Cloud Computing Services Potential Analysis

An integrated model for evaluating Software as a Service

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***Abstract*— This paper address, in a practical and integrated model, a possible solution of issues concerning the Software as a Service (SaaS) introduction and evaluation. A selective top-down analysis is proposed to guide the overall assessment. The construction of the Potential Adoption Index (PAI), in the last stage of the process, aims to facilitate the evaluation and comparison process of the acceptance of this technology by evaluating: the functional requirements, the total cost of ownership (TCO) and the related concerns and benefits from technical and business perspective.**

Keywords-Cloud Computing; SaaS; adoption; evaluation

I. INTRODUCTION

In recent years, the term cloud computing has been used to identify an evolution paradigm in the computer industry.

This refers to a set of advanced technologies that affect the focus of the organizations and businesses in plan, management and use of its technology infrastructure in the near future.

As noted by [1] the base of the cloud computing is the evolution of three phenomena: virtualization, grid computing and web services

The increasing bandwidth availability of Internet connection and the accessibility from mobile and portable devices has encouraged the spread of applications created for this environment and the access to available resources exclusively through internet (both often offered free of charge for a basic or private usage).

In this way everyone can connect to a website with a browser, fill out a form to access the service, select the available options, the most convenient form of payment and start working with the program or service contracted, without requiring a server, Information Technology (IT) staff, software licenses, installing applications or arrange a backups strategy.

Still, despite the availability of SaaS solution, the main question is that if it is convenient to adopt a solution based on cloud computing.

This article examines the pros and cons described in scientific literature and the potentials that this form of computing may have inside an enterprise.

The topic of this research may be found in the line of "Technology adoption and implementation research" in the business-technology framework defined by [2].

An integrated model for calculating the Potential Adoption Index (PAI) will be presented in order to quantify the benefits and disadvantages of cloud computing adoption.

The PAI, which includes the evaluation of features, benefits and concerns from the business perspective and the technical fit from cloud experts' viewpoint, indicates the overall adoption utility level.

The structure of the paper is as follows. Firstly, the term cloud computing will be referenced. Then an integrated model analysis is presented in three stages. The computation of the PAI synthesizing, in a numerical result, benefits and disadvantages of adopting a cloud computing SaaS solution. A numerical example is presented in order to explain the construction of the PAI and the interrelation between the different elements of the model.

II. TOP-DOWN SELECTIVE ANALYSIS

There are a multitude of definitions of cloud computing as in [2], [3], and [4] the one taken as a reference for this paper is the one proposed by [5].

The proposed evaluation model for the development of the PAI, consists of three consecutive steps, related to each other, in order to consider:

A. a functional analysis, that explores the features of the SaaS solution the company would like to implement/ deploy or integrate;

B. an economic analysis, that quantifies the costs of implementation and maintenance;

C. an attribute analysis, that evaluates characteristics, benefits and concern also needed for the PAI calculation.

The top down process, guide the reader from a rough overall assessment to a more defined quantification of the analytical aspects of the Saas analyzed.

A. Functional analysis: identifying cloud candidate

Primarily the company must decide which business functions want to move into the cloud and the type of data that will be stored and shared in order to be able to monitor, develop, analyze and use these actions for their growth, implementing services that meet business needs.

If there is at least one alternative to consider in order to facilitate the comparison between different products "white

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papers", reviews or comparisons papers, that examine the functional features of the programs offered by the providers could be downloaded.

In addition, most of the SaaS providers, normally, offer full product evaluation for a limited period of time which facilitates the analysis and comparison without any installation or additional cost. Other providers allow some interaction with the support staff, via email, chat or phone for free. This helps the evaluation of the products offered and to clarify the software functionalities.

For an adequacy SaaS selection, the software functionalities are first inspected because some of the features of Cloud Computing do not lend themselves to an easy customization [3], [6], and multitenant application customization should be made through configuration [7].

