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# Improvement of Security and Trustworthiness in Cloud Computing using Fuzzy Logic

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**Abstract -** *The rapid development in the fields of IT sector, science & technology & cloud computing services plays very crucial character in an organization. The profit of having these methods increases the use of organizational services. Computing upon cloud has become an evolving scenario which is an outcome of programming, databases together with the communication networks & internet. There are several no. of sectors or organizations that give impart several type of services to customers in organizing & improving information systems via cloud. CS are affordable in every aspect as regards the cost, infrastructure, operation & processing are concerned. This paper discusses the QoCS & Cost grounded services of cloud Framework based upon the Fuzzy Logic. This is completely a trustworthiness framework which helps in analyzing any cloud services in detail with multidimensional perspectives. It specifically analyses the cloud services model of trustworthiness by using a set of parameter as Response Time, Cost, Security, and Throughput & Speedup-Ratio. These parameters are collectively known as QoCS parameters. The framework is created upon parameter of finance as a chief representative for selection of Cloud Services. Practical results show that the model improves the QoCS as well as assist the customer in making decision about the choice of services with cloud based upon their financial constraints from among the different cloud services providers for the common type of services.*

***Key Words***: Quality of Cloud Service (QoCS), Measurement of Trustworthiness, Cost, Selection of Cloud Services, Fuzzy etc.

## 1. INTRODUCTION TO CLOUD COMPUTING

National Institute of Standards of Technology (NIST) has elaborated the cloud computing as a prototype for providing configurable computing resources that are convenient & have on-demand network access (Example Networks, Services Storage, Servers, and Applications) which are speedily authorized & are out with negligible management efforts or services provider interactions. Here in cloud services the application & data are sustained by the application of central remote servers & internet and provides platform to the end users to use the applications with no need of installing it. This service too allows the users to gain access to their files remotely even if they don't possess their personal laptops and computers. These services include Yahoo, Hotmail, Gmail, Flipkart, Snapdeal etc. The software that maintains the emails and servers are overall managed by the CSP Google, Yahoo and are total on cloud. Cloud Computing ensures the security of the information as well as client. The information can't be shared with anyone else's input. Thus the computing distributed over the large scale stores the information in a cloud framework. Number of organizations support the computing at distributed stages; some are IBM, VMware, Microsoft, Amazon, Google etc. The common element of these have been done by cloud computing; despite the truth that the distributed computing has numerous advantages but still the questions related to the security and protection concerns are major concern.

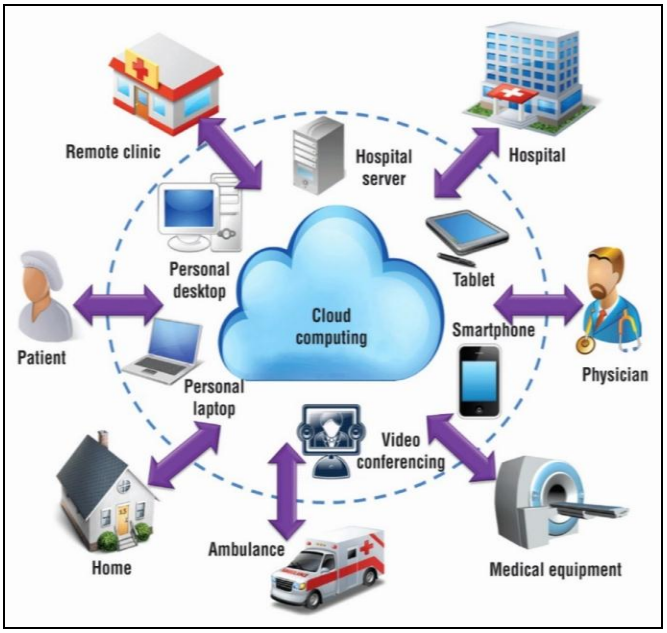


**Fig -1**: Schematic Representation of Cloud Computing

We have proposed a CSTM model that can be used as a benchmark for trustworthiness evaluation of cloud services. Cloud Services are deeply affected by the trustworthiness to a larger extent. The model dealt in the research has 5 parameters for the output i.e. trustworthiness. These parameters are Cost, Throughput, Speedup-Ratio, Security

and Response Time. Dynamic trustworthiness is measured by considering the fact that value of trust for CS can change with time based upon changes in technology, end customer requirements, user's feedback etc.

The paper has been set into various sections. Section II deals with the Literature Review that is the related work, Section III offers Model Analysis & validation of the Proposed Work of CSTM model using the Fuzzy Logic Approach, Section IV has been covered with the Performance Evaluation and last but not the least the Conclusion has been dealt in the Section V.

## 2. RELATED WORK

S. Pandey & A.K Daniel defined trustworthiness of CS as a degree of confidence with which the cloud services can fulfil the set of requirements of the end users [1].
Shuai Ding et al. stated offline evaluation condition according to time consuming and price cloud requirement development. Thus, the idea that various trustworthiness [6].

