

Evaluating User Expectations and Quality of Service: A Novel Approach to Understanding Cloud Services

Jolly Upadhyaya, Neelu Jyothi Ahuja, Kapil Dev Sharma

Abstract: *Cloud Computing technology has revolutionized over the past decade as one of the fastest growing and adopted paradigm especially in the higher education sector. Its impact and popularity as a support system for learning is primarily based on the fact that it provides fast access to educational services and resources with high performance and support. At the same time, lack of institutional budgets, concerns for cyber security, and cost of technical and computer support continue to impact educational administration decision while adopting this enriched service. There is consensus that not enough consideration is given to the quality of cloud services experienced at the users' end while pursuing such methods to fulfil the academic requirements. Currently, unavailability of a reliable standard model that effectively defines the "Quality of Experience," QoE parameters from the users' point of view impacts the recommendation of use for the cloud service across various educational institutions. Hence, it has become increasingly necessary to monitor, track, and quantify the variables influencing QoE for cloud computing-based e-learning applications and develop a new QoE Metrics Model. The current study was performed implementing quantitative method to collect and analyze the data received from various levels of educational institutions. The participants surveyed for study in the current work include students, librarians and faculties that were aware of cloud computing applications and services for higher education. Our study emphasized on variables like accessibility, demographics, age, income, educational status etc. and were statistically analyzed. The results of our study identified a correlation between the research questions and inferred hypotheses from them, leading to create an instrument that could be helpful in future as a diagnostic tool for the customer of cloud services, in academia. The implication of this study is to further help improve the qualitative process needed to identify the gap between user expectations and the experience of real quality of service (QoS) leading to build a reliable conceptual model for service evaluation in cloud computing.*

Keywords: *Cloud Computing; Higher Education; Metrics, Quality of Service (QoS), Quality of Experience (QoE).*

I. INTRODUCTION

Cloud Computing can be defined as a pool of resources that can be delivered through the internet. Institutions together with educational governance bodies are making efforts to innovate learning opportunities with improved infrastructure quality at lower costs (Horizon Report, 2015). Educational establishments and students are becoming increasingly dependent on information technology for the delivery of higher education study material. The interest and demand of students as the end users of online interface is

consistently shifting towards cloud computing resources leading it to become the main source of digital content, interactive classes and other online study material for them. (Almajalid, 2017). The ability of these class of end users' being able to rapidly evaluate Quality of Experience (QoS) through high quality performance models of a system can be taken as a source to improve and facilitate service level agreement (SLA) - based cloud scheduling (TECIRES REPORT, 2010).

The growing technological impact on education leads to many challenges faced by its end users. One of the major area of concern is the Quality of Service (QoS) provided to them. The evaluation of services before it is used is vital in promoting the Cloud environment for higher education. These services ought to be examined by QoS metrics to meet specified criteria such that the services are satisfying the consumer's expectancy. (Bardsiri et al, 2014). Though much emphasis has been put on the studies conducted in the related areas of cloud computing that include resource allocation, scheduling, security, maintenance etc., less significance has been given to the Quality of Service (QoS) as experienced by the end user. Therefore, such concern has lead the focus of this research study analyzing in detail on Quality of Experience (QoE). Monitoring the performances of quality of service (QoS) is very difficult for service providers and data center's that have challenges in dealing with the QoS related issues (Akpan et al, 2015). In order to improve the quality of service, it would be prudent to monitor and evaluate the gap between the promised and experienced quality. Without this measurement it is not possible to ensure coverage in quality of service gap. It is evident that measuring and quantifying the Quality of Experience as the concept is evolving at a varied speed in different parts of the world. Hence the current study focused on establishing the end user as the focus of study and provide a clear approach towards understanding the influence of various factors on their experience during CC function and runtime. This analysis was achieved by developing a survey instrument, which included quantifying and analyzing the responses of the end users based on defined variables and finding the gap between the promised and experienced quality thus leading to the foundation of conceptual model and its development based on the outcome.

The findings have been proved for better performance and quality of service in four aspects: the response time, the throughput passing, the scalability, and accessibility [Hamidi & Rouhani, 2018], but no emphasis was given to the users' experience.

