Analysis of Variation in the Pair wise Ratings Assigned to Collaboration Services in Cloud Computing over other Cloud Services

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***Abstract*—various categories of cloud computing services are available today. Cloud Computing enables one with better Information Technology infrastructure in the sense that it saves the cost of setting up large infrastructure since large infrastructure can be installed at lower costs as compared to conventional methods. Firms can look up at cloud offerings as a readily available service with great amount of flexibility and scalability to deal with varied system requirements. Today it is possible to set up a complete Information Technology network of high end services in virtualized form using cloud services. However it would be desirable to evaluate such services for specific purposes that will help in customizing the requirements for a firm in setting up cloud services for their Information Technology services. This will also help firms to optimize their cost in managing their supply chain processes which are driven through IT services. In this paper the cloud characteristics which enable increased collaboration of Information Technology services for supply chain firms is analyzed based on pair wise rating scores. The collaboration characteristics is compared with other cloud characteristics of metered pay services, expandability of information technology infrastructure, capex, support for decision making using multi criterion decision analytic hierarchy process and understanding the effect of variation in the rating score on selected factors.**

Keywords*—Cloud computing, cloud services, cloud characteristics, rating score., analytic hierarchy process.

I. INTRODUCTION

There is an ever growing demand for better IT services. In the present day competitive world, firms look for better technology that will lead to cost reduction and provide quick service. Cloud computing has emerged as a platform offering such benefits. A cloud is a virtual resource of shared pool of configurable devices which are located in various geographical locations. A user gets access to such resources at a lower cost than what is incurred in setting up the infrastructure in its traditional physical form. Cloud offers varieties of services to the user and services that are supported on expandable resources. This gives advantage to firms to collaborate with each other through a network of hosted resources. The resources are highly customizable. A cloud computing service addresses various issues that are faced in the traditional setup like latency, overloading, limited size of resources, security, licensing and many more.

Collaboration is the need of the day to manage resources effectively. It helps in optimizing the cost of setting up IT infrastructure and enables sharing and authoring of documents with partners, including nongovernmental organizations and foreign governments in a secured manner. According to National Institute of Standards and Technology, US Government Cloud Computing Technology Roadmap Volume II, Release 1.0 Draft, Collaboration helps to allow the creation of common workspaces either within the agency, across agencies, or with partners of agencies on a project-by-project basis. Cloud-computing service offers varieties of facilities and services to firms. Firms can adopt cloud computing services which is available at reasonable cost. Firms can further think in terms of increased collaboration thereby gaining further cost reductions and better service provision. Though cloud offers various services with different characteristics, it is important to understand and analyze each characteristic in terms of relative importance of one over the other. Firms which have their supply chains enabled on Information Technology can derive better advantages when migrated to cloud infrastructure.

Various cloud characteristics that can be considered for a detailed analysis are on demand self-service, pay as you go, sharing of resources, access to highly configured machines, increased broad band access, elasticity, provision of metered service, competitive pricing, easy maintenance, global accessibility to virtualized machines, networking of virtual machines, facility to switch from one service mode to another , better utility, better quality of service, ease of up-gradation and many more. Companies have already started migrating to cloud. Services are readily available through Microsoft Azure Portal, Amazon EC2 services, Salesforce.com and others. Setting up a Cloud infrastructure is highly cost effective and customizable. Deployment of services that were either complex or cumbersome is made very simple through cloud service providers.

In this paper the focus is on analyzing the rating scores of cloud characteristics – Increased Collaboration Facility (ICF) over other characteristics of cloud computing services. The authors have considered a 9 point rating scale for variations and pair wise comparisons as referred in Saatys analytical hierarchy processing (AHP). The maximum rating of 9 point is assigned to ICF over others and the ratings varied to check

for consistency. The maximum rating resulting in a consistent score is considered to generate the weighted average scores for each characteristics based on maximizing ICF scores.

II. RESEARCH OBJECTIVE

- To derive functions relating various cloud characteristics based on the impact of maximum rating of increased collaboration facility as one characteristics over other characteristics.
- To analyze the outcomes based on ratings from various hierarchical categories like prospective employee, coder, nod coding employees and strategic managers.