Assessment difficulties need not be the only objective calculated if else also theoretical reception, the paper tries to develop a novel background called CS Trust for implementing trustworthiness of the cloud services; assessment via mixing quality of assessment observed and consumer satisfied calculated data. The stated system observed that to increase the efficiency of Quality of assessment value observed on calculated reliability characteristics, also how to compute the consumer gratification of goal cloud service through consuming benefits of the Thoughtfulness qualities on measured gratification. The stated approaches are satisfied through Simulink diagrams., review of that CSTrust can efficiently object analysis data and remove evaluative outputs of reliabilities on the details the might be evaluated along with subjective calculation and subjective thoughtfulness, we have seen that the cloud service reliabilities calculations systems via joining multiple measured data. To increase the effectiveness of QoS analysis, he uses foundation factor to diminishes the characteristics of unknown national's difference calculation, and showed the exactness assess to find natives records have been take to analysis lost QoS value. Our objective hazels analysis the consumer satisfaction computation method for analysis qualitative gratification.

Afnan Bawazira et al. implemented the Service Oriented Computing (SOC) are accomplished & relief via the initiative application request growth and distributed computing. The three basic interacting mechanism in SOC are service supplier, service requesters and archives. One of the difficulties that comes the sender when select a service is to allocate the reliability service which trustworthiness and serves the sender and supplier. This is due to the increasing number of services in registries. Thus, there is a need for a ranking situation which takes into version both the opulent textures and the context of facility receivers and senders, in sequence to increase the usage of a top-ranking outputs.
We have presented a generic system for texturing and ranking reliability context supplement facilities. By uses logic and set theory, we providing a formal requirement for texturing along with ranking services that are reliability and context-supplementary uses the formal requirement, the case analysis classify the energy of the included data and the skills of our method framework to be using in forever various varieties of uses that can be transformed to various programming languages [7].

Hua Maa et al. presented the design of a novel system & named it as CSTrust while presenting the trustworthiness analysis by combining the QoS for costing & consumer requirement estimate. The framework of the technique tells how to increase the exactness of the QoS rates forecast while measuring the trustworthy qualities and how to estimate the consumer fulfilment of goal. The presented trends have been authenticated by the implementation, representative which state that the CSTrust can efficiently forecast the valuation information & discharge evaluation outputs of trustworthiness. The reliability of the cloud services assessment system by mixing multiple -source valuation information. To increase the exactness of QoS forecast, methodology explains the use of organization factor to decrease the effect of adverse neighbors in comparison to computation, accessing the closeness of parameter to find how the records of the various neighbors are working adopted to forecast absent QoS value. The methodology has also revealed the satisfaction of consumer for measuring the qualitative attribute [8].

Deutsch described trust as "self-assurance that a separate will, what is wanted from additional in instead what is dreaded" [9]. Diego Gambetta described trust as "a specific level of the particular likelihood with which a mediator measures that additional mediator or collection of mediators will performed a specific act, together before he can screen such ac (or self- sufficiently of his volume ever to be able to screen it) and in a setting in which it moves his individual act" [10].

## 3. PRELIMINARIES

### 3.1 Security

Security is a vital property which comes to picture when it comes to save critical data of the company on the cloud. The cloud security is a set of technology based upon the cloud together with the policies designed to adverse the rules of the regulatory compliance to protect the data together with application and infrastructure associated with use of CC.

### 3.2 Response Time

It denotes total performance of CS with an easy means. It expounds how speedily the CS can be presented for being used. Average time for response can be found by sending request by a user *x* to the cloud till the response message is received from the server request. Maximum RT is the time taken by CS to process the request. Response of time-out is designated in value of percentage where responses of CS is greater than maximum promised RT.

PTOR (percentage) = (No. of Request Timed Out /Total Number of Request) × 100

### 3.3 Throughput

It indicates the quantity of tasks that have been completed by CS with a stipulated transaction processing system. It is measured in transactions per seconds.

### 3.4 Speedup

It is well-defined as the magnitude of difference b/w avg. processing time of s/y & cloud network. This ratio denotes speed of encryption for a given time. This illustrates the time that how speedily can a data be encrypted. This gives the clue about speed of encryption.

Speedup = Processing Time in Local – Processing Time in Cloud

### 3.5 Cost

The cost is the prime decision factor for any cloud service. In the present scenario the end user only pays only for what they use. The usage depends upon the 2 simple properties i.e. acquisition & on-demand. The cast characteristically uses SaaS. This requires the sign in to service webpage in a week or in a month for billing amount other than current ongoing prices & is the supreme common pricing model for computing service. That has been termed utility pricing, since payment to service providers are based on number of used units.

## 4. IMPLEMENTATION

### 4.1 Investigation & Authentication with Fuzzy Logic

Here, Fuzzy Assessment prototype that can reasonably estimate trustworthiness of any CS [14] [15]. Each constraint or parameter have their own set of sub parameter to be defined accurately. The parameters have been defined as Response Time, Speedup-Ratio, Security, Throughput, and Cost.

$$P = \{R_1, R2, R3, R4, R5\}$$

Now, the 1st grade index is Pi (i = 1, 2… 5) & 2nd Grade Indexes, Ki can be illustrated as:

Pi = {Ri1, Ri2… Rij} for i= 1, 2…5 & j= 1, 2… ki

Here, Rij is jth 2nd Grade Index of parameter Ri

### 4.2 Determination the Weightiness Distribution

Various CS(s) have diverse requirement of each military, space & aerospace systems for security [13]. Thus, specialists are required so, experts are required to decide the weightage for each parameter as per the level of importance.

