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Measuring Prefered Services from Cloud Computing Providers Using Linear Algebra

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Abstract— **Many Cloud Computing providers offer many services for users to choose from. However, this is time-consuming and the information regarding the services keeps changing. Some tools compare providers but none that assist users to decide which Cloud Computing providers about functional services. There exists research that employs linear equations in making decisions in other areas. In this paper, a linear equation has been experimented with to measure the functional services of selected Cloud Computing providers to meet user-preferred needs. The linear equation calculates the weights of the functional services that rank the providers. This tool called measuring user preferred service certainly assists users to decide provider based on current needs without visiting its website and the information presented is up to date.**

Keywords-Cloud Computing Providers; Measuring Preferred Service; Linear Equation; Weight; Ranking

I. INTRODUCTION

Cloud Computing is represented as the mover of resources and systems across the Internet. It allows user to use the software, systems, and services from anytime and anywhere. Providers who provide these services are very competitive, for instance, Dropbox, Google Docs, Pixlr Editor, and Jaycut [1]. The Cloud Computing models are distributed into three types, Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) [2].

Well-known companies such as are Google, Amazon, Microsoft and IBM have established large high-capacity servers for Cloud Computing services [3]. The number of providers and their services are increasing and in addition, their cost is on the rise. They provide services that are changeable and adaptable to user requirements, for instance, automatically scalable storage and CPU, depending on the load on the server. Providers are always seeking to improve and develop their services. This makes the competition strong and provides many options for user to choose [4].

User can request any service needed with a certain cost [5]. Examples of widely known providers are Google Compute Engine (GCE), Microsoft Azure (Azure), Amazon Web Services (AWS), and Rackspace Cloud (Rackspace). Users are interested to know which providers give high-quality services versus costs.

If the users are novices, they will face difficulties and take a long time to find their preferred services [6]. The users also need to ascertain the Quality of Service (QoS) of the providers [7, 8]. In addition, the users must be familiar with the providers and services [9]. This increases the difficulty of the user's ability to decide to choose the best provider based on their preferred services [10].

Currently, there are no systems that can help the user to make the right decision in choosing the providers concerning services [11] and Quality of services (QoS) provided [8]. Many systems employ linear models in making decisions [12], linear models are utilized to help the decision maker, in another word the decision maker in clinical versus statistical controversy, represent the changes in decision-making and initiate the decision maker [13].

Whatever, this paper is arranged as follows. Section II presents concerning research in Cloud Computing, its challenges, user selection, ranking, measurement, and linear models. Section III discusses the experimental setup that consists of test data collection and evaluation procedure. Results and discussion are presented in Section IV. Section V shows the Measuring Preferred Service tool that implements linear algebra to assist users to decide on the provider and services. Finally, Section VI concludes the findings in this paper.

II. RELATED RESEARCH

Cloud Computing has gained large importance as of late. There is an increasing number of users, associations, and companies that have transferred their businesses into the Cloud regarding versatility and negligible exertion. Amazon, Google Compute Engine (GCE), Sun Microsystems Salesforce, IBM, Microsoft, and Sun Microsystems have begun to set up new server branches to encourage Cloud Computing applications to give assurance-enduring quality [3]. Due to the variety of providers and their services in Cloud Computing, the computational environment becomes gigantic in the cases of AWS, AZURE, Google Compute Engine (GCE), and Rackspace.

The advantage of Cloud Computing is that the users will save money, and time, enhance the execution of their work, and many advantages. Cloud Computing is the innovation for the decade. It is needed by users for storing huge measure of information in Cloud storage and used as and when needed from any place around the world, using any terminal hardware [5].

With multi-Agents joining with Service-oriented architecture (SOA) the innovation is considered to have the most advantages [6]. However, the user will still face difficulties in defining optimal preferred choice for the best service provider.

A. Challenges in Selecting Cloud Services

Selecting services and suppliers require more consideration, as the users need to know more about their prerequisites and which providers that give ideal Cloud service selection [7]. There are two types of users when making the decision. The first type of user clearly be aware that the QoS standard of the needed service and the weight of these services. The second type is the user who is unsure of the QoS. In this case, if selecting a storage which is a Cloud services for any server, the user should not know if downtime or availability or the cost is more important, if the user have not tried any storage servers and experienced their performances.