III. LITERATURE SURVEY

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

Bhaskar Prasad Rimal, Admela Jukan Dimitrios Katsaros, and Yves Goeleven have shown that several architectural features will play a major role iln the adoption of cloud computing services and provides key guidelines to software architects with cloud computing [1]. Anil B Gowda and K N Subramanya have earlier analyzed the cloud characteristics using Saathys analytic hierarchy process to bring out the base model function that relates various cloud characteristics. It is felt that variation in ratings with changing scenarios could be analyzed [2]. Heilig,L and Voss S identifies lack of a comprehensive scientometric study in the area of cloud computing and has provided extensive insights into publication patterns, research impact and research productivity in the area of cloud computing [3]. Jamshidi P and Ahmad A Pahl have concluded that cloud migration research is in early stage of maturity and identifies the needs for migration framework to improve migration to cloud. [4]. Moreno I S, Garranghan P, Townend P and Jie Xu have analyzed and identified model parameters and their value for the simulation of the workload related performances in the context of cloud data center services. Model derived by them is analyzed and implemented by extending the capabilities of the CloudSim framework which is then validated using empirical comparison and statistical hypothesis tests [5]. Rodriguez, M.A. and Buyya, R proposed a resource provisioning and scheduling strategy for scientific workflows in infrastructure as Service clouds and presented algorithm based on meta heuristic optimization technique aimed to minimize the workflow cost [6]. Zhou A, Wang S, Zheng S and Hsu C have proposed a cloud service reliability enhancement approach for minimizing network and storage resource using cloud data center [7]. Qij Zhang, Lu Cheng, and Raouf Boutraba have highlighted key concepts through a survey of cloud computing covering architectural principles and state of the art implementations and research challenges [8]. J. Chen and H. Yu have evaluated the key performance indicator of the whole supply chains by building and simulating models of agricultural distribution systems. The study provides flexible simulation techniques which could be used in management system and improving supply chains [9]. J. Singh, JJ. Powles, T. Pasquier and J. Bacon has brought out the importance of information management obligations on data sharing and transmission within cloud hosted applications and services [10]. J Mitchell stated that cloud service on pay as you go unleashes a new way of managing IT services [11]. Saaty Thomas L has emphasized the importance of measuring intangibles that will enable decision making process. Analytic Hierarchy Process is used to measure and evaluate all such intangibles involved in a service [12].

From the literature review, it is observed there is tremendous potential to consider adopting cloud computing services. There is a scope to research various cloud services in terms of its characteristics. A comparative analysis of one service over the other will help decision makers to take suitable decision on cloud computing services.

IV. METHODOLOGY AND RESULTS

The impact of the cloud computing service characteristics of offering increase collaboration facility (ICF) to the firms is analyzed by considering rating scores as in Saathys Analytic Hierarchy Process (AHP) used for multi criterion decision analysis. 1-9 point rating scale is considered for the analysis as in Saathys work. A hierarchy of options and categories is considered by taking 4 levels in the hierarchy and 5 factors representing the cloud characteristics. AHP analysis is done and Consistency ratio is worked out for each case.

Categories: PSM - Prospective entrants to the IT companies, IMN – IT employees who are not coders, COD – Software employees who are coders, STR - Strategic Managers.

Characteristics (Factors): EXD - Expandability, CPX-Capex savings, ICF-Increased Collaboration Facility, MPS-metered pay service and SDM- Support for Decision Making.

A test case is considered wherein pair wise rating of category PSM of one characteristic over other characteristics A vs B as shown in Table 1.

Table 1 Pair wise Importance – Category PSM

		B				
		EXD	**ICF**	**SDM**	**MPS**	**CPX**
A	**EXD**	1.00	0.25	0.14	0.11	0.20
	ICF	4.00	1.00	0.50	0.25	2.00
	SDM	7.00	2.00	1.00	0.25	2.00
	MPS	9.00	4.00	4.00	1.00	7.00
	CPX	5.00	0.50	0.50	0.14	1.00

Using the method of AHP, the normalized comparisons are done and the PSM scores with respect to (EXD, ICF, SDM, MPS, CPX) are obtained.

PSM scores (0.035, 0.134, 0.199, 0.531, 0.101)
IMN scores (0.539, 0.228, 0.132, 0.069, 0.032)
COD scores (0.037, 0.084, 0.253, 0.491, 0.135)
STR scores (0.098, 0.263, 0.165, 0.277, 0.197)

From AHP analysis, the (PSM, IMN, COD, STR) scores are (0.042, 0.117, 0.307, 0.534).

