CHAPTER – 3

MODELLING THE PROBLEM

In modelling the problem we undertake a general approach for solving where the innovative creation was outlined with a detailed problem solving process. Various mathematical literatures and procedures are examined to develop and validate the model as self consistency. In this modelling approach limitations are reduced to increment the confidence and make more applicative at all computing environments.

3.1 Proximity in Modelling the Problem

The proximity for this modelled problem deploys the sequence of process as it takes the research gaps from the literature survey as a primary step. The elevated research gaps are tagged as problem statements which are used for defining the problem. Consistency levels of auditing; acquiring data from cloud through auditing and Applicative roles of Cloud broker was clearly discussed. The proximity level for this modelled problem solving involves previous algorithm schemes where its results are compared with our proposed mathematical sets in coming chapters.

3.1.1 Consistency levels for Auditing Cloud

To ensure high availability and high performance cloud is designed as a distributed system with servers located at different geographical locations. Based on consistency, availability and partition strategy principle all the service providers maintain consistency which provides low latency to improve their performance hike. The approach provides stale data to customer as all the nodes may not maintain accurate data. When we consider interactive applications it needs a strong consistency. Type of consistency may vary based on an application. Cloud consistency auditing structure is a mix of a set of verification clouds and an information cloud. In information cloud every bit of information is distinguished with a key. Cloud providers duplicate the data on multiple servers in multiple locations. Verification cloud comprises of a group of clients with unique id for each of them. Verification cloud and information cloud comes on a service level agreement (SLA) before deploying the client's cooperating tasks into information cloud. SLA assures the

guarantee given by the information cloud. Verification cloud verifies the SLA is followed by information cloud or not.

Liu et al addressed a novel framework which resembles as the above described method but this framework supports dual auditing. This framework depends on unsynchronized clock in cloud auditing. It focuses on violations and their intensity. In this approach potential service provider was suggested with limitations. [47]

Gentle Rain structure executes consistency for information cache which is distributed. This structural architecture produces increased overhead, over storage and computations. [48]

The following research script addresses metric related to tuneable consistency for detection of inconsistency logic which outcomes the innovative certifications for consistency verification models. This tuneable consistency based on consistency index deployed on workload scheduling which acknowledges duplicates at high level of abstraction. [49]

3.1.2 De duplication-Acquiring cloud data through auditing

The need of cloud auditing for carrying of deduplication task involves cloud customer, validate or verifier and cloud server. As the cloud consumer forwards the document of a particular cloud server that validate or verifier provides support in uploading of document and checking its integrity through audit. The task of valuator or verifier show cased with guidelines that verifies the document for owner ship and compares the matching of document in cloud repository. The proposal of SecCloud and SecCloud+ enhances the security by considering genuine information and de duplication in cloud environment. Map reducing methods were enabled in SecCloud which considers the object for verification for generating data tags in showcasing of genuine information that prevails in the cloud. The performance of SecCloud was noticed as low as this framework considers multiple stages. The maximization of verification procedure with de duplication using encoded information declares SecCloud+ framework which is more secure. [50]

Empirical researchers proposed many options on the issue of de duplication in cloud scenario. Many more proposals produce integrity de duplication mechanism which are novel and fit to the hybrid cloud architectures. These mechanisms enhances little computation overheads. [51]

The mechanism for server side which elevates the de duplication for encoded information was addressed. The role of server restricted the information changes dynamically. This mechanism exposes trust in opposing leak of information, revoking client towards safe storage. This mechanism includes additional computational overheads. [52]

The admissions to de duplication procedure for a key administration task ensure safe distribution of keys. The mechanism deploys on various servers for achieving de duplication on convergent key portion on data. The addressed mechanism employs secret key distribution mechanism with encryption and decryption based on RAMP approach. [53]

In the perspective of data storage record level is classified as small chunks. Block level message locked encryption was proposed for de duplication to accomplish chunk level verification in using small set of data about data. This novelty approach does not support for the storage level of data which was not consistent for computation. [54]

The need of classification between streaming of storage and end to end encryption was outlined. It opens the internal intermediate activities of storage streamlining strategies. The procedure mainly projects the high abstraction popular files. In discussion of disadvantages the efficiency is very low for space allocation of data storage. [55]

