendors*, http://blogs.gartner.com/andrea_dimaio/2010/04/27/community-clouds-from-governments-to-banks

Fuchs, V. 1968, *The service economy*, National Bureau of Economic Research, distributed by Columbia University Press

Gartner, ICT *Glossary*, http://www.gartner.com/it-glossary/cloud-computing

Grance, T. and Mell, P. 2011, *The NIST Definition of Cloud Computing*, NIST Special Publication 800-145, http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf

Hollmann, J.K. 2012, *Total Cost Management Framework*, AACE International, http://www.aacei.org/non/tcm/TCMFramework_WebEdition.pdf

Khajeh-Hosseini, A., Greenwood, D., and Sommerville, I. 2010, *Cloud migration: A case study of migrating an enterprise it system to IaaS*. In Cloud Computing CLOUD, 2010 IEEE 3rd International Conference on Cloud Computing, pp. 450-457.

Kondo, D., Javadi, B., Malecot, P., Cappello, F., and Anderson, D. P. 2009, *Cost-benefit analysis of cloud computing versus desktop grids,* In Parallel and Distributed Processing, 2009. IPDPS 2009. IEEE International Symposium on pp. 1-12.

Maurer, M., Emeakaroha, V. C., Brandic, I., and Altmann, J. 2012, *Cost–benefit analysis of an SLA mapping approach for defining standardized Cloud computing goods,* Future Generation Computer Systems, 281, 39-47

Mateos, A., Rosenberg, J. 2011, *Chmura obliczeniowa* [Computing Cloud], Helion

Megginson L.C. 1963, *Lessons from Europe for American Business*, Southwestern Social Science Quarterly, 441: 3-13, at p. 4

Nicoletti, B. 2013, *Cloud Computing in Financial Services*, Palgrave Macmillan, London, UK, ISBN 978-1137273635

Rosenberg, J., and Mateos, A. 2011, *The Cloud at Your Service*, edited by Manning Publications Co., ISBN 978-1935182528