Let us assume $\mathbf{w_i}$ = weight for $P_i$ & 1st Grade Weight set is:

$$W = \{w_1, w_2, w_3, w_4, w_5\}$$

$$\sum_{i=1}^{5} w_i = 1$$

Let,

$W_{ij}$ (i = 1, 2…5 & j = 1, 2…Wi) be weight of $P_{ij}$ & 2nd Grade Weight set is:

$$W_i = \{W_{i1}, W_{i2}.....Wij\} \qquad 0 \le W_{ij} \le 1$$

Now, for ∀ *i*= (i= 1, 2….5),

$$\sum_{j=1}^{5} w_{ij} = 1$$

### 4.3 Determine the Result Grading

There are subset parameters of various different parameters & thus they are calculated on the basis of quality and quantity. Here, we have used skilled assessment technique to associate 2 quantities. Every assessment result has been distributed in 5 levels:

L= {VH, H, M, L, and VL} where

VH stands for Very High

H stands for High

M stands for Medium

L stands for Low

VL stands for Very Low

whereas

L= {LV1, LV2, LV3, LV4, LV5} & $L_m$ where m=1,2,3,4,5 is the $m^{th}$ level.

### 4.4 Evaluation Matrix

Membership Degree has been denoted as

$$(a_{ij1}, a_{ij2}, a_{ij3}, a_{ij4}, a_{ij5})$$

The Assessment Result for $K_i$ Factor Can Be Represented by $K_i$×5 Order of Fuzzy Matrix Fi ∀ I =1,2,3,4,5

$$Fi = \begin{bmatrix} a_{i11} & a_{i12} & a_{i13} & a_{i14} & a_{i15} \\ a_{i21} & a_{i22} & a_{i23} & a_{i24} & a_{i25} \\ a_{i31} & a_{i32} & a_{i33} & a_{i34} & a_{i35} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{iki1} & a_{iki2} & a_{iki2} & a_{iki3} & a_{iki3} \end{bmatrix}$$

Here, Fi signifies membership degree for each sub constraint or parameter $P_i$ for CS in specified trustworthy level.
$F_i$ stands for only element assessment matrix for fuzzy assessment of 1st grade index of $P_i$ & $d_{ijm}$ is membership degree of sub constraint $P_{ij}$ for grade m. As the weightage for $K_i$ is determinant, as the weight set $K_i$ is determinant, fuzzy assessment array for 1st grade index for $P_i$ & has been calculated by Min-Max composition as:

"X to Y" is a Fuzzy Relation denoted by Wi
"Y to Z" is a Fuzzy Relation denoted by Fi
WioFi, is fuzzy relation from "X to Z" and is expressed as:

$$Qi = Wi \circ Fi \text{ ™ } d_{wi} \circ Fi(x, z)$$

$$Qi = \check{}y \{d_{wi} \quad (x, y) \hat{} dFi(y, z)\}$$

Min-Max composition states ^ has been used to denotes Maximum & ᵛ has been used to denote the Minimum [16] Further, applying the various Fuzzy Operations for CS(s), $B_i$ is Fuzzy Assessment Matrix for the 1st Grade index.

$$\begin{bmatrix} w_{i1} & w_{i2} & w_{i3} & \cdots & w_{iki} \end{bmatrix} \times \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{iki1} & a_{iki2} & a_{iki3} & a_{iki4} & a_{iki5} \end{bmatrix}$$

After composition operation of Min-Max, resultant membership degree of parameter Ri is:

$$Q_i = \begin{bmatrix} q_{i1} & q_{i2} & q_{i3} & q_{i4} & q_{i5} \end{bmatrix}$$

The resultant matrix Bi will be a matrix of size 1×5 [(1×ki) × (ki×5)].

Bi is computed for every parameter of the cloud service.
"Qi" denotes membership degree of the attribute Ai for CS in specified trustworthiness levels. Computation at the parameter level results into the better assessment for trustworthiness. Results may represent which parameter is specifically responsible for lower value of trustworthiness.