To protect from malicious client in the usage of video a secure measure of de duplication mechanism was proposed in the segment of untrusted cloud scenario. RSA-OPRF is an algorithm used to implement for the support of video protection where the information leakage level is low. A brute force method behaves like a guard for predicting and protecting videos. In decentralized environment this approach has more computational overhead. [56]

In the scenario of distributed environment an I-SIEVE framework was proposed for deduplication where its performance shows a bit difference. In discussion of this framework targets the small computer system application which utilizes the carrier medium as internet. Mostly this I-SIEVE framework fits for tiny storage situations with enabled virtual machine applications. This framework consumes more computational overheads as it is accomplished with sensitive data security. [57]

3.2 Applicative role of Broker approaches

The delegate role of broker helps the cloud consumer as a fair premium decision in the utilization of resources as the consumer was busy in attempting his works, the prediction of utilization of resources rating is termed to be bias situation. The broker is an intermediate interface who acquires the accurate information from the service provider's services from client responses. The broker witnesses all the interactions between provider and consumer discloses his honesty for consumer benefits or provider's service claims in order to emphasize ethical conduct.

3.2.1 Broker approaches for Service Utilizations

Many earlier researchers evaluate SLA policy management frameworks and architectures which shows the importance of SLA life cycle in service oriented architectures. CONTRAIL project takes a major role in determining service provider services in multi cloud environment. SLA@SOI framework deals with SLA negotiations in comprehensive perspective. Most of the theories involve the broker part for doing intermediate service like negotiations between service provider and cloud consumer. The monitoring, metering in the utilization of available services are synchronized with SLA considerations. These abilities are coordinated with WSLA language which supports SLA policies between cloud consumer and provider. The empowering of this language helps to deal SLA automations and negotiations to certain extent. [58]

The involvement of automated services in aggregation of reliability and trust factors towards service levels are not feasible in all the situations. The involvement of automated procedures for negotiations, targets time boundaries which discriminate the service utilization levels. Decision making on opponent stake holder tactics may not give consistent optimal outcome in the process of bargaining. Current market strategy constraints and heuristic generator strategies are involved. [59]

Broker takes the part of mediating control service for SLA negotiations for choosing the best service provider. Many broker based approaches are evaluated in this theory to exhibit their optimal outcomes in the pattern of SLA negotiations. Broker helps as a monitoring service in screening of SLA document for negotiations between consumer and provider. [60]

The evaluations of broker based frameworks are deployed in integrated services of SaaS Provisioning. The aim of these frameworks synchronizes with SLA document evaluates the compliance monitoring and helps in negotiation process. The involvement of sensitivity factors about SLA attributes are considered that exhibits few ambiguities. [61]

The utilization of resources promotes an active plan in predicting financial scope. The cost factor determines time, rental schemes which targets rate of return. As the cost stretches with discrete intervals an average weighted model was incorporated to show the importance of cost. A break even analysis was considered with a mathematical equation which represents the initial cost and alternative attributes for optimal solution. Most of the uncertainties forecast with identical values of cost and time discrete values. [62]

In SaaS delivery model the consumer may have privileges in configuring services whereas, the provider dominates in managing of cloud service for maintaining and monitoring of cloud consumers. In PaaS service model the cloud consumer have advantage to create test sets and propose solutions for the cloud service. In IaaS delivery model the consumer face a little bit complexity in configuring of infrastructure and installations. The provider in this IaaS model can flexibly manage physical resources which are going to be provisioned for utilization. The process of network enabling, hosting and monitoring can be easily manipulated by the provider.