In this stage, the suggested methodology (see Table I) include to:

- Identify one or more Saas solutions available on the market for the specific aspect that the company would like to implement (Collaboration, CRM, ERP, SFA, etc.);
- Identify the functionalities that are required for the company, tagging each of them with a label "Required", "Nice to have" and "Not required";
- After having investigated the specific functionality in any specific SaaS or using professional experts for the specific software, mark each of the functionality attribute with a tag indicating if is it available:
  - "Yes";
  - "Yes but need to be configured";
  - "Yes can be customized";
  - "Not Available"

Candidates for the functional evaluation are key users, managers-owners and product experts.

TABLE I. FUNTIONAL SUITABILITY TABLE IN SUPPORT OF FUNCTIONAL ANALYSIS WITH QUALITATIVE ORDINAL SCALE

Software Functionality	Is it Available?	Is the Saas Suitable? *(Qualitative ordinal scale)*
REQUIRED	YES	**SUITABLE**
	CONFIGURABLE	**SUITABLE but** +COST / +TIME for the implementation
	CUSTOMIZABLE	**SUITABLE but** +++COST / +++TIME for the implementation
	NO	**NOT SUITABLE:** REJECT
NICE TO HAVE	YES	**SUITABLE:** no cost for an nice to have functionality
	CONFIGURABLE	**SUITABLE but** +COST / +TIME if implemented
	CUSTOMIZABLE	**SUITABLE but** +++COST / +++TIME if implemented
	NO	**SUITABLE but** not implementable if will became a requirement
NOT REQUIRED	YES	**SUITABLE:** no cost if this functionality will became a requirement
	CONFIGURABLE	**SUITABLE but** +COST / +TIME if will became a requirement and implemented
	CUSTOMIZABLE	**SUITABLE but** +++COST / +++TIME if will became a requirement and implemented
	NO	**SUITABLE but** not implementable if will became a requirement

Each level of suitability will have an immediate repercussion at this stage (e.g., if a required functionality is not available imply the rejection of the Saas solution) or in will be penalized/rewarded in the further assessment (e.g., in the economic analysis with integration and customization costs evaluation).

The main purpose of this process is to verify the overall fit of the analyzed SaaS package to meet the functional requirements needed by the company.

This relatively simple process helps formal selection of a SaaS without any deep or wide expertise in Cloud Computing. This aims at reducing the number of candidates by selecting some of them very quickly based on a brief review of key functionality and company needs. This also keeps additional costs to a minimum level and stays in line with specific characteristics of cloud computing.

At the end of the first stage will be one or more programs offered as SaaS that should be at least functionally compatible with the essential requirements of the company, with an explicit level of integration and customization required for its adoption. The essential requirement identified, which will need configuration or customization, will be economically estimated in the next phase.

B. Economic analysis: identifying the costs

An assessment could be obtained using the Total Cost of Ownership (TCO) formulation proposed by [8] based on the combination of three costs types, in order to determine the financial impact of SaaS adoption.

Alternatively the proposed TCO method in [9], where a mathematical modeling of cost types is introduced along with a case study, could be used for the same purpose.

The identified economic values will be evaluated within the financial dimension in the next phase (attribute analysis).

C. Attribute analysis and the Potential Adoption Index (PAI) calculation

The evaluation of attributes as features, benefits and risks associated with a SaaS solution will be analyzed in order to calculate the "Potential Adoption Index" (PAI).

In order to determine the SaaS benefits and concern the taxonomies proposed in [10] has been used to generate an evaluation matrix:

- the three main dimensions of cloud related benefits (deployment advantages, financial savings, and functional aspects) have been integrated with the main cloud characteristics (on demand self-services, broad network access, resource polling, rapid elasticity, measured services) in Table II;
- the three main dimensions of cloud related concerns (alignment with existing operating model in organization, management and control of organizational data and services, and legal aspects) have been incorporated in Table III.

For each dimension, underlying category and attributes has been specified to improve the level of detail to offer a more analytic evaluation.

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In Table II are exposed the essential characteristics of cloud computing, with cloud deployment, financial and functional benefits.