Weighted average scores of (EXD, ICF, SDM, MPS, CPX) are (0.098, 0.263, 0.165, 0.277, 0.197).

Therefore, base function f(β) is

$$\mathbf{f(\beta) = 0.098\,\beta_1 + 0.263\,\beta_2 + 0.165\,\beta_3 + 0.277\,\beta_4 + 0.197\,\beta_5}$$

For details, authors work on the analysis of the Benefits of Cloud Services for Supply Chain using Analytic Hierarchy Process listed in the references may be referred. To analyze the variation of the ratings on various characteristics of ICF on others, a rating range is generated using AHP by considering maximum rating using sensitivity method and values are recorded. The results of such variations are reported as C- Consistent and NC-Non consistent depending on the value of consistency ratio obtained in AHP. ICF which is considered as deciding factor is worthwhile to look into the extreme ratings. Decision pertaining to ICF ratings is market sensitive and hence in this paper the key factors are sensitized by considered extreme ratings. ICF is rated on other factors CPX, MPS, SDM, EXD respectively by taking a maximum 9 on the rating scale and investigating the entire range for other ratings. For the results to be consistent it is necessary that the Consistency Ratio ≤ 0.1. The sensitivity analysis results are compiled and tabulated for each case and are shown in the Tables 2(a), 2(b), 3, 4(a), 4(b) and 5.

Table 2(a): Consistency Results of ICF ratings for Category PSM

	Rating Range	Factor/Options - Sensitivity				Result (C/NC)
		CPX	MPS	SDM	EXD	
CASE – 1a (PSM)	R1	9	9	9	9	NC
	R2	1-8	9	9	9	NC
	R3	9	1-8	9	9	NC
	R4	9	9	1-8	9	NC
	R5	9	9	9	1-8	NC
	Result : Non Consistent PSM					

Since for highest rating of 9, results were all non-consistent, base level ratings are considered and the rating range is investigated. Following results are obtained based on based ratings obtained in the analysis of AHP done earlier. The base ratings for (CPX, MPS, SDM, EXD) were (2, 1/4, 1/2, 4). 1/4 indicates reciprocal rating should be read as 4 relative to ICF. Similarly '1/2' should be read as 2 relative to ICF. Sensitivity results are shown in Table - 2b.

Table 2(b): Consistency Results of ICF ratings for Category PSM (Base)

	Rating Range	Factor/Options - Sensitivity				Result (C/NC)
		CPX	MPS	SDM	EXD	
CASE – 1b (PSM)	R1	1-**2**-4	1/4	1/2	4	C
		5-9	1/4	1/2	4	NC
	R2	2	1/1	1/2	4	NC
		2	1/2-**1/4**-1/9	1/2	4	C
	R3	2	1/4	1/1-**1/2**-1/4	4	C
		2	1/4	1/5-1/9	4	NC
	R4	2	1/4	1/2	1	NC
		2	1/4	1/2	2-4-9	C
	Selected Maximum : (4, 1/2, 1/1, 9)					

Table 3: Consistency Results of ICF ratings for Category IMN (Max rating 9)

	Rating Range	Factor/Options - Sensitivity				Result (C/NC)
		CPX	MPS	SDM	EXD	
CASE – 2 (IMN)	R1	9	9	9	9	NC
		1-8	9	9	9	NC
	R2	9	1-8	9	9	NC
	R3	9	9	1-8	9	NC
	R4	9	9	9	1	C
		9	9	9	2-9	NC
	Selected Maximum : (9, 9, 9, 1)					

Table 4(a): Consistency Results of ICF ratings for Category COD

	Rating Range	Factor/Options - Sensitivity				Result (C/NC)
		CPX	MPS	SDM	EXD	
CASE – 3a (COD)	R1	9	9	9	9	NC
	R2	1-8	9	9	9	NC
	R3	9	1-8	9	9	NC
	R4	9	9	1-8	9	NC
	R5	9	9	9	1-8	NC
	Result : Non Consistent COD					

Since for highest rating of 9, results were all non-consistent, base level ratings are considered and the rating range is investigated. Following results are obtained based on based ratings obtained in the analysis of AHP done earlier. The base ratings for (CPX, MPS, SDM, EXD) were (1/2, 1/6, 1/5, 4). 1/4 indicates reciprocal rating should be read as 4 relative to ICF. Similarly '1/2' should be read as 2 relative to ICF. Sensitivity results are shown in Table - 4b.