To lucidly clarify the above discussed topics in this chapter 3.1 and 3.2 we tabulated the above theoretical procedures. The below Table 3.2.1.1. gives strategies for consistency levels for cloud auditing which clearly differentiates various algorithms and list their advantages and disadvantages. Table 3.2.1.2 Broker approaches for service utilizations were addressed with different algorithms and showcases their advantages and disadvantages. Table 3.2.1.3 Strategies for de duplication helps in acquiring cloud data through auditing which considers heterogeneous algorithms with their advantages and disadvantages. Broker strategies and Auditor strategies are distinguished in a constructive perspective From the below Table 3.2.2.1

Strategies for Consistency levels of Cloud Auditing

Algorithm/Concept	Advantages	Disadvantages
Heuristic Audit Approach/ Auditing for Consistency. [47]	Select potential service provider through user access	Heuristic approach
Gentle Rain/Usage of Clocks.[48]	Throughput Efficiency maximized	Storage overhead maximum
Consistency Index on Selective data/Tuneable Consistency.[49]	Efficient work load scheduling	Taking more response time

Table 3.2.1.1 Strategies for Consistency levels of Cloud Auditing

Broker approaches for Service Utilizations

Algorithm/Concept	Advantages	Disadvantages
WSLA language for supporting SLA policies [58]	SLA automation can be carried to the maximum extent	Negotiations between consumers and providers are carried to the minimum levels
Automated negotiations with time boundaries for discriminate service utilizations[59]	Opponent stake holder tactics are predicted for decision drawing	Optimal outcomes for bargaining process cannot be achieved
Monitoring service screening for SLA document was addressed[60]	Broker takes a major role to deploy monitoring strategy	Negotiations between consumer and provider exhibit empirical approaches
Synchronization of SLA documents for compliance monitoring [61]	Negotiation process was considered more	Sensitivity factor on SLA attributes exhibit ambiguity
Average weighted model evaluates the importance of cost[62]	Breakeven analysis was computed for the initial cost and other alternative attributes	Some discrepancy was observed for the derived cost attributes

Table 3.2.1.2 Broker approaches for Service Utilizations

Strategies for De duplication-Acquiring cloud data through auditing

Algorithm/Concept	Advantages	Disadvantages
Map reducing methods using SecCloud[50]	Data tags are generated and show case the genuine information	The verification procedure for the encoded information consider multiple stages
Integrity de duplication mechanisms[51]	Minimizing computing overheads	This novel approach cannot fit for all hybrid architectures
Server side algorithm was addressed for de duplication of encoded information [52]	Evaluating trust and opposing the leak of information	Restriction of server for the dynamical changes of information which generate additional computational overheads
Safe key distribution mechanism in distributed server environment[53]	Encryption and decryption based on RAMP approach	Deploying of various servers in order to achieve de duplication
Block level message locked encryption algorithm[54]	Data was classified into small chunks for better encryption	This novelty approach cannot fit for all storage levels
End to End encryption algorithm was outlined[55]	Streamlining strategies are improved at higher level abstraction	Efficiency was considered low for data space allocations
RSA-OPRF was implemented[56]	Brute force method was used for predicting and protecting of video data	Computational over heads are high
I-SIEVE framework [57]	Virtual machine with small storage situations are applicable	Security for the sensitive data was not accomplished to the mark.

Table 3.2.1.3 Strategies for De duplication-Acquiring cloud Data through auditing

3.2.2 Comparison of Broker Strategies and Auditor Strategies

Broker Strategies	Auditor Strategies
The objective of cloud broker is to act as a mediator for consumer and provider in resource utilization	Cloud auditor objective is to conduct audit trail assessment independently
The responsibilities of broker are intermediation, aggregation and arbitration	The responsibilities of auditor is to evaluate the trust between cloud consumer and cloud provider
The roles of broker offers value added services by enhancing service intermediation, service aggregation and service arbitration	The roles of auditor can perform security audit, privacy audit and performance audit
Purchasing time of resources was saved to the consumer for resource utilization	Assessment of resources can be carried without any favours
Broker can negotiate pre defined contracts between provider and consumer	Auditor can assess the contract compliance monitoring and does not go for complex negotiations.
Cloud brokerage models are still evaluating	Audit trail assessments are standardized
Broker may have partnership with cloud service providers and consumer	Auditor provides robust, transparent, impartial services
Broker always focus on utilization of services between consumer and provider but never on security control assessments	Security control assessments can be examined more for evaluating trust mechanisms
Broker may not have complete privileges in monitoring system and kernel level operations	An auditor can assess system operations and kernel level