An expert user will concentrate on particular characteristics, for example, down time, uptime, client bolster, and adaptation to non-critical failure capacity and idleness and every one of these qualities' factors in the capabilities of the providers to fulfill the necessities of users to choose the best choice [9, 4]. Right now, there is no system that give users to assess Cloud services and classify them in light of the ability to satisfy the users' Quality of Service (QoS) needs [8]. There is no system which can permit clients to assess Cloud services and rank them in view of their capacity [8].

Furthermore, with the development of Cloud Computing associations, for example, Amazon, IBM and HP began to provide Cloud service. The increase number of Cloud services and providers impose difficulties for users to choose Cloud services [11].

Another problem faced by users is the issue of failures or down time. This puts the user in critical situation in making the optimal decision for choosing the best service provider with considering the user's preference and help users to define the best provider through reliable information. There are relevant models devoted to defining the quality of services, based on how the definition of the services of Cloud Computing and the selection of the best service provider by users. These models help users to understand their service requirements. A trust and reputable system is an instrument utilizing users' criticisms. This will distinguish great services [14].

B. Ranking Models

Cloud Rank model is proposed for ranking QoS Cloud services by knowing the advantage of the past uses service experiences of other customers, there can be a prediction of Two Clouds. The first one belongs to the past user and the second belongs to the current user [8]. The importance of the reputation of the provider in the market, and the needs of users depending on their conditions, such as costs and services should be included in the ranking. There is a web service representation model that considers service QoS data and then introduces a general service selection and ranking model with QoS (WSSR-Q). [10]. A Cloud Service Provider Selection Engine (CSPSE) model is not just to assist the customers in understanding one's request, however, helps to specify the ranking sort Cloud providers based on QoS which is necessary according to specific use [14].

A sorting model that compares the Cloud providers of different QoS, ranks them in line with their performance and shows the realization of four Cloud providers with an assessment of all the QoS attributes: response time; elasticity; cost; availability. The hierarchical structure of QoS proposes that the characterization of QoS properties required by the user for choosing the fitting specialist organizations depends on cost, performance, assurance, security, usability, agility, and accountability [9]. [14], proposed a sorting model that compares the Cloud providers on different QoS and ranks them based on their performances. The four essential QoS services are cost, availability, response time, and elasticity.

[15], analyzed, ranked, and compared the current methods for ranking Cloud Computing services. The method can empower providers to contrast their quality services, with other competitors and also can improve quality services. It can resolve a portion of the user's difficulties in choosing the best service which fulfills their needs. This work notices the strengths and weaknesses or challenges of the current methods.

There is a model that proposes a QoS ranking forecast model for Cloud services by taking into account the advantage of previous experiences to use the service of other users and produce QoS ranking prediction methods to meet users' requirements. [7]. This proposed model helps the users to select the best service provider who satisfies their QoS needs, [16].

C. Measurement Models

The measurement model gives a choice to the client to assess different accessible Cloud Service Providers (CSPs) because of their notoriety in business sector on QoS given and chooses the most dependable CSP after a profound examination of users' needs and prerequisites qualities. The proposed Cloud Service Users (CSUs) model will offer the Cloud some assistance with servicing users in discovering effective and reliable Cloud Service Providers (CSP) on the premise of information taken from administrative powers [17].

[17] proposes a model of Cloud service selection based on comparing and evaluating data from users and quantitative QoS monitoring and benchmark testing. This model depends on combined Cloud, which consists of various mists and a Cloud trade unit. Every Cloud has an organizer component, which gathers the solicitation from the users and.

The mathematical model addresses the Cloud service provider selection depend on guarantees of QoS, as well as displaying the suggested QoS utility-based model for best Cloud service provider selecting in the market of Cloud Computing platforms to match the advantages of various kinds of Cloud Computing services (Salama et al., 2012).