TABLE II. ASSESSING KEY FEATURE AND MAJOR BENEFITS ASSOCIATED WITH THE CLOUD

Cloud characteristics and benefits			WEIGHT	RATING	WEIGHT * RATING
Essential Characteristics		On-demand self-service	0,013	3	0,039
		Broad network access	0,013	3	0,039
		Resource pooling	0,025	3	0,075
		Rapid elasticity	0,025	4	0,100
		Measured service	0,005	4	0,020
Benefit	deployment	similarity with other technolgy already used inthe company (ie. Outsourcing)	0,006	1	0,006
		ease to setup	0,006	3	0,018
		ease to maintain	0,006	2	0,012
		speed - implementation time	0,006	4	0,024
	financial	**structuring of payment**			
		contract payment terms (monthly...)	0,018	2	0,036
		change of subscription fee (end of contract, anytime)	0,019	4	0,076
		penalty on early termination	0,025	4	0,100
		data return on subscription cancel	0,076	4	0,304
		cost scalability (per user, group)	0,013	2	0,026
		pay-for-use			
		Total cost per year	0,025	3	0,075
		small capital expense	0,025	2	0,050
		convert capex to opex	0,025	2	0,050
		(saving)			
		personnel	0,000		0,000
		hardware	0,000		0,000
		infrastructure	0,000		0,000
		maintenance (update/upgrade)	0,000		0,000
		energy	0,000		0,000
		management	0,000		0,000
		other services			
		provide user training	0,025	3	0,075
		training charges fee	0,025	2	0,050
		self support /documentation	0,025	2	0,050
		customer support by phone	0,025	3	0,075
		customer support by email	0,025	3	0,075
		customer support web-ticket	0,025	3	0,075
		Client manager (primary contact)	0,025	2	0,050
		business consulting	0,013	2	0,026
	functional	**up to date**			
		planned frequency	0,005	1	0,005
		policy to notify update/upgrade	0,013	3	0,039
		expansion (new modules deployment)	0,013	2	0,026
		evolution	0,013	2	0,026
		TOTAL BENEFIT	**0,563**		**1,622**

The financial dimension in the category saving will be used if the SaaS solution replaces a non-cloud application (dismission) with identifiable economies or if a different deployment method (other than public cloud) is adopted in order to evaluate the economies from moving some of the company resources (IT staff, hardware, infrastructure, maintenance, energy, management) in the cloud provider domain.

Table III includes the list of concerns attributes evidenced when implementing a cloud computing solution.

TABLE III. ASSESSING KEY FEATURE AND MAJOR BENEFITS ASSOCIATED WITH THE CLOUD

Cloud related concerns			WEIGHT	RATING	WEIGHT * RATING
Concerns	alignment	**integration**			
		existing formats, interface, structured data	0,005	3	0,015
		operating system compatibility	0,013	3	0,039
		mobile compatibility	0,020	2	0,040
		browser conpatibility	0,013	4	0,052
		customization			
		customization	0,003	2	0,006
		configurability	0,013	2	0,026
		availability			
		Network provider	0,025	2	0,050
		Intranet- LAN	0,025	3	0,075
		Saas Provider	0,025	3	0,075
		performance			
		network bandwith usage/available	0,013	2	0,026
		response time-reactivity (latency)	0,013	2	0,026
		Quality of service	0,003	3	0,009
		off-line functionality (if any)	0,000	0	0,000
		redundancy in data	0,000	0	0,000
		redundancy in services	0,000	0	0,000
		uptime/downtime requirement (99,9%)	0,000	0	0,000
		transfer (data lock-in)			
		manegeble transferability of data	0,025	3	0,075
	management and control of data and services	**security**			
		Authentication (ie. User+psw)	0,025	4	0,100
		secure protocol	0,013	2	0,026
		security certification (ES. ISO 27001/27002, ISACA COBIT, PCI, NIST)	0,003	1	0,003
		encription option	0,003	3	0,009
		disaster management	0,012	2	0,024
		security record	0,003	1	0,003
		management			
		data encription	0,003	2	0,006
		updates/upgrades	0,013	4	0,052
		deletes	0,003	2	0,006
		backups/recovery	0,013	2	0,026
		logs and access investigation	0,003	1	0,003
		relocation (data lock-in)			
		fast data portability	0,005	2	0,010
		secure data portability	0,005	2	0,010
		simple data portability	0,005	2	0,010
		control loss			
		granularity of access control	0,012	2	0,024
		layer of security	0,005	2	0,010
		data loss			
		reliability	0,008	2	0,016
		recover on client request	0,008	2	0,016
		disaster plan	0,003	2	0,006
	legal	**liability (of cloud provider)**			
		legal protection	0,003	2	0,006
		disclosure with governament agency and courts	0,008	3	0,024
		legislation	0,013	1	0,013
		data confidentiality - privacy	0,013	2	0,026
		data ownership	0,013	2	0,026
		data auditability	0,013	2	0,026
		location of the information- country	0,020	4	0,080
		SLAs negotiation or customization	0,013	1	0,013
		TOTAL CONCERN	**0,437**		**1,088**
		TOTAL BENEFIT	**0,563**		**1,622**
		GRAND TOTAL	**1,000**	**PAI**	**2,710**