Table 3.2.2.1 Comparison of Broker Strategies and Auditor Strategies

3.3 Research Approach

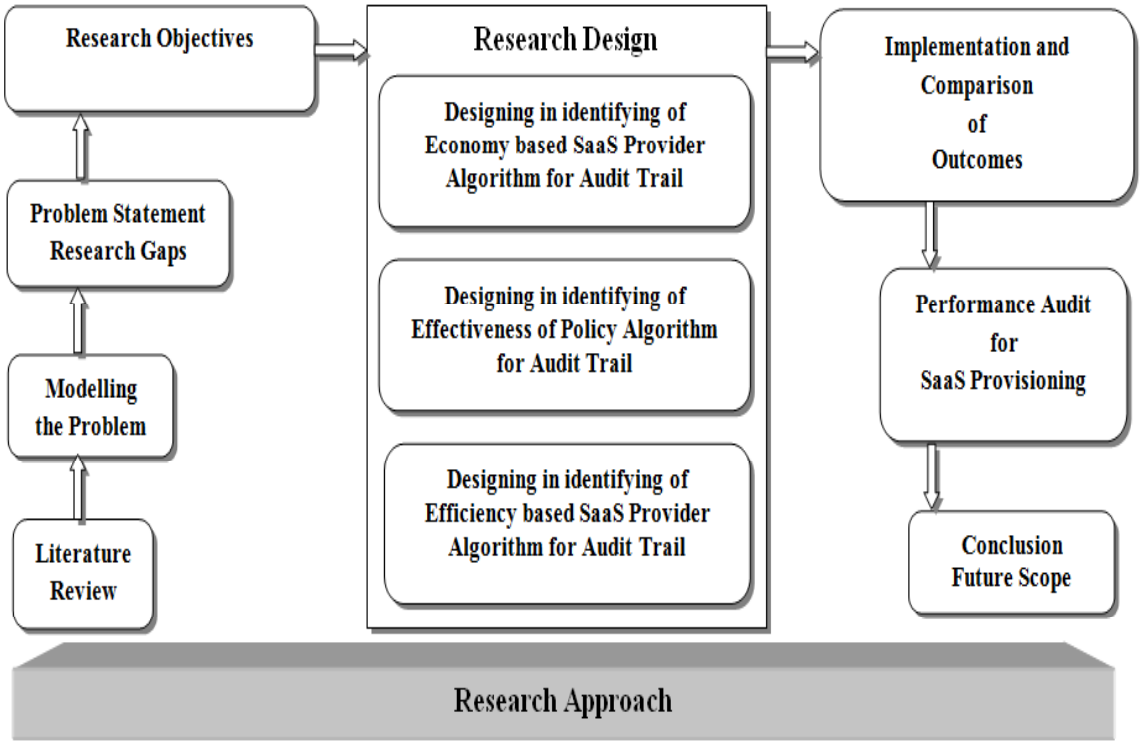

Fig3.3: Research Approach

The research approach enlightens the sequential steps of research assumptions, research methods, analyzing of data and its collections and understand with detailed interpretations. The decision making process in this approach involves literature survey, identification of research gaps, constituting of research objectives from gaps, research methodology design with algorithms which evaluates research methods, comparison of outcomes and evaluating the research problem with proper justification and finally concluded with conclusion and future scope.

This research approach is a combination of qualitative and quantitative approaches which targets the research problem with determination, reduction, empirical study, theoretical validations, participant preferences, framework proposal, transformative changes and feasibility towards pragmatic orientation.

3.3.1 Research Gaps

***Research Gap1*:**

SaaS providers service offering are heterogeneous, may vary in quality of service levels that they deliver which exhibit complexity.

***Research Gap2*:**

Lack of provenance based audit trail on policy monitoring between potential SaaS provider services and customer preferences which lead to an ambiguity.

***Research Gap3*:**

Lack of provenance based audit trails for measuring SaaS provider's service efficiency which lead obscure to customer utilization.

3.3.2 Research Objectives

Objective 1

To perform, Performance audit trail on SaaS providers QoS economics.

Objective 2

To develop performance audit trails on policies between providers and consumer based on provenance and compare the outcomes.