The Cloud Service Measurement Index Consortium (CSMIC) proposed a model for best provider selection using Ranked Voting Method. Therefore, the model has been designed that considers measurements characterized by SMI, moreover, different measurements will be doing as an elector and compare its demanded value from providers, then do ranking providers accordingly. (Baranwal and Vidyarthi, 2014).

Service measurement index (SMICloud) systematically measure all the QoS attributes and rank the Cloud services based on mentioned attributes, and also creates metrics for every accountable QoS to measure the service level of each Cloud provider accurately. The Analytical Hierarchical Process (AHP) based on ranking algorithm, which can estimate the Cloud services relayed on various applications based on QoS needs. SMICloud is able to compare various Cloud providers based on user needs and the SMICloud would allow users to compare various Cloud services, in line with their preferences [8].

A novel Cloud service selection model based on comparing and collecting of data evaluating taken out from Cloud user feedback and objective evaluating from quantitative performance testing is proposed by Qu et al. (2013). The proposed mathematical model produced salutation for the service selection problem, and QoS dimensions (Salama et al., 2012).

The Cloud service priority is based on user requirements, visually presents and compares solutions through an interacting web Graphical User Interface (GUI) [4].

The model of Cloud service selection based on collecting the data from both the users feedback and performance analysis objectively by a trusted third party [17].

D. Linear Model

There are assortments of linear model-based methods for variable determination (Hall and Miller, 2012). In this model, it is contended that a reaction variable, Y_i may be expressible as a linear shape in a long p-vector, X_i of informative variables, in addition to an error that is $Y_i = \alpha + \beta_1 Xi + \ldots + \beta_p X_{ip} + error$.

The fuzzy Analytical Hierarchical Process (FAHP) is used first to analyze the weights of the numerous elements. The variables considered are cost, quality dismissal rate, late conveyance rate, greenhouse gas outflow, and interest. The weights of the various elements are utilized as a part of fuzzy multi-objective linear programming for supplier determination and quantity assignment. An outline with the information set from a practical circumstance is displayed to show the adequacy of the proposed model. The proposed methodology can deal with practical circumstances when there is data dubiousness identified with inputs [12].

Unlike previous experimental Bayes variable selection methods that are most functional situations can be executed only during distinct stages algorithm. Efficiently, this method gives a comprehensive solution. [16, 17]. The proposed method and real examples display that there is very competition regarding variable selection, evaluating the accuracy, and computation speed compared with other variable selection and evaluating methods. In addition, it considered the issue of variable determination and coefficient estimation in the regular typical linear equation model have n perceptions on a dependent variable Y and P predictors (x_1, x_2, x_3, x_p) and $Y= X\beta + \varepsilon$.

III. Experimental Setup

In this section, the test data collection, data center architecture, the evaluation procedures are discussed.

A. Test Data Collection

The test data collection consists of the selection of users, providers, and services. There are more than a thousand providers but the four best providers will be chosen based on ranking by CloudHarmony (2014). Users of the IaaS model is selected from the research and higher Computing areas from universities and customer service companies. In addition, these users are in charge of overseeing more: applications, information, runtime, middleware, and O/S. Providers still oversee virtualization, servers, storage, hard drives, and networking. What users get with IaaS is infrastructure in which they can install any required platforms. Additionally, users are in charge of updating the platforms if new versions are released.

There are various Cloud Computing services, namely function and non-functional services that depend on the user's needs and vision such as availability, security, reliability, operating systems support, data centers, cost and platforms supported, virtualization technique, customer support facility, throughput, efficiency, capacity and response time, and more.

However, in this paper the essential and functions services for any virtual private server (VPS), which are solid-state drive (SSD), random-access memory (RAM), central processing unit (CPU), bandwidth and cost and additionally, and non-function services such as reputation, age of company and availability are considered.

B. *Evaluation Method*

The data which are gathered from user and provider are calculated into percentages, based on reputation of provider, preferred services and importance from user. The percentage is calculated using linear equation.

The linear equation for measuring preferred service (LEMPS) is procured by two processes, the first process is finding out the value of isolated service equation (VISE) according to the calculation of the percentage of priority of services user and the second process is finding out the summation values of total services equation (VTSE) to produce the final result.