The evaluation of cloud computing characteristics included in Table II, looks to verify the need for this new technology for the company while the supplier's ability to provide a product according to the commonly accepted basic general requirements. In fact, quite often, for marketing reasons and without considering the essential features, web-based solutions are advertised as cloud computing solution, also known as "cloud washing" [11].

Two columns, “Weight” and “Rating”, must be evaluated to measure the relevant factors in cloud computing environment during the SaaS product evaluation analysis:

- "Weight": considers the importance, relevance or interest of the company to the examined characteristic in a Cloud Computing context to meet the business needs (with a decimal valuation between 0 and 1, with 0="not important" and max.value < 1). The total sum of the values given in this column for the two tables must be equal to 1.
  Candidates for evaluation are stockholders having reviewed the functional and economic analysis results of the Saas under evaluation.
- "Rating": estimates the SaaS solution predisposition of addressing the specific attribute in conformity with the specific company context (with values between 1 and 4. With the following evaluations 1="compliance is poor", 2="the compliance is less than average ", 3="above average ", 4="top").
  Candidates for evaluation are SaaS experts having analyzed the functional and economic analysis results of the Saas under evaluation.

A third column "Weight * Rating" or calculated weighted score contains the multiplication result between the "Weight" and "Rating" of each row.

The "Potential Adoption Index" (PAI) is the result of the sum of the weighted score calculated (column "Weight * rating") in Table II and Table III.

Regardless the number of aspects analyzed (or rows) and included in Table II and Table III, the PAI may range from a minimum of 1 and a maximum of 4. The total average score is 2.5.

If the PAI value exceeds 2.5 this means there is a positive balance between economic components, characteristics, risk factors and benefits of cloud computing in the adoption of the analyzed SaaS solution for the particular company. The results, in the proposed example presented in Table III, PAI = 2.71 indicates this event.

In case of multiple comparison, the Saas solution with the highest PAI indicates the product that has greater potential for the company.

III. CONCLUSIONAND FUTURE WORK

This paper presents an integrated top-down selective analysis for calculating the PAI index representing the adoption potential of a SaaS solution for a company.

Functional analysis, economic analysis (TCO) and a detailed attribute analysis are evaluated and linked together in the integrated model.

These attributes (characteristic, benefit and concern) are estimated from stakeholders for their specific relevance in regard to the company and the cloud environment; and from SaaS experts for their willingness to generate benefits that could be made in the specific business context.

The joint result determines the PAI value, which could be conveniently used to select or assess the SaaS adoption.

The presented framework has not been tested or applied in any real case study. After these preliminary findings, in order to confirm the validity of the proposed solution a more in depth study should be conducted. A case study or other research strategy must also be completed and the results need to be verified and validated.

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