Objective 3

A Novel approach for performing audit trails on provider's service efficiency based on provenance.

3.3.3 Problem Statement

Defining our research problem helps in identifying the importance of performance audit for SaaS provisioning in cloud environment. In determining of economic performance of service provider, consumer preferences are considered for utilization of quality driven services. In assessing effective performance policy monitoring was considered for evaluating the SLA compliance. To cull the efficient service providers, customer utilization percentage of services is considered. The above defined

perspectives are integrated with provenance data to showcase the essence of our research work.

3.3.4 Conceptual view of Proposed Work

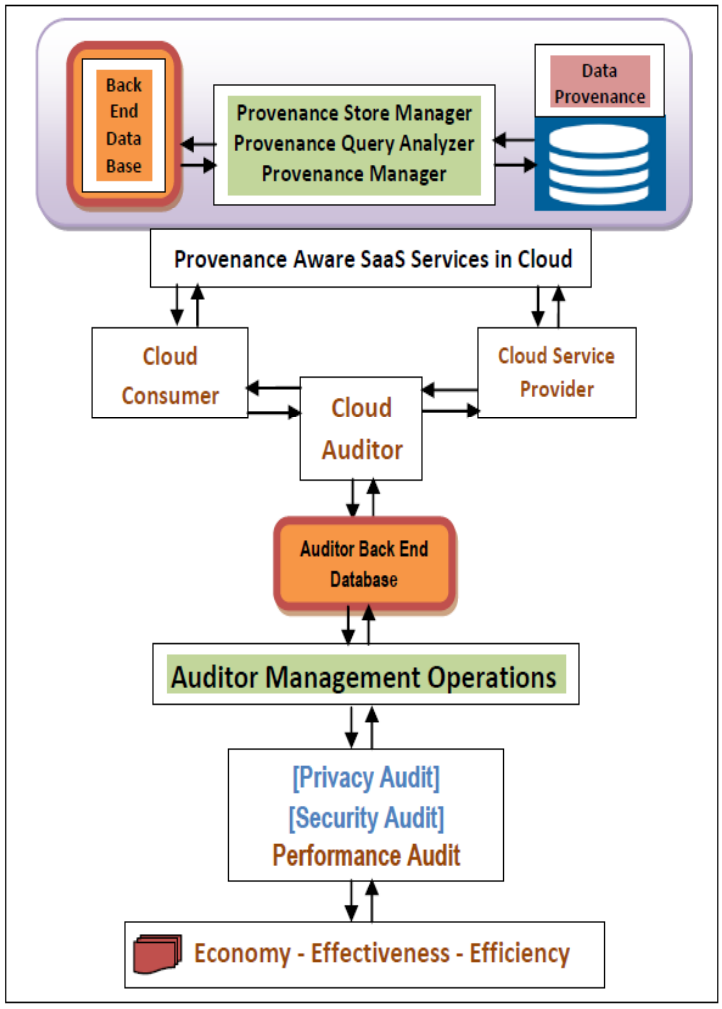

Fig 3.3.4.1 Conceptual view of Audit Trail

Figure-3.3.4.1 depicts the overall scenario of provenance based auditing. Every SaaS service in cloud is collaborated with provenance to overcome the unrecoverable situations towards their data. Provenance aware services are an integration of provenance manager and provenance query manager. Our research work initiates near cloud auditor who collects the provenance from the provenance store based on the request of either cloud consumer or provider. Cloud auditor performs various management operations on the collected provenance data like performance audit,

privacy audit and security audit. Performance audit specifically focuses on economic, effectiveness and efficiency of services as discussed in figure-2.