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Jolly Upadhyaya, Ph.D. Scholar, Computer Science, UPES, Dehradun, Uttarakhand, India **Dr. Neelu Jyothi Ahuja**, Professor, School of Computer Science, UPES, Dehradun, Uttarakhand, India

Kapil Dev Sharma, Asst. Professor, JIMSEMTC, Greater Noida Uttarpradesh, India



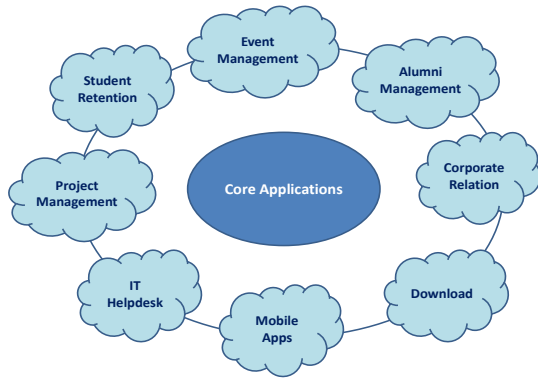


Figure 1: Cloud Computing in Education

II. RELATED WORK

There has been a growing need to define models and standards to establish protocols related to quality of service. As proposed and outlined by the author (Upadhyaya, et al) of the current paper, the new “Innovative Model” takes into consideration the foundational standards for QoE as identified and established in the SERVQUAL model. It merges the Cloud Computing Service (CCS) attributes which analyze the major quality variables recommended by NIST,USA. This would ensure the QoS of cloud computing applications, as well as the functional & runtime layer’s quality indicators & variables, which are critical as user level quality indicators to ensure the QoS of the functional requirements and operations of the cloud computing services. Certain demographic attributes of the user are also taken into consideration as they play an important role in how the user accesses any online service, thus helping in the correct assessment of the quality of experience from users’ point of view as depicted in the figure below.

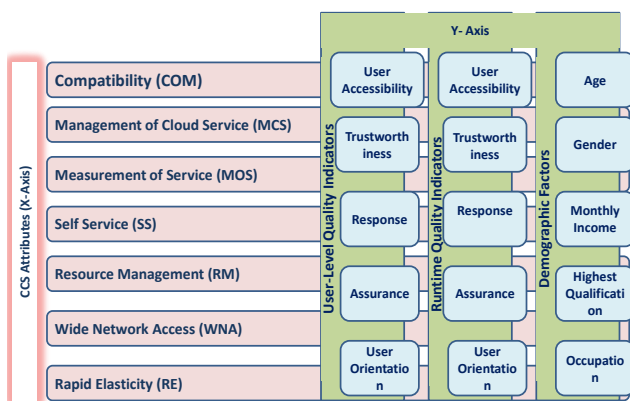


Figure 2. Proposed Innovative User-Centric QoE Model

III. RESEARCH QUESTIONS AND HYPOTHESES RECAP

Research questions and hypotheses related to student survey had been already formulated and followed as stated in Upadhyaya and Ahuja, 2017.

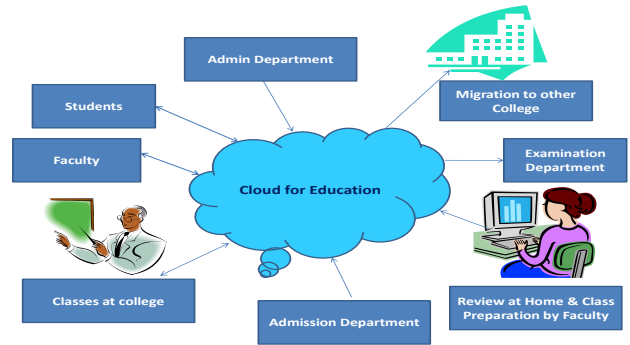


Figure 3: Cloud Computing in Higher Education Systems

Research Questions: To approach our hypotheses, the following questions were addressed during the current study that help approach how to develop a conceptual Quality of Service (QoS) metrics prototype model. This would help identify the quality defining metrics and their relationship to evaluate them through a real time case study for different quality attributes for cloud computing applications with emphasis on online learning in higher education sector. First, the variables that are related to providing quality of service in cloud computing applications and services to improve and standardize the quality of service and experience from the users’ perspective were identified. Second, a detailed inventory was obtained of metrics and processes for quantification of selected variables which emphasize on quality of experience of cloud computing applications in online learning. Finally, all results were analyzed to help design a quality of service computing framework and further develop it into a prototype conceptual model. In continuation of the previously reported work, the hypotheses formulated was tested using extensive survey questionnaire instrument that included “students” as the end users of cloud computing services rendered for higher education. To find out if the hypotheses was true or not, data was subjected to ANOVA statistical analysis to reach the conclusion.