### 4.5 Fuzzy Comprehensive Evaluation Model

We have executed subsequent calculations for assessing the overall trustworthiness membership degree of CS in predefined levels:

$$F = \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \\ Q_5 \end{bmatrix} = \begin{bmatrix} W_1 & O & F_1 \\ W_2 & O & F_2 \\ W_3 & O & F_3 \\ W_4 & O & F_4 \\ W_5 & O & F_5 \end{bmatrix}$$

"F" stands for single factor assessment matrix for assessing, entails fuzzy assessment matrix of 1st grade index $Q_i$ (i=1, 2, 3, 4, 5).

$$F = \begin{bmatrix} q_{11} & q_{12} & q_{13} & q_{14} & q_{15} \\ q_{21} & q_{22} & q_{23} & q_{24} & q_{25} \\ q_{31} & q_{32} & q_{33} & q_{34} & q_{35} \\ q_{41} & q_{42} & q_{43} & q_{44} & q_{45} \\ q_{51} & q_{52} & q_{53} & q_{54} & q_{55} \end{bmatrix}$$

Further, 2nd fuzzy assessment set can be computed as:

$$Q = W \times F$$

$$B = \begin{bmatrix} W_1 & W_2 & W_3 & W_4 & W_5 \end{bmatrix} \circ \begin{bmatrix} q_{11} & q_{12} & q_{13} & q_{14} & q_{15} \\ q_{21} & q_{22} & q_{23} & q_{24} & q_{25} \\ q_{31} & q_{32} & q_{33} & q_{34} & q_{35} \\ q_{41} & q_{42} & q_{43} & q_{44} & q_{45} \\ q_{51} & q_{52} & q_{53} & q_{54} & q_{55} \end{bmatrix}$$

Applying Min-Max composition

$$Q = \begin{bmatrix} q_1 & q_2 & q_3 & q_4 & q_5 \end{bmatrix}$$

Here, B shows the membership degree for overall CS in a specified trustworthiness.

### 4.6 Proposed Algorithm

**Step1.** Set the five parameter Security, Response-Time, Speedup, Throughput and Cost.
**Step2**. Model Analysis using a Fuzzy Logic.
**Step3.** Check of the weight distribution.
**Step4.** Determine the result grading of result divide in five part levels very high, high, medium, low and very low.
**Step5.** Used a membership degree in five comment set each factor.

(aij1, aij2, aij3, aij4, aij4, aij5)

**Step6.** Using a Min-Max technique by ^ for maximum ˅ for minimum.

**Step7.** After min-max operation; resulting membership degree of constraint Pi is as

Qi = [qi1, qi2, qi3, qi4, qi5]

**Step8.** We perform fuzzy comprehensive matrix.

**Step9.** The second fuzzy compressive evaluation set may be computed as Q = W×F.

**Step10.** By using min-max composition

Q = [q1, q2, q3, q4, q5]

**Step11.** B represent membership degree for overall CS and total membership value.

**Step12.** Adding the above membership values

**Step13.** After normalization process of the final membership.

**Step14.** Represent the table form Trustworthiness levels of cloud service and its distinct parameter.

**Step15.** Table 2 Normalized trustworthiness levels of cloud service parameters and cloud service itself is also shown.

**Step16.**Table1 and Table2 that security of the.

| | | |
|---|---|---|
| Cloud service | = | low |
| Response Time | = | medium |
| Speedup | = | medium |
| Throughput | = | very high |
| Cost | = | very low |

Overall cloud service is very high.

**Step17.** Membership degree of all cloud service parameter and cloud service itself is also is prepared.

**Step18.** Normalized values are used for this bar chart.

**Step19.** Comparative trustworthiness of cloud service and security. It is illustrated that trustworthiness level of overall CS is very high.

**Step20.** Comparative trustworthiness of cloud service and Response Time.

It is illustrated that trustworthiness level of Response parameter is medium while trustworthiness overall cloud service is very high.

**Step21.** Comparative trustworthiness of cloud service and Speedup.

It has been illustrated that trustworthiness level of Speedup parameter is medium while trustworthiness overall cloud service is very high.

**Step22.** Comparative trustworthiness of cloud service and Throughput.

It has been illustrated that trustworthiness level of Throughput parameter is very high while trustworthiness overall cloud service is very high.

**Step23.** Comparative trustworthiness of cloud service and Cost.

It has been illustrated that trustworthiness level of Cost parameter is very low while trustworthiness overall cloud service is very high.

**Step24. Chart -1** depicts Normalized value are used for all the diagrams above represent the trustworthiness degree of all distinct parameter.

**Step25.** However, each parameter cannot give the VH result.

**Step26**. In 1st grade assessment result:

| | | |
|---|---|---|
| Security | = | low |
| Response time | = | medium |
| Speedup | = | very high |
| Throughput | = | very high |
| Cost | = | very low |

**Step27.** Final results are influensive by VH weight of throughput &

**Step28.** The problem correlated with security & cost are solved for improving the trustworthiness of CS.

**Step29.** Stop.

### 4.7 Performance Assessment for CSTM Model

Random experimentations have been performed for assessing the CS

Let us take,

1st Grade Weight as:

W= {w1, w2, w3, w4, w5} = {0.1, 0.2, 0.2, 0.4, 0.1}

2nd Grade Weight as:

w1 = {0.1, 0.1, 0.2, 0.3, 0.1, 0.2},

w2 = {0.08, 0.12, 0.14, 0.08, 0.12, 0.14},

w3 = {0.14, 0.14, 0.2, 0.16, 0.16, 0.2},

w4 = {0.16, 0.16, 0.14, 0.2, 0.2, 0.14} &

w5 = {0.16, 0.14, 0.16, 0.14, 0.2, 0.2}

The comment set is L = {L1, L2, L3, L4, L5}

Membership Degree of 2nd Grade Index has been taken as:

Thus, after the calculation of the values

Q1 = {0.08, 0.05, 0.12, 0.22, 0.007},

Q2 = {0.08, 0.12, 0.14, 0.08, 0.12},

Q3 = {0.16, 0.008, 0.2, 0.13, 0.001},

Q4 = {0.26, 0, 0.14, 0.2, 0.01} &

Q5 = {0.16, 0.14, 0.16, 0.14, 0.2}

$$F=\begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \\ Q_5 \end{bmatrix} = \begin{bmatrix} W_1 & O & F_1 \\ W_2 & O & F_2 \\ W_3 & O & F_3 \\ W_4 & O & F_4 \\ W_5 & O & F_5 \end{bmatrix}$$

In this, F stands for the assessment matrix of single factor that evaluates the fuzzy which consists of fuzzy assessment matrix for 1st grade Index of $Q_i$:

$$F=\begin{bmatrix} q_{11} & q_{12} & q_{13} & q_{14} & q_{15} \\ q_{21} & q_{22} & q_{23} & q_{24} & q_{25} \\ q_{31} & q_{32} & q_{33} & q_{34} & q_{35} \\ q_{41} & q_{42} & q_{43} & q_{44} & q_{45} \\ q_{51} & q_{52} & q_{53} & q_{54} & q_{55} \end{bmatrix}$$

$$Q = W \times F$$

B signifies membership grade of specified CS in different predefined trustworthiness levels.

$$Q=\begin{bmatrix} W_1 & W_2 & W_3 & W_4 & W_5 \end{bmatrix}\times \begin{bmatrix} q_{11} & q_{12} & q_{13} & q_{14} & q_{15} \\ q_{21} & q_{22} & q_{23} & q_{24} & q_{25} \\ q_{31} & q_{32} & q_{33} & q_{34} & q_{35} \\ q_{41} & q_{42} & q_{43} & q_{44} & q_{45} \\ q_{51} & q_{52} & q_{53} & q_{54} & q_{55} \end{bmatrix}$$

Later, we have calculated the value of "B" using the Min-Max composition to get membership value of trustworthiness

$$\begin{bmatrix} 0.1 & 0.2 & 0.2 & 0.4 & 0.1 \end{bmatrix}\times \begin{bmatrix} 0.08 & 0.05 & 0.12 & 0.22 & 0.007 \\ 0.08 & 0.12 & 0.14 & 0.08 & 0.12 \\ 0.16 & 0.008 & 0.2 & 0.13 & 0.001 \\ 0.26 & 0 & 0.14 & 0.2 & 0.01 \\ 0.16 & 0.14 & 0.16 & 0.14 & 0.2 \end{bmatrix}$$

$$Q = [0.26, 0.12, 0.2, 0.2, 0.12]$$

Meanwhile, B illustrates the MD i.e. membership degree for overall CS for a specific trustworthiness level; Total value of the membership for all the parameters should be 1. Therefore, summing above membership values, we can have,

$$0.26+0.12+0.2+0.2+0.12 = 0.9$$

Finally, after performing the normalization the final membership represents

$$Q = [0.2888, 0.1333, 0.2222, 0.2222, 0.1333]$$

**Table -1:** Trustworthiness levels of cloud Service and its distinct parameters

| Parameter / T Level | S | R | SR | TP | C | CS |
|---|---|---|---|---|---|---|
| VH | 0.08 | 0.08 | 0.16 | 0.26 | 0.16 | 0.26 |
| H | 0.05 | 0.12 | 0.008 | 0 | 0.14 | 0.12 |
| M | 0.12 | 0.14 | 0.2 | 0.14 | 0.16 | 0.2 |
| L | 0.22 | 0.08 | 0.13 | 0.2 | 0.14 | 0.2 |
| VL | 0.007 | 0.12 | 0.001 | 0.01 | 0.2 | 0.12 |