Table 4(b): Consistency Results of ICF ratings for Category COD

CASE – 3b (COD)	Rating Range	Factor/Options - Sensitivity				Result (C/NC)
		CPX	MPS	SDM	EXD	
	R1	1/1-1/3	1/6	1/5	4	C
		1/4-1/9	1/6	1/5	4	NC
	R2	1/2	1/1-1/2	1/5	4	NC
		1/2	1/3-1/9	1/5	4	C
	R3	1/2	1/6	1/1-1/7	4	C
		1/2	1/6	1/8-1/9	4	NC
	R4	1/2	1/6	1/5	1-5	C
		1/2	1/6	1/5	5-9	NC
	Selected Maximum : (1/1, 1/3, 1/5, 5)					

Table 5: Consistency Results of ICF ratings for Category STR

CASE – 4 (STR)	Rating Range	Factor/Options - Sensitivity				Result (C/NC)
		CPX	MPS	SDM	EXD	
	R1	9	9	9	9	NC
	R2	1	9	9	9	NC
		2-3	9	9	9	C
		4-8	9	9	9	NC
	R3	9	1-8	9	9	NC
	R4	9	9	1-8	9	NC
	R5	9	9	9	1-8	NC
	Selected Maximum : (3,9,9,9)					

FINDINGS

From the sensitivity analysis of various categories and options in the hierarchy model considered, the following results on the importance of cloud characteristics for supply chain network are found. The final AHP scores based on the sensitized 4 cases and maximum rating of IC on (CPX, MPS, SDM, EXD) are: PSM (4, 1/2, 1/1, 9), IMN (9, 9, 9, 1), COD (1/1, 1/3, 1/5, 5), STR (3, 9, 9, 9). The considering category score (weight) obtained in the preliminary analysis is shown in Table 6

Table 6: Sensitivity Table - Rating of ICF on (CPX, MPS, SDM, EXD)

CASE	Category	EXD	ICF	SDM	MPS	CPX
1	PSM	0.030	0.240	0.174	0.469	0.087
2	IMN	0.381	0.427	0.106	0.055	0.031
3	COD	0.036	0.121	0.273	0.448	0.121
4	STR	0.033	0.561	0.082	0.119	0.119

The sensitivity table is then applied on the category scores to obtain the weighted average score. The results are shown in Table 7, Table 8, Table 9, and Table 10.

Table 7: Final AHP scores - maximum rating of ICF w.r.t. preliminary weight

Preliminary	EXD	ICF	SDM	MPS	CPX
Weighted Average Score	0.075	0.397	0.147	0.227	0.108

Preliminary Category Score (0.042, 0.117, 0.307, 0.534) wrt PSM, IMN, COD, STR

For the preliminary category, function f(β) based on the weighted average score indicating the rating coefficients is:
$\mathbf{f(\beta) = 0.075\,\beta_1 + 0.397\,\beta_2 + 0.147\,\beta_3 + 0.227\,\beta_4 + 0.108\,\beta_5}$

Sensitizing the STR ratings set with respect to PSM, IMN and COD for maximum ratings on consistency basis is (9, 9, 4). The category score obtained from AHP analysis will be (0.041, 0.098, 0.236, 0.625). The final AHP scores based on the sensitized 4 cases listed above and considering STR category dominant over other categories is shown in Table 8.

Table 8: Final AHP scores - maximum rating of ICF w.r.t. STR rating

STR	EXD	ICF	SDM	MPS	CPX
Weighted Average Score	0.068	0.431	0.133	0.205	0.110

For this STR case, function f(β) indicating the rating coefficient based on the weighted average score is

$f(\beta) = 0.068\ \beta_1 + 0.431\ \beta_2 + 0.133\ \beta_3 + 0.205\ \beta_4 + 0.110\ \beta_5$

Sensitizing the COD ratings set with respect to PSM, IMN and STR for maximum ratings on consistency basis is (9, 9, 2). The category score obtained from AHP analysis will be (0.039, 0.088, 0.534, 0.339). The final AHP scores based on the sensitized 4 cases listed above and considering STR category dominant over other categories is shown in Table 9.