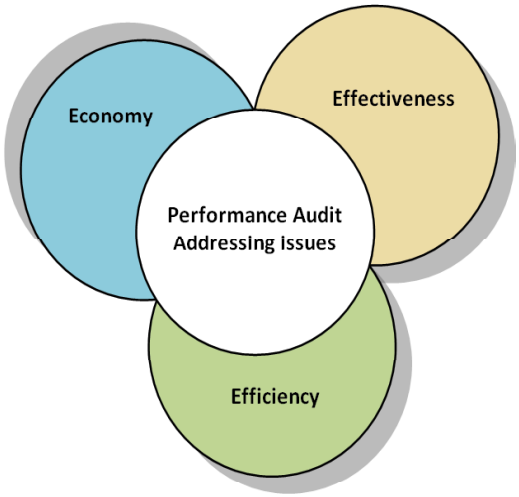

Fig 3.3.4.1(a): Performance Audit addressing issues

Figure-3.3.4.1(a) explains the overview on various addressing issues which are to be considered while assessing the performance of Cloud service provider. The diagram illustrates the three important categories in assessing the performance which are stated as economic, effectiveness and efficiency. These three integrated together can provide complete performance audit trail. [63]

3.4 Erecting the Problem definition

Most of the SaaS services applications exhibit flexibility, robustness features and the performance outages of the SaaS services are minimum are noticed. As per the empirical calculations SaaS providers produces availability rate as 99.9% and the remained (i.e., 43 minutes) is termed as downtime per month [64]. Generally these downtime situations can be complemented with different resources optimization techniques. If the downtime situations are more the consumers may migrate to the new provider or the providers has to pay penalty for the outage situation to the client. In general monitoring services play key role in computation of service deliveries and outage performance. In the part of our research we target this issue as key problem

and provide the auditor assessment role in constituting Performance audit trail with the aware of provenance.

3.4.1 Acquiring Dataset and Parameters discussion

SaaS_ID	*Availability*	*Reliability*	*Cost ($)*	*Response time (ms)*
1	0.99988	0.9995	16.1	6
2	0.99968	0.99953	38.1	2
3	0.99935	0.99962	8.4	3
4	0.99988	0.99964	40.2	3
5	0.99959	0.99954	12.6	4
6	0.99963	0.99958	22.2	6
7	0.99939	0.99971	33.2	7
8	0.99918	0.99975	25.3	2
9	0.99995	0.9999	30.8	7
10	0.99958	0.99956	24.2	3
11	0.99945	0.99971	22.8	7
12	0.99981	0.99976	6.7	7
13	0.99911	0.99987	15	3
14	0.99924	0.99983	11.7	5
15	0.99912	0.9998	24.8	5
16	0.99948	0.99973	22.7	3
17	0.99952	0.99967	31.9	5
18	0.99999	0.99962	23.9	2
19	0.99944	0.99975	33.7	3
20	0.99943	0.99972	20.7	5
21	0.99987	0.99957	19.6	5
22	0.99959	0.99977	27.2	2
23	0.9997	0.99952	20.4	4
24	0.99999	0.99992	25.4	5

Fig:3.4.1.1 Snapshot of Dataset

The above snapshot of dataset is acquired from the previous research contributions which are proposed for brokers delegate role in accounting of SaaS services provisioned by the provider towards consumer preferences. This dataset is aggregated with four parameters like Availability, reliability, Cost, and Response time where these attributes are fulfilled by each service provider. This data set consists of twenty four potential service providers where the choice of consumer preferences triggers for service utilizations.

3.4.2 Show casing the Brokers algorithm on the modelled problem

Step: 1

Let Q = {Q_1, Q_2, Q_3… Q_n} list of QoS attributes

Step: 2

Utility driven QoS attributes availability and reliability are taken into consideration

Step: 3

Cost driven QoS attributes cost and response time are taken into consideration for this algorithm

Step: 4

SP = {SP_1, SP_2…, SP_K} list of potential SaaS provider

C = {c_1, c_2…, c_n} vector of Consumer specifies quality of each QoS attribute in Q.