By assumption, a user A has the following demands. The user browses catalogue service and finds that there are *N* Cloud service providers C_1, C_2 ... C_N who can provide service that meets his requirements. Then the user submits the list of services providers C_1, C_2 ... C_N with the list of requirements according to its priority to measuring preferred service (MPS) System. The list of resource providers and requirements are forwarded to the MPS and retrieves the trust values of *N* Cloud providers from the MPS system. Then it sorts the provider companies based on the trust values, [18, 19].

For example, there are four Cloud companies *P1, P2, P3 P4* with their list of services. The offered services of *P1* are better than *P2*. On the other hand, the trusted values of *P1* are better than *P2*. Thus, employing linear equation will assist the user to make an optimal decision. There are three levels in the selection system, which are low, medium and high. These levels are used for the user's preference and evaluate services based on its requirements. Each level represents a percentage, where the lowest level represented 34%, 67% represents medium and the high level is 100%. Measuring preferred service that is selected are independent. The linear equation can be defined by:

Let r be Pearson's r, s_x the standard deviation and $\bar{x}_x$ the mean of all the numbers on the x-axis, s_y the standard deviation and $\bar{x}_y$ the mean of all the numbers on the y-axis. Then the slope will be $m = r\frac{\bar{x}_y}{\bar{x}_x}$ and y-intercept $b = \bar{x}_{y-m}\,\bar{x}_x$, for linear trend line $y = mx + b$. Trend lines or best fit lines are applied to data after plotting on the x, and y-axis. The idea of a trend line is to reveal a linear relation between two variables, x, and y, in the $y = mx + b$ form. Extracting the linear equation that related two variables which allows extrapolation or prediction of how one variable will change given any change in the other. Most of the time, a line cannot simply be drawn through real-life data because it will rarely fit perfectly (Chang, Lai, and Huang, 2012; Adamuthe, Tomke, and Thampi, 2014; Gupte, and Wang, 2015).

IV. Results and Discussion

The information obtained from the websites of Cloud Computing providers on the current perceptions and adoption of selected services of Cloud Computing (AWS, Azure, GCE, and Rackspace) is shown in Table 1.

TABLE 1. Cloud Computing Providers Services

VPS	AWS	Azure	GCE	Rackspace
SSD	1000 GB	800 GB	1500 GB	1,200 GB
RAM	60 GB	112 GB	104 GB	120 GB
CPU Core	36 cores	16 cores	16 Cores	32 Cores
Bandwidth	2000 Mb/s	2000 Mb/s	10000 Mb/s	5000 Mb/s
Cost/ Month	$1828.48	$1271.33	$923.47	$4529.79

SSD, RAM, CPU, and bandwidth services are measured by defining the maximum and minimum volume according to the preferred service of users. The cost is the most important service that the user wants to know. This is a common concern of users, but at the same time, the increase or decrease of the cost depends on the performance and reputation of the provider. Table 2 shows the requirement level of service. The score values of 1-3 indicate the essential degree of requirement. A score value of 1 indicates user requires a high level of service; a value of 2 implies a medium level; whereas a value of 3 indicates a low level.

TABLE 2. Requirement Level of Service Needs of User

User	SSD	RAM	CPU	Bandwidth	Cost/Month
1	2	1	3	1	2
2	2	1	2	3	1
3	3	2	1	2	3
4	1	3	2	1	2
5	2	1	3	2	1
6	3	2	2	2	3
7	1	3	2	1	3

The results of employing linear equation are shown in Table 3 for user 1. It shows that the highest percentage of preference and evaluation in preference has been given to the GCE provider which is 50.2% due to the user preference for bandwidth and RAM, which is reflected in the values provided by the company. This indicates that it is not all the well-known companies fits user 1 needs. This user chooses these services according to his priority and the final result of the sum percentages of functional services and the non-function services is displayed [18, 19].

Due to trusted values of services being the most informative, GCE which is at the top of the table is the best services provider among the rest of providers. Nevertheless, these are definitely very interesting values and preferred services for the user in Cloud Computing. In contrast, Azure is in the last rank which has the lowest ratio of 30.3%.

