# EVALUATION MECHANISM FOR SERVICE QUALITY OF CLOUD COMPUTING BASED ON ITIL

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## ABSTRACT

This study used the ITIL as the framework to develop a mechanism for evaluating the Cloud computing service quality. Through literature review and Delphi expert survey, this study confirmed 44 measurement items of Cloud computing service. Finally, the proposed evaluation mechanism was assessed by using the AHP method to determine the weights of different Cloud computing services in various modules, processes and items. The research findings can help Cloud computing service providers to measure their service quality, and ensure the user satisfaction on Cloud computing service quality. The findings can also provide Cloud service users with a reference in the evaluation and selection of different types of Cloud computing services.

## INTRODUCTION

The development of Cloud computing has attracted wide attention in the academia. Studies have pointed out that Cloud computing is expected to grow rapidly in the future. Gartner [5] predicted the Cloud computing market to reach150 billion USD in 2013, and 80% of the Fortune Top 1000 companies will adopt Cloud computing in 2012. Gallotti, Bigliani, Semernya, and Isernhagen [3], the research fellows of the U.S. International Data Corporation (IDC) predicted that the Cloud computing market in Asian countries, excluding Japan, will grow at an annual rate of 40% before 2014. The global Cloud computing market is expected to soar from 21 billion USD in 2010 to 73 billion USD in 2015 [8]. It is apparent that Cloud computing is service-oriented. Hence, there is urgent demand of the suppliers on the Cloud computing service quality evaluation mechanism, which can satisfy the customer demands on service quality (Quality of Service, QoS), and realize SLA (Service Level Agreement). Moreover, from the user perspective, the evaluation mechanism can provide the basis for selecting the Cloud computing service and the criteria of service measurement [4].

According to Chen, Srivastava and Sorenson et al. [2], even successful SaaS (Software as a Service) applications, such as Salesforce.com and Google Apps, have been successfully developed, tools and mechanisms in support of organizational evaluation and planning of SasS quality have not been widely

used. On the basis of the maturity model, to construct a community platform to evaluate Cloud computing service quality [11] has not been widely supported because of the limitation of the platform database list. Garg et al. [4] used the SMI (service measurement index) established by the international CSMIC (Cloud Service Measurement Index Consortium), and proposed the Cloud service measurement index architecture (SMI Cloud architecture). The architecture was used to establish the basic IaaS provider selection indicators and the priority sequence of the indicators. Dubey and Agrawal [10], from the perspective of the Cloud computing service system, proposed two algorithms to find the optimal route of the service and arrange service procedure, in order to satisfy QoS. The most widely used and accepted IT service management mechanism in the world is ITIL (Information Technology Infrastructure Library), which provides the optimal architecture and guiding principles of IT service management [1]. Based on ITIL, this paper proposes a mechanism for measuring the quality of three types of Cloud computing services. It attempts to comprehensively discuss the key indicators for measuring the Cloud computing service quality, construct the ITIL-based Cloud computing service quality evaluation mechanism, and validate the proposed Cloud computing service quality evaluation mechanism through the Analytic Hierarchy Process (AHP).

## LITERATURE REVIEW

### Cloud computing service and ITIL

Cloud computing services can be divided into three models: SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service). SaaS is a service that allows enterprises to rent application software. Through the SaaS service platform, enterprise can set the desired functions and relevant database, while software and hardware maintenance is provided by the SaaS service providers. PaaS is a service-type mainframe platform or virtual solution set. Users do not need to install the mainframe and operating system, but rent the virtual mainframe platform provided by the PaaS service through the network. IaaS turns the IT infrastructure into a service, and the IaaS providers construct the IT architecture for the enterprises [9].

ITIL not only provides the best architecture and guiding principles for IT service management, but is also the most widely applied and accepted IT service management mechanism in the world [1]. ITIL is an IT service management method developed by the British OGC (Office of Government Commerce). It mainly describes the best practice of IT service management based on process management, and emphasizes IT service and the maintenance of information systems, in order to enhance the business performance by process improvement and management tools. Since ITIL emphasizes that the modularized information management practice is suitable for all information organization, IT personnel not only consider from the technological perspective, but also combine the commercial purposes, thus proving the value of the IT organization to the enterprise. In the mid and late 1980s, OGC proposed ITIL 1.0, which is a manual that covers more than 40 IT service management systems with 26 modules. By 2004, as the enterprises continuously improved the service model, ITIL1.0 was updated. The main dimensions were modularized and ITIL 1.0 was condensed into the ITIL2.0 of eight core manuals. The ITIL3.0 launched in 2007 added the service life management cycle. This study summarized the information service process standardization import guidelines proposed by Brewster et al. [1] and the Research, Development and Evaluation Commission of the Executive Yuan, totaling five modules and 25 processes.