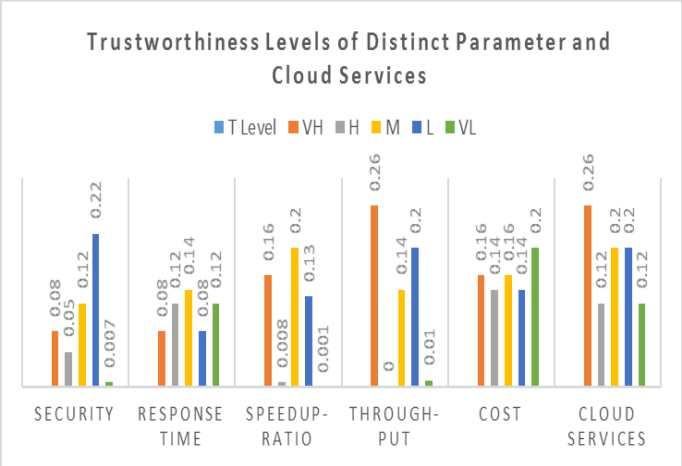


**Chart -1**: Trustworthiness Level for parameters and CS

**Table -2:** Normalized Trustworthiness Levels of cloud services its distinct Parameters

| Parameter / T Level | S | R | SR | TP | C | CS |
|---|---|---|---|---|---|---|
| VH | 0.167 | 0.15 | 0.32 | 0.433 | 0.2 | 0.29 |
| H | 0.105 | 0.22 | 0.016 | 0 | 0.175 | 0.13 |
| M | 0.252 | 0.26 | 0.4 | 0.232 | 0.2 | 0.22 |
| L | 0.461 | 0.15 | 0.26 | 0.332 | 0.175 | 0.22 |
| VL | 0.015 | 0.22 | 0.002 | 0.016 | 0.25 | 0.13 |

It can be observed from Table 1 and Table 2 that Security of the Cloud Service is Low, Response Time is Medium, Speedup is Medium, Throughput is Very High, Cost is Very Low, & the Overall Trustworthiness of the Cloud Service is Very High.

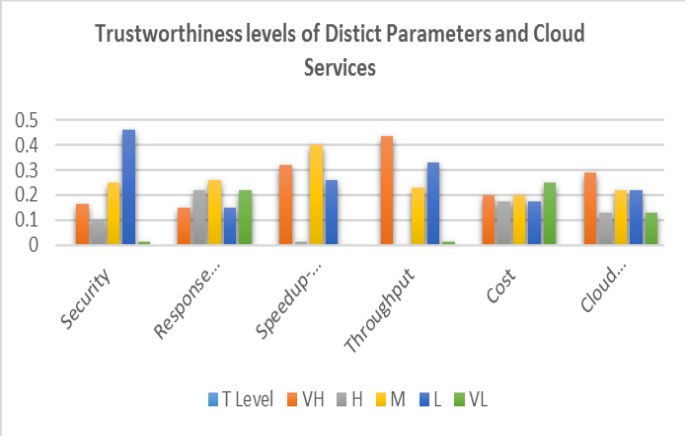


**Chart -2** Graphical Representation of Trustworthiness of cloud Service and its Distinct Parameters.

The above bar chart shows the comparative trustworthiness values of different cloud service parameters and the cloud service itself. In this diagram, membership degree for all CS parameter and cloud service itself is also shown. Normalized values are used for this bar chart.

**Table -3:** Normalized value of Security in cloud Services.

| Parameter / T Level | S | CS |
|---|---|---|
| **VH** | 0.167 | 0.29 |
| **H** | 0.105 | 0.13 |
| **M** | 0.252 | 0.22 |
| **L** | 0.461 | 0.22 |
| **VL** | 0.015 | 0.13 |

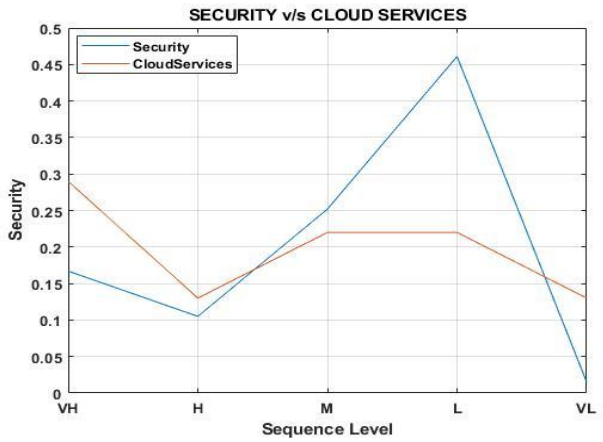


**Chart -3**: Relative Trustworthiness of Cloud Service and Security.

In the above Matlab, trustworthiness values of security parameter and the overall cloud service are compared. It is shown that trustworthiness level of security parameter is low while trustworthiness level for overall CS is very high. It indicates that the improvements required regarding the security parameter of the above mentioned cloud service.

**Table -4:** Normalized value of Response Time in cloud Services

| Parameter / T Level | RT | CS |
|---|---|---|
| **VH** | 0.167 | 0.29 |
| **H** | 0.105 | 0.13 |
| **M** | 0.252 | 0.22 |
| **L** | 0.461 | 0.22 |
| **VL** | 0.015 | 0.13 |

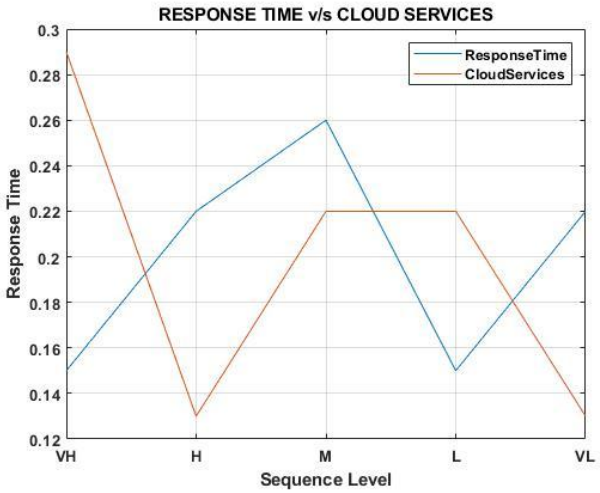


**Chart -4**: Relative Trustworthiness of RT & CS

In above Matlab plot for response time and cloud services, it can be seen that trustworthiness level of response time parameter is medium while trustworthiness level for overall CS is very high. It indicates that the budget for the required cloud service lies in medium category.