TABLE 3. Trust Value Based on User Requirement

	SSD	RAM	CPU	Bandwidth	Cost/ Month	Percentage
AWS	10.4	1.0	67	1.0	75.2	30.9%

GCE	34	49.4	1.0	67	100	50.2%
Rackspace	19.9	67.0	53.8	25.8	1.0	28.3%
Azure	1.0	58.2	1.0	1.0	90.5	30.3%

V. Implementation Of Measuring Preferred Service

This section demonstrate the implementation of a web based Measuring Preferred Service (MPS) system that includes the functionality to prioritize requirements and to optimize selection decision of the best services provider. The interesting characteristic of the implementation is the ability to add more services.

In the first screen, the system administrator has to submit permission to login into the MPS system as shown in Fig. 1.

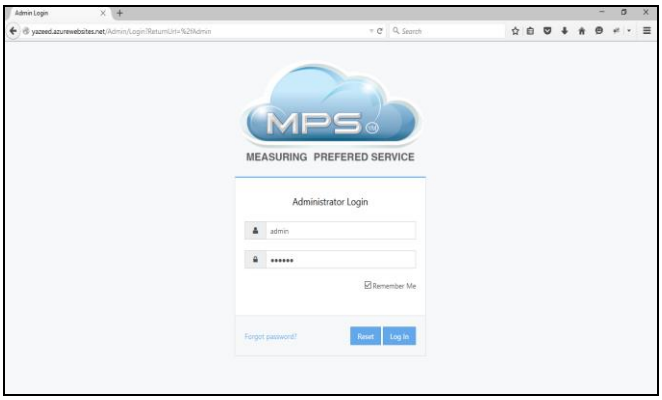

Figure 1. Administrator Login

To facilitate add, remove, and prioritize services in election list by order, there are three buttons: new, edit and delete services provided. The administrator of the system is responsible for updating the system as shown in Fig. 2.

Figure 2. Picklist for Updating the System

The targeted data of the provider and preference order given by the user are considered based on the type of services required as explained in the following subsections.

A. *Functional Services*

The user will be shown services and individual costs for each service provider, as shown in Fig. 3. In this case the providers are AWS, GCE, Rackspace, and Azure.

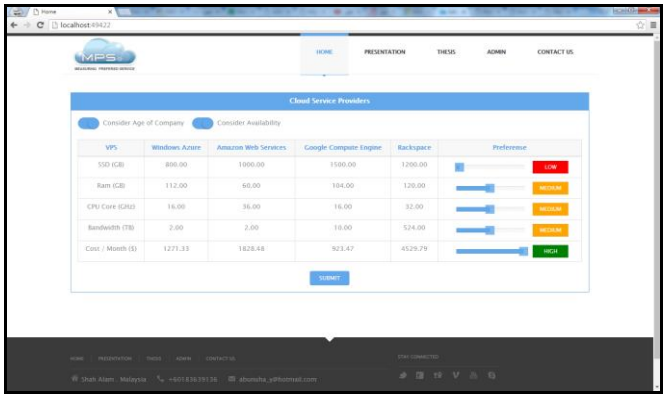

Figure 3. List of Preferred Providers and Services

The provider is ranked according to the priority of service according to the need of a user. The value of priority ranges from 1% which implies the lowest value to 100% which implies the highest value of services. Additionally, there are also CSP Cloud services providers. *P1* represents AWS, *P2* represents GCE, *P3* represents Azure and *P4* represents Rackspace. CSPs are Cloud providers who can provide services meeting the user needs and requirements based on their priority. Then the user submits the list of services to the MPS System. The user chooses their preferred services as follows: Low level which is 34% for SSD, medium level which is 67% for RAM, medium level which is for CPU, medium level which is for bandwidth and high level which is 100% for cost service. The results of adding the total services must be 100%, which is then calculated using linear equations for measuring preferred services.

The output of the measuring preferred services of the provider is a set of possible dispositions arranged for the best service, which is gained by the provider. Fig. 4 shows the output screen provided by the system.