### Service quality management measurement mechanism

The concept of “quality” is concerned by enterprises, academia and government. Parasuraman, Zeithaml and Berry [15] proposed the PZB model, providing a relatively complete concept of service quality. The model suggests that customer is the decision-maker of service quality, and service quality is generated from the gap between customer expectations and perceptions of the service. In order to satisfy customer demands, the enterprises need to shorten the five gaps, including Consumer Expectation–Management Perception (Gap1), Management Perception–Service Quality Specification (Gap2), Service Quality Specification - Service Delivery (Gap3), Service Delivery-External Communication (Gap4), and Consumer Expectation-Perception (Gap 5). The function relationship of the five gaps is: Gap5=f(Gap1,Gap2,Gap3,Gap4).

Parasuraman et al. [15] conducted in-depth interviews in four service industries, including the electronics repair, banking, securities brokerage and credit card service industries, and summarized 10 measurement dimensions and 97 measurement items. By adding samples of the long-distance telephone company, Parasuraman et al. [16] further redesigned the scale to simplify the 10 dimensions into 5 dimensions, which include 22 measurement items. The research findings are widely studied and applied in service quality tool, the SERVQUAL scale. However, some studies have argued that the SERVQUAL scale should be adjusted for different industries, and the concept of customer satisfaction has the problem of difficulty in categorization [19].

In response to the debates over the SERVQUAL, Parasuraman et al. [17] used the samples from two banks, one telephone repair company, and two insurance companies for analysis, and produced the modified SERVQUAL scale. The suggestions for the use of the scale include: 1) specific question items can be added into the SERVQUAL scale, but the meanings should be the same as the original items; 2) the SERVQUAL is the basic architecture of measurement service quality, and it can be slightly modified according to the characteristics of specific industries; however, all dimensions and items should have equal emphasis; 3) the SERVQUAL should be used along with other qualitative and quantitative research to find out the real cause of gap, in order maximize the effectiveness of the SERVQUAL.

## RESEARCH METHOD

The research process architecture established by Gowin's Vee model [6] [12] [13] [14]. This study constructed the prototype to measure the Cloud computing service quality. For empirical study, this study used the Delphi expert questionnaire to collect expert opinions, in order to ensure and improve the content validity of the measurement dimensions and items. The CVR (Content Validity Ratio) method and validation process proposed by Lawshe [10] were adopted to screen the measurement dimensions and item indicators, and further extract items suitable for measuring the Cloud computing service quality. Finally, AHP was conducted to confirm the relative weights of the measurement items, and the Cloud computing service quality evaluation mechanism for different types of Cloud service was constructed.

## THE DEVELOPMENT, MODIFICATION AND EMPIRICAL STUDY OF THE ITIL-BASED CLOUD COMPUTING SERVICE QUALITY EVALUATION MECHANISM PROTOTYPE

This study used the Delphi method [7] to test the rationality of the Cloud computing service quality measurement prototype, and acquire expert consensus. The Delphi expert selection principle involves work content, as well as Cloud computing service or information quality evaluation. The Delphi expert panel of this study was consisted of 14 experts, among which 7 experts are employees of the Cloud computing service providers with more than two years of working experience, while the other 7 experts have experience in information service evaluation. The main purpose of the Delphi expert survey is to

confirm the items suitable for measuring the Cloud computing service quality, and verify whether evaluation items are correctly categorized to ITIL V3 modules and processes. Therefore, the questionnaire design is based on logic judgment, and blank space is provided for experts to offer suggestions.

**Research prototype development**

First, the measurement items of relevant scales, including SERVQUAL, IS-SERVQUAL, E-Qual 4.0, E-S-Qual and E-RecS-Qual, are summarized to develop the prototype of ITIL architecture. The items of the above scales are numbered as SQ1~22, ISQ1~22, EQ1~23, ESQ1~22, ERQ1~11, respectively. After generalizing the items relating to the concept of Cloud computing service quality into the procedures of ITIL V3, the prototype of the evaluation mechanism was constructed for measuring the Cloud computing service quality. The prototype included 5 modules and 19 processes of the ITIL V3 information service life cycle. This study summarized 51 items and renumbered those items.

**Modify research prototype by using the Delphi method**

After the two rounds of Delphi expert surveys, the experts were invited for discussion and opinions. The CVR and interquartile range was used to modify the questionnaire to obtain 5 modules, 19 relevant processes, and 44 items. The prototype of the quality evaluation mechanism of the ITIL-based Cloud computing service thus became the ITIL-based Cloud computing service quality evaluation mechanism with face validity and content validity.