**Table -5:** Normalized value of SR & CS

| Parameter / T Level | SR | CS |
|---|---|---|
| **VH** | 0.32 | 0.29 |
| **H** | 0.016 | 0.13 |
| **M** | 0.4 | 0.22 |
| **L** | 0.26 | 0.22 |
| **VL** | 0.002 | 0.13 |

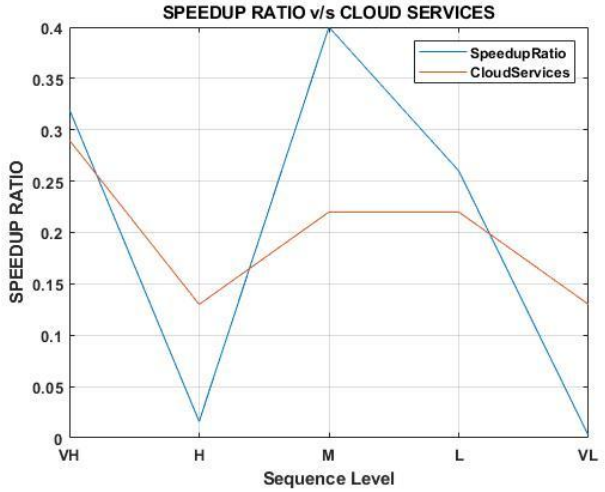


**Chart -5**: Relative Trustworthiness of Speed Ratio and Cloud Service

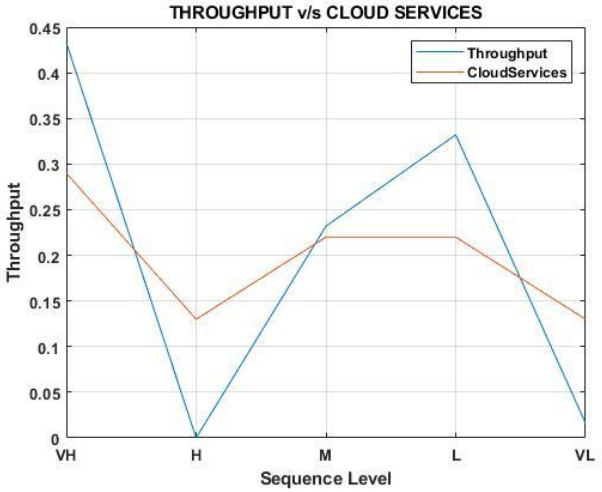


**Chart -6**: Relative Trustworthiness of Throughput and Cloud Service

In the above Matlab plot for security and cloud services, trustworthiness values of speedup Ratio parameter and the overall cloud Service are compared. It is shown that trustworthiness level of Speedup Ratio parameter is medium while trustworthiness level for overall CS is very high. It indicates that the maintainability of the overall CS lies in the medium category.

In the above Matlab plot for throughput and cloud services, trustworthiness values Throughput parameter and the overall cloud service are compared. It is shown that trustworthiness level of Throughput parameter is very high while trustworthiness level of overall CS is very high. It indicates that no such improvements required regarding the Throughput parameter of the above mentioned cloud service.

**Table -6:** Normalized Value of TP & CS

| Parameter / T Level | TP | CS |
|---|---|---|
| VH | 0.433 | 0.29 |
| H | 0 | 0.13 |
| M | 0.232 | 0.22 |
| L | 0.332 | 0.22 |
| VL | 0.002 | 0.13 |

**Table -7:** Normalized Value of Cost in Cloud Services

| Parameter / T Level | C | CS |
|---|---|---|
| VH | 0.2 | 0.29 |
| H | 0.175 | 0.13 |
| M | 0.175 | 0.22 |
| L | 0.175 | 0.22 |
| VL | 0.175 | 0.13 |

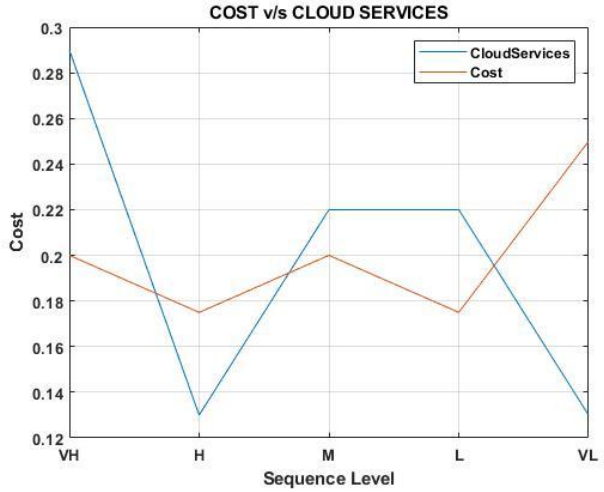


**Chart -7**: Relative Trustworthiness of Cloud Service and Cost

In the above Matlab plot for cost and cloud services, trustworthiness values of Cost parameter and the overall cloud service have been compared. It is shown that trustworthiness level of Cost parameter is very low while trustworthiness level of overall CS is very high. It indicates that the significant improvements required in the case of Cost parameter of the above mentioned cloud service.