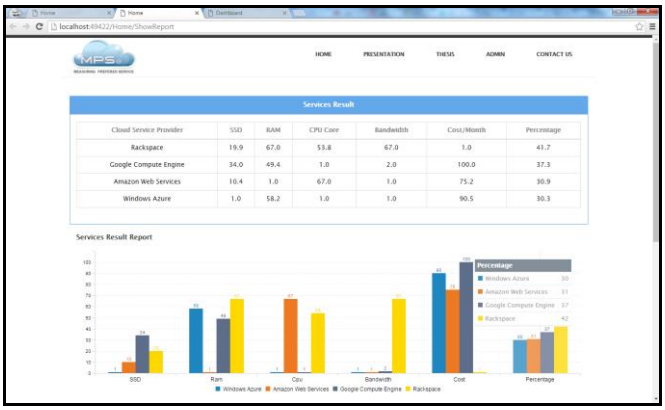

Figure 4. Services According to User Preference

B. *Functional Services and Availability Service*

In Fig. 5 other availability service that is non-function service can be added. The result will not be affected because it will not be measured in the MPS. In case the user decides to select the availability service, the system can input this automated service and output updated data.

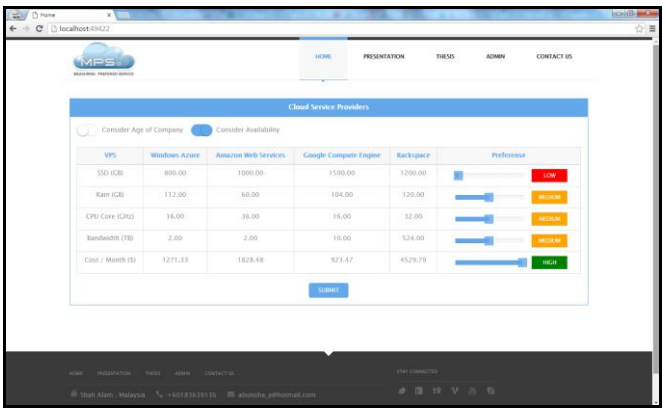

Figure 5. Available Services

The list keeps the same layout as the input data, which may be utilized as the input of the following next service of the model, which is the automated service distributor. The screen of this operation is summarized and displayed in Fig. 6.

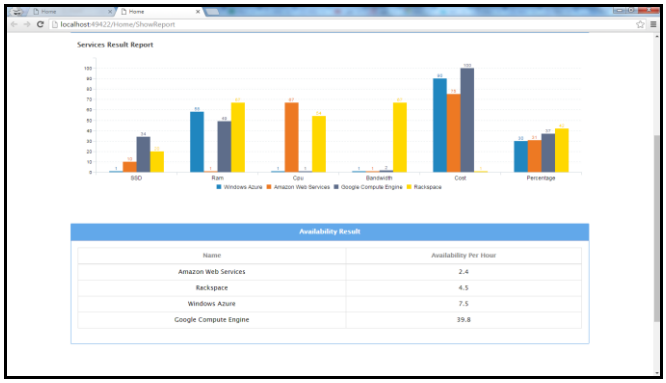

Figure 6 Final Result of Availability & Services

C. *Functional Services and Age of Company Service*

The age of company service is used as input for the non-function that is not measuring service in the MPS system as shown in Fig. 7.

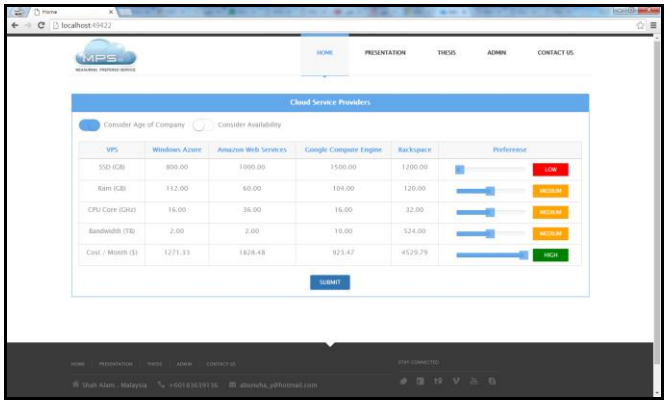

Figure 7. Services and Age of Company

Fig. 8 shows an addition to the age of the company with other services. The output result is shown in Fig. 8. If the user is interested in the age of the company service, this output presents the final data.