Qr = {Q_1^r, Q2r….Q_n^r} Qos offering of the SaaS Provider SPr

Step: 5

The process of ranking is given according to QoS offers of Service provider for this,

The defined utility function for cost driven attributes, is minimization parameters taken to cost and response time and for utility driven attributes, maximization parameters taken as availability and reliability)

Utility function $U_r = \sum_{i=1}^{n} wi\ qi^r$

Where “r” is the number of Service provider and “i” is the number of QoS attributes

$qi^{r,}$ is the normalized value for the offer of (SaaS provider) SP_r regarding the QoS attribute Q_i

wi is the weight associated with the quality attribute(CSB may assign the weight)

Step: 6

$qi^{r,}$ is calculated in two ways

$qi^r = Q_i^{|max} - Q_i^r / Q_i^{|max} - Q_i^{|min}$ Cost driven equation

$qi^r = Q_i^r - Q_i^{|min} / Q_i^{|max} - Q_i^{|min}$ Utility driven equation

Step: 7

Q_i^r is the values of QoS attribute where, Qi provided by SP_r

$Q_i^{|max} = \max(c_i, Q_i^{max})$, $Q_i^{|min} = \min(c_i, Q_i^{min})$ where c_i is the quality requirement of service consumer for Q_i

$Q_i^{max} = \max_{1<j<k}(Qi^j)$, $Q_i^{min} = \min_{1<j<k}(Qi^j)$

Step: 8

Function F(x) for quality attribute X for the Utility driven

$$\mathbf{F(x) = x\beta_x (1+\infty_x) / 1+\infty_x x\beta_x}$$

where x is the normalized value of the offer by SP for X,

∞_x is the SLA value for X, and β_x represents the sensitivity of the service consumer with respect to X.

β_x >1 increasingly sensitive, =1 moderately sensitive , and <1 increasing in difference

Function G(x) for quality attribute Y for the Cost driven

Step: 9

$$\mathbf{G(y) = 1- y^{\beta y} / 1+\infty_y y^{\beta y}}$$

$\infty_{y\,x}$ is the SLA value for Y, $^{\beta y}$ is the sensitivity towards Y

G reaches its max which is 1, when y=0 decreases to 0, when y reaches 1.

Step: 10

Global Utility function serves to evaluate the SP offer during negotiation phase

$U=\sum_{Qi\,\epsilon\,v} wi\ Fi + \sum_{Qi\,\epsilon\,R} wj\ Fj \quad wi\ \epsilon\ [0,1]$ such that $\sum^{n}_{i=1} wi = 1$

SaaS_ID	Availability	Reliability	Cost($)	Response Time(ms)
SP1	0.99988	0.9995	0.322	0.6
SP2	0.99968	0.99953	0.762	0.2
SP3	0.99935	0.99962	0.168	0.3
SP4	0.99988	0.99964	0.804	0.3
SP5	0.99959	0.99954	0.252	0.4
SP6	0.99963	0.99958	0.444	0.6
SP7	0.99939	0.99971	0.664	0.7
SP8	0.99918	0.99975	0.506	0.2
SP9	0.99995	0.9999	0.616	0.7
SP10	0.99958	0.99956	0.484	0.3
SP11	0.99945	0.99971	0.456	0.7
SP12	0.99981	0.99976	0.134	0.7
SP13	0.99911	0.99987	0.3	0.3
SP14	0.99924	0.99983	0.234	0.5
SP15	0.99912	0.9998	0.496	0.5
SP16	0.99948	0.99973	0.454	0.3
SP17	0.99952	0.99967	0.638	0.5
SP18	0.99999	0.99962	0.478	0.2
SP19	0.99944	0.99975	0.674	0.3
SP20	0.99943	0.99972	0.414	0.5
SP21	0.99987	0.99957	0.392	0.5
SP22	0.99959	0.99977	0.544	0.2
SP23	0.9997	0.99952	0.408	0.4
SP24	0.99999	0.99992	0.508	0.5

Table:3.4.2 Normalized Table from Snapshot of Dataset

3.5 Chapter Summary

Modelling the problem task aggregates with logical and technical parameters which helps in showcasing the problem solution. The task of encountering important research scripts which are proximity to our identified problem targets in identifying consistency levels of auditing, de duplication analysis of auditing that helps for designing problem statement. Broker approaches are taken perusal study which can be helpful for comparison with auditor assessment services. Tabulation for consistent level strategies and de duplication in auditing are structured. Comparison of broker strategies and auditor strategies are tabulated. Our research approach is picturized with diagram where research gaps and objectives are clearly stated. The conceptual view of proposed work, problem definition with acquired data set parameters are described clearly. Broker's algorithm for the modelled problem was show cased as a reference segment.