IV. DATA COLLECTION AND ANALYSIS TOOLS

National and international students at higher education level are now exposed to different level of cloud computing services. Our survey was based on their daily interaction which included admissions online form and data submission (which was then analyzed by cloud service software to assign admission to specific degree program), use of google doc (which is used for assignments, communication projects and exams and marks visualization before the hard copy is obtained by student). Data was obtained from survey from higher education centers in India and USA via email correspondence. The survey entry values from each section (5 in expectation and 5 in experience of QoS) of questions were averaged and made to whole numerical value to be analyzed by ANOVA. Students which are the end users belonged to either to Bachelors (India) /undergraduate

(USA), Master or Ph.D. degree programs that were included in this study. The survey questionnaire was sent to the University administration who emailed it to its faculties and students who then volunteered to respond to this survey

for QoS. The institutions selected were ranked the top most in academics and regarded to keep the system updated with technological infrastructure requirements.

Table 1 shows ANOVA analysis

Table 1: ANOVA Results of Survey data conducted in 2018 for the variables (the number N=5 or 6 as mentioned) form College level students from Indian and USA Universities. The variables were subjected to statistical analysis at 95% Confidence level, with df = 1, to find which is significant (when p<.05) that would help build the QoS model for use of CC in higher education recommendation (df = degree of freedom).

Variables	Mean		Standard Deviation		SS (Sum of Squares bet. two Univ users)	F	P	Result Not Significant Or significant Atp <.05
(i) Expectations of Quality of Service								
	Indian Univ User	USA Univ User	Indian Univ User	USA Univ User				
-on tangibles (n=6)	5.66	6.0	1.60	2.44	2.08	0.49	0.48638	Not significant
-on Assurance (n=6)	6.33	6.89	0.52	0.41	0.75	3.46	0.924	Not significant
-on Responsiveness (n=6)	4.83	6.83	1.72	0.41	12.0	7.66	0.0198	Significant
-on Reliability (n=5)	6.33	6.6	0.82	0.52	0.33	0.714	0.417	Not significant
-on Empathy (n=5)	2.4	6.2	1.14	0.84	36.1	36.1	0.00032	Significant
ii) Experience of Quality of Service								
-on tangibles (n=6)	3	5.5	0.63	1.05	18.75	25	0.000537	Significant
-on Assurance (n=6)	2	6.33	1.27	0.52	56.33	60.35	0.000015	Significant
-on Responsiveness (n=6)	1.66	6.83	0.512	0.41	80.08	369.6	0.00001	Significant
-on Reliability (n=5)	2	6.4	0.707	0.54	48.4	121	0.00001	Significant
-on Empathy (n=5)	1.8	6.8	0.44	0.45	62.5	312.5	0.00001	Significant

Data was collected by surveying students, faculties from Mumbai Pharmacy Colleges and Banaras Hindu University (B.H.U.). However, it was observed during the interview that google docs is currently the most common IaaS platform for submission of assignments and including exam paper submission to evaluation among the student and Professors users at Colleges.

In order to understand the gender diversity, the comparison was made with USA University depicting the statistics.