**Table -8:** Normalized Value of Security, Response, Speedup-Ratio Throughput

| Parameter / T Level | S | RT | SR | TP |
|---|---|---|---|---|
| **VH** | 0.08 | 0.08 | 0.16 | 0.26 |
| **H** | 0.05 | 0.12 | 0.008 | 0 |
| **M** | 0.12 | 0.14 | 0.2 | 0.14 |
| **L** | 0.22 | 0.08 | 0.13 | 0.2 |
| **VL** | 0.007 | 0.12 | 0.001 | 0.01 |

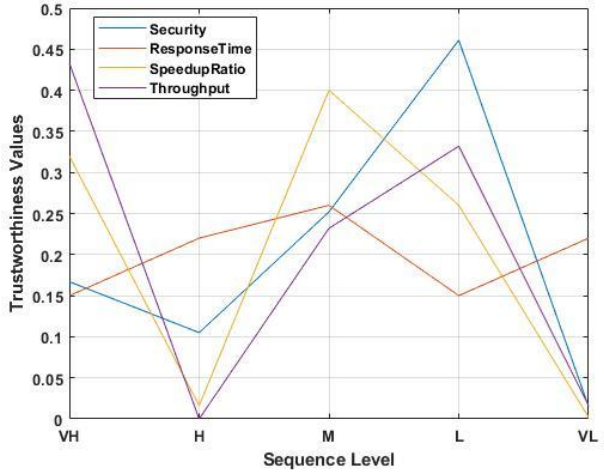


**Chart -8**: Graphical Representation of Trustworthiness & its distinct parameters

The above Matlab plot for all the factor shows the comparative trustworthiness values of different cloud service Parameters and the cloud service itself. Normalized values are used for all the diagrams shown above in Figure 2 &3. Figure 2 & 3 illustrates trustworthiness degree of every parameter in appropriate level. The overall trustworthiness of CS has also been represented. As regards the maximized membership degree principle for the level of trustworthiness of CS is Very High. Moreover, this is not sure that every parameter will get the VH value. For 1st grade assessment results, security is low, Security, Response Time, Speedup- Ratio is VH and Throughput is VL. Thus final outcome is inspired by VH weightage of Throughput & medium weightage of finance & maintainability in the assessment result, Therefore, the final result is motivated by the VH weight of. The difficulties associated to security & Throughput should be fixed specifically if the trustworthiness of the CS needs to be improved.

## 4. CONCLUSIONS

We have proposed a fuzzy mathematical model for the trustworthiness. Here, a measurement of overall CS & thus leads to five constraint trustworthiness of overall trustworthiness. This approaches can be improving better the performance of cloud services.

Due to the easy identification of the parameters responsible for the less trustworthiness of the Specific cloud services. The result shows that the QoS of cloud services enhance significantly.

## REFERENCES

[1] Pandey, Sarvesh, and A. K. Daniel. "Fuzzy logic based cloud service trustworthiness model." Engineering and Technology (ICETECH), 2016 IEEE International Conference on. IEEE, 2016.

[2] Mell, Peter, and Timothy Grance. "The NIST definition of cloud computing (Draft)." NIST special publication 800.145 (2011):

[3] Microsoft, http://www.microsoft.com/,

[4] Ren, K., Wang, C. and Wang, Q., 2012. Security challenges for the public cloud. *IEEE Internet Computing*, *16*(1), pp.69-73. K.

[5] Vieira, A. Schulter, C. Westphall, and C. Westphall, "Intrusion detection techniques for Grid and Cloud computing environment," IT Professional, vol. 12, no. 4, pp. 38-43, Jul. 2010. M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[6] Ding, Shuai, Shanlin Yang, Youtao Zhang, Changyong Liang, and Chengyi Xia. "Combining QoS prediction and customer satisfaction estimation to solve cloud service trustworthiness evaluation problems." *Knowledge-Based Systems* 56 (2014): 216-225.

[7] Bawazir, Afnan, Wadee Alhalabi, Mubarak Mohamed, Akila Sarirete, and Ammar Alsaig. "A formal approach

for matching and ranking trustworthy context-dependent services." *Applied Soft Computing* 73 (2018): 306-315.

[8] M. Deutsch, Cooperation and trust: Some theoretical notes, in: Nebraska Symposium on Motivation, Nebraska University Press, 1962.

[9] Chakrabarti, Grid Computing Security, Springer, Berlin, Heidelberg, 2007.