Table 9: Final AHP scores - maximum rating of ICF w.r.t. COD rating

COD	EXD	ICF	SDM	MPS	CPX
Weighted Average Score	0.065	0.302	0.190	0.303	0.111

For this COD case, function f(β) based on the weighted average score is

$f(\beta) = 0.065\ \beta_1 + 0.302\ \beta_2 + 0.190\ \beta_3 + 0.303\ \beta_4 + 0.111\ \beta_5$

Sensitizing the PSM ratings set with respect to IMN, COD and STR for maximum ratings on consistency basis is (7, 9, 9). The category score obtained from AHP analysis will be (0.037, 0.14, 0.303, 0.520). The final AHP scores based on the sensitized 4 cases listed above and considering STR category dominant over other categories is shown in Table 10.

Table 10: Final AHP scores- maximum rating of ICF w.r.t. PSM rating

PSM	EXD	ICF	SDM	MPS	CPX
Weighted Average Score	0.083	0.397	0.147	0.223	0.106

For this PSM case, function f(β) based on the weighted average score is

$f(\beta) = 0.083\ \beta_1 + 0.397\ \beta_2 + 0.147\ \beta_3 + 0.223\ \beta_4 + 0.106\ \beta_5$

IMN category is not considered because the consistency ratio is more than 0.01 based on maximum rating for entire range. The Function f(β) is reported for STR, COD and PSM. The functions obtained above are consistent with respect to ICF category and hence can be adopted for other related analysis involving cost, time and other supply chain variables. Similarly a range analysis with respect to other factors can be taken up depending upon the critical nature of the characteristics involved in cloud computing and supply chain management.

CONCLUSIONS

The derive beta functions relating various cloud characteristics (EXD, ICF, SDM, MPS, CPX) based on the impact of maximum rating of ICF characteristics are :

(Base) $f(\beta) = 0.075\ \beta_1 + 0.397\ \beta_2 + 0.147\ \beta_3 + 0.227\ \beta_4 + 0.108\ \beta_5$

(STR) $f(\beta) = 0.068\ \beta_1 + 0.431\ \beta_2 + 0.133\ \beta_3 + 0.205\ \beta_4 + 0.110\ \beta_5$

(COD) $f(\beta) = 0.065\ \beta_1 + 0.302\ \beta_2 + 0.190\ \beta_3 + 0.303\ \beta_4 + 0.111\ \beta_5$

(PSM) $f(\beta) = 0.083\ \beta_1 + 0.397\ \beta_2 + 0.147\ \beta_3 + 0.223\ \beta_4 + 0.106\ \beta_5$

It is found that the maximum rating of ICF with respect to other characteristics results in a variation of the coefficient of β_1 in the range of 0.065 to 0.083. The percentage variations with respect to the base values are:

The variation of the coefficient of β1 is -13.33% to +10.67%
Similarly other variations are:

(i) Coefficient of β_2 is -23.93% to +8.56%.

(ii) Coefficient of β_3 is -9.52% to +29.25%

(iii) Coefficient of β_4 is -9.69% to + 33.48%

(iv) Coefficient of β_5 is -1.85% to + 2.78%

It is also seen that when ICF is subjected to variation because of various influencing factors driven by market conditions, the maximum variation (+34.48%) is observed in β_4 corresponding to MPS i.e. metered pay service. Hence firms can exercise greater control and monitor the metered pay services in order to check the fluctuations. This may cause fluctuations in usage and hence would affect the billing.
The next maximum variation (+29.25%) is observed in β_3 corresponding to SDM i.e. support for decision making. Hence firms can concentrate on stabilizing the decision supports through a proper reporting system only to tide over the changes in the business environment.

LIMITATIONS

- This study has certain limitations. The impact of variation of ratings of increased collaboration facility (ICF) is considered on four other characteristics namely metered pay service, expandability, support service for decision making, and savings on capex. Other characteristics like latency time, increase bandwidth, multi tenancy could also be explored.

- There is also a large potential in considering different configurations of virtual machines that could be set up to counter the huge maintenance and service costs involved in traditional systems.

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