V. RESULTS AND HYPOTHESES PROVED

Demographics of the survey conducted for higher education of QoS

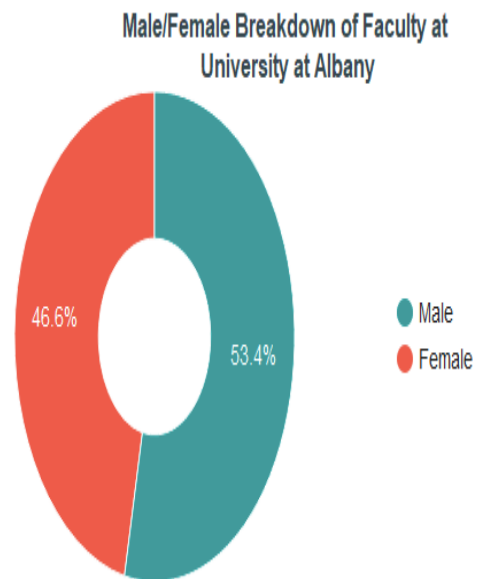
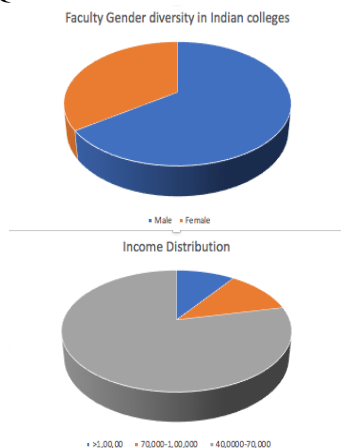


Figure 4: Shows distribution of Gender and income of faculty in Indian higher education taken as average number from the colleges that responded to survey. The male faculty were overall higher in number.



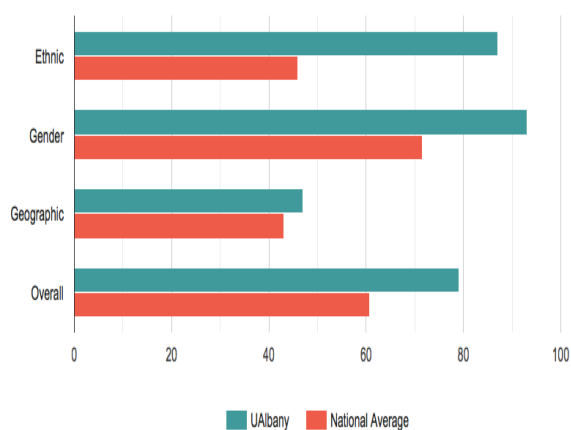


Figure 5: Demographic statistics of American University: Shown on left is the SUNY faculty gender diversity while on right is comparison made with the US demographics. (Ref: University of Albany overall Diversity score. <https://www.collegefactual.com>. Accessed in Dec 2018.

Most of the demographic studies show prevalence of males vs. female users.

We observed in this study that Quality of Experience on tangibles and assurance variables were not significantly related with that of USA end user data, meaning there is no difference in expectation of student population between Indian and USA universities as to this area of QoE.

VI. CONCLUSION

Report from UGC show that there are approximately 700 Indian Higher Education Degree-granting institutions and 35,500 affiliated colleges, with 20 million student enrollment which is and 110% growth in this sector in last decade. To improve towards excellence for global ranking of Indian institutions needs investments in educational infrastructure together with overcoming bureaucratic hurdles. This study, which analyzed that expectation in QoS responsiveness and empathy showed significant difference between the students of Indian and USA universities, meaning there was differences between the services that students and faculties encounter during its use. This is likely due to difference in resources available to support the infrastructure. As of now currently to solve QoS service problems in Indian environment of higher education, it appears that it is still preparing the resources to be at the international level (Choudaha, 2017).

However, the significant value in results as observed in table1, for two user population pursuing higher studies for the experience of QoS indicates that it needs extensive remodeling at the administrative level supported by financial backup to match the international levels of QoS quality. The migration from traditional system towards CC would enable the higher education institutions to cope with rapidly changing software and hardware needs at lower cost. It would help to standardize and update the educational content, and help enhanced collaboration between higher education institutes (Pardeshi, 2014).

Thus, there need to be set indicators for comparing performance and availability versus service level

agreements (SLA), utilization, as well as costs. Service Quality is one of the reasons cited by learning institutions for not shifting to cloud computing. They argue that the SLAs stipulated by the providers of cloud services are insufficient when it comes to guarantying performance, availability, as well as scalability. Thus, without adequate guarantee, institutions of higher learning shy away from adopting cloud computing in running their operations. (Almajalid, 2017).

Further, a better supportive infrastructure for Indian Universities and colleges end users will help to overcome the observed in QoS expectation to experience ratio. Likely this can therefore be the tool and model to evaluate the QoS service experience for end users at higher educational level.

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