**Weight distribution of the ITIL-based Cloud computing service quality evaluation mechanism**

AHP can respond to and compromise the advantages and disadvantages of different projects on major influencing factors. Scientific methods were adopted to form the basis for decision making [18].

(1) AHP results of Cloud computing service SaaS

Regarding the analysis on the responses of SaaS users, the overall C.I. (Over Inconsistency) is 0.01, suggesting that the responses of SaaS users to the AHP questionnaire is generally good. The weight of the service strategy module is 0.156 (C.R.=0.000, C.R.= C.I./R.I.= 0/0.9), that of the service design module is 0.193 (C.R.=0.006, C.I./R.I.= 0.01/1.59), that of the service transition module is 0.163(C.R.=0.000, C.I./R.I.= 0/1.49), that of the service maintenance and operation module is 0.223(C.R.=0.006, C.I./R.I.= 0.01/1.48), and that of the continuous service improvement module is 0.264(C.R.=0.000, C.I./R.I.= 0/0.58). As seen from the C.R. and C.I. values of the 5 modules that all of the modules have passed the consistency test. Moreover, regarding the relative weights of the 5 modules, SaaS users emphasized more on the continuous service improvement module and the service maintenance and operation module.

(2) AHP results of Cloud computing service PaaS

Regarding the analysis on the responses of PaaS users, the overall C.I. (Over Inconsistency) is 0.09, suggesting that PaaS users have good overall consistency in response to the AHP questionnaires. The weight of the service strategy module is 0.37(C.R.=0.09, C.I. =0.08), that of the service design module is 0.22(C.R.=0.10, C.I. =0.17), that of the service transition module is 0.12 (C.R.=0.00, C.I. =0.00), that of the service maintenance and operation module is 0.15(C.R.=0.01, C.I. =0.02), and that of the continuous

service improvement module is 0.14(C.R=0.03, C.I. =0.02). The C.R. and C.I. values of the 5 modules suggest that all the modules have passed the consistency test. Moreover, from the perspective of weight, the addition of the weights of the service strategy module and service design module is close to 0.60, suggesting that PaaS users are considerably concerned about the two modules.

(3) AHP results of Cloud computing service IaaS

In the analysis of the responses of IaaS users, the overall C.I. (Over Inconsistency) is 0.06, suggesting that the responses of IaaS users are relatively consistent. The weight of the service strategy module is 0.053(C.R.=0.089, C.I. =0.08), that of the service design module is 0.132(C.R.=0.082, C.I. =0.13), that of the service transition module is 0.107(C.R.=0.047, C.I. =0.07), that of the service maintenance and operation module is 0.172(C.R.=0.054, C.I. =0.08), and that of the continuous service improvement module is 0.537(C.R.=0.00, C.I. =0.00). The C.R. and C.I. values of the 5 modules suggested that the 5 modules have passed the consistency test. Moreover, from the perspective of weight, IaaS users are more concerned about the continuous service improvement module, as compared to other four modules. On the contrary, the weight of the service strategy module is far lower than the other four modules.

## CONCLUSION

The models of service quality measurement in past literature overly focus on the perception of service or customer satisfaction. Moreover, as market size of Cloud computing grows and the demands of Fortune Top 1000 enterprises [5] increase, the tools and mechanisms that can support the evaluation and planning of the Cloud computing service quality by support organization or personnel are yet to be developed. There are no mechanisms for users to select Cloud computing service that meets their needs, or for service providers to improve service quality. This study constructed and empirically tested an evaluation mechanism for Cloud computing service quality, thus providing a feasible evaluation mechanism for both service providers and users. ITIL is an IT service management tool, and provides IT service guidance and the best practice descriptions.

Service can realize the value for the enterprise. Through Cloud computing service, enterprises can reduce information service construction cost, thus focusing on their core business to improve efficiency and competitiveness. Based on literature review, this study summarized service quality items of the Cloud computing service providers and provided a comprehensive consideration to the Cloud computing service providers. Hence, the service quality of Cloud computing providers can be effectively evaluated to avoid their bias or lack of the evaluation dimensions in service quality. Moreover, this study provided follow-up researchers a basis for the reference indicators. The findings of this study offer a measurement method for the Cloud computing providers to measure service quality, thus ensuring the satisfaction of the user demand and improving Cloud computing service. They can also be a standard for Cloud computing service users in the selection and adoption of Cloud computing providers.

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