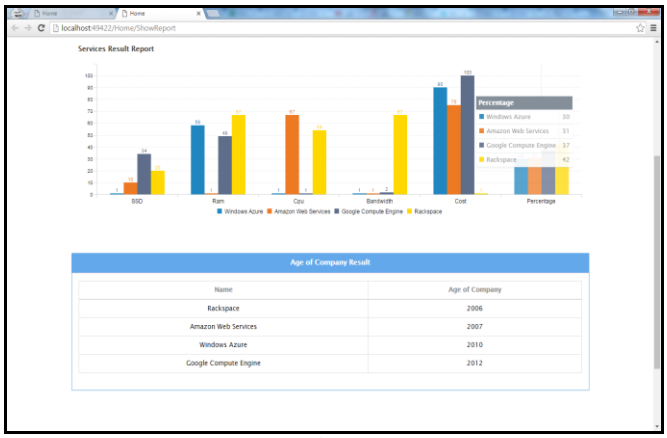

Figure 8. Age of Company and Services

D. *Functional and Non-Functional Services Selection*

Assume that the user selects reputation services. In this case, the user can choose the service that is shown in Fig. 9. After the user submitted the services, the screen shows trust information of functional and non-functional services and finds that there are CSP Cloud service providers. P1 represents AWS, P2 represents GCE, P3 represents Azure and P4 represents Rackspace. CP can provide services that meet the user needs and requirements based on their intent.

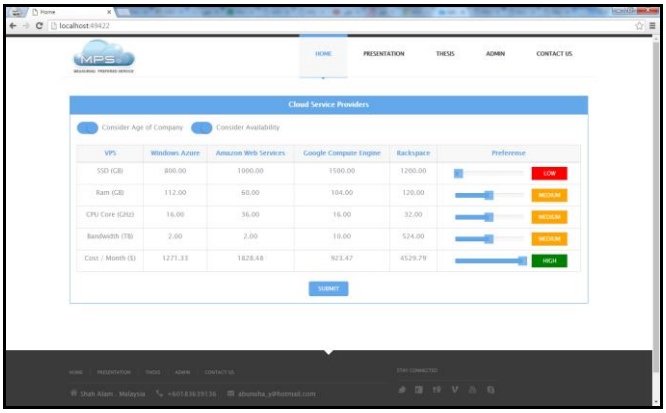

Figure 9. VPS Services and Reputation

Fig. 9. leads the user to the optimal choice of the best service provider according to their preferences of function and non-function services.

VI. SUMMARY

Experimental results on selection strategies in MPS algorithms based on the two selection strategies are tested on examination timetabling problem, and the comparison between them is done to examine the performance of these providers of Cloud Computing with different selection strategies from the user side. The following algorithms are based on two selection strategies mentioned above in Section III. MPS system has been developed to explore optimal selecting for the best service provider in Cloud Computing by means of multi-provider simulations.

This selection allows both higher/best and lower/good services to be selected. Rank selection could change value for each service and computing isolated service and computing the total sum of aggregation services produced new and different results according to the priority of user. Best selection to each individual provider is based on best provided service from opinion of user according to their preferred services that meet with its need and application.

To suggest a set of possible configurations prioritized by user, the optimal selection decision for the best service provider receives the Cloud resources requirements. Preferred features and services which include new limitations along with the priority given by administrator to selected services should be considered to select the most adequate providers. The model is based on the priority of users, but it has been improved. First, propose extending the database plan and adding new screens to store the values that Cloud providers have for new services. For example, downtime and age of company services could be added to store the information related to the history of different Cloud providers and availability to include a minimum percentage of downtime and maximum age of provider to sort the candidate providers [18, 19].

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