International Journal of Cloud Applications and Computing
Volume 11 • Issue 1 • January-March 2021

A Robust and Efficient MCDM-Based Framework for Cloud Service Selection Using Modified TOPSIS

Rohit Kumar Tiwari, Madan Mohan Malaviya University of Technology, India
https://orcid.org/0000-0001-6501-2043

Rakesh Kumar, Madan Mohan Malaviya University of Technology, India

ABSTRACT

Cloud computing has become a business model and organizations like Google, Amazon, etc. are investing huge capital on it. The availability of many organizations in the cloud has posed a challenge for cloud users to choose a best cloud service. To assist the cloud users, we have proposed a MCDM-based cloud service selection framework to choose a best service provider based on QoS requirement. The cloud service selection methods based on TOPSIS suffers from rank reversal problem as it ranks optimal service provider to non-optimal on addition or removal of a service provider and deludes the cloud user. Therefore, a robust and efficient TOPSIS (RE-TOPSIS)-based novel framework has been proposed to rank the cloud service providers using QoS provided by them and cloud user's priority for each QoS. The proposed framework is robust to rank reversal problem and its effectiveness has been demonstrated through a case study performed on a real dataset. Sensitivity analysis has also been performed to show the robustness against the rank reversal phenomenon.

KEYWORDS

Cloud Service Provider, Cloud Service Selection, Cloud User, MCDM, Rank Reversal Problem, TOPSIS

INTRODUCTION

Cloud computing plays a vital role for start-ups as well as small enterprises to start their business with low capital investment. It is a new form of utility computing that delivers computing resources, storage, software, platform, etc. on-demand to the customers over the internet on pay as per usage like other utilities (e.g. gas, Internet data, electricity, etc.). It also provides scalable, ubiquitous, reliable and dynamic services to customers to fulfill their requirements. Its services are broadly categorized into three major areas- Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). SaaS provides ready-made applications for use like customer relationship management (CRM) (Cusumano, 2010), Gmail, Saleforce.com, etc. PaaS provides an environment or platform like Google App Engine (Ciurana, 2009), Windows Azure Cloud Services to develop applications on top of it. IaaS provides compute, network, and storage services for hosting the applications. The major IaaS service providers are Amazon Web Services (AWS), IBM Bluemix, Rackspace, Google Compute Engine, etc.

Cloud computing is boon for medium and small enterprises as they do not have to invest a large amount of capital on their infrastructure setup and maintenance. They have to only focus on

DOI: 10.4018/IJCAC.2021010102

their innovation and business policy as computing resources, storage, network, platforms, etc. are available at a competitive cost on a subscription basis and resources are maintained by the cloud service providers (CSPs). It also provides the freedom to the business community from scalability and elasticity (Shojafar, 2016) perspective as services are scalable within a minute based on demand. Due to the above benefits, many companies like Coursera, Siemens, Netflix, etc. (AWS Customer Success, 2018) are managing and developing their services on the cloud. It is also motivating large enterprises like Google, IBM, Microsoft, etc. to move their business to cloud due to its accessibility at anytime and anyplace. Its usage is growing at a very fast rate as its users are from the individual level to small enterprises to big organizations. But there are a lot of challenges to move applications to cloud as each application has specific requirements like response time, security, availability, etc. So, before moving the applications to the cloud, there is a need to select the best CSP that could fulfill the specific requirement of the application.

As there is a scope of a lot of profit in cloud computing in upcoming future due to its growing use, many big organizations like Microsoft, Google, IBM, Amazon, etc. have invested huge capital and started providing cloud services. Therefore, for a cloud user, it has become a difficult task to choose an appropriate CSP available in the market like AWS, IBM Bluemix, Google Cloud, Salesforce, Microsoft Azure, etc. according to their requirements as they are providing similar QoS at different cost and performance. There are many CSPs that provide one service like computing at lower cost and storage at a higher cost than the others. Some CSPs also charge a different cost for a service based on regions like AWS EC2 (Varia, 2011) has different pricing for EC2 instances based on the region where it is located. All the CSPs are competing based on QoS provided by them.

So, the selection of right CSP as per cloud user requirement is a challenging task as there are many CSPs in the market and its selection depends on many functional and non-functional QoS requirements. Therefore, there is a need for a framework that can assist the cloud user in efficient and accurate way to select the right CSP and rank them. In this context, there is a need for identification of standard QoS metrics for cloud services and a ranking algorithm to rank CSPs based on QoS. To identify the standard QoS metrics, the leading global organizations of the world formed a consortium named Cloud Services Measurements Initiative Consortium (CSMIC) (SMI framework 2019) to identify the QoS metrics for services provided by CSPs. CSMIC proposed a framework called Service Measurement Index (SMI), which has seven major QoS metrics like Accountability, Financial, Usability, Performance, Agility, Assurance, and Security & Privacy. Further, they divided each metric into various sub-metrics to describe each one in detail. These metrics are used by cloud users to compare various CSPs.

The ranking of CSPs based on various QoS is an MCDM problem. There are many works (Garg et al., 2013; Baranwal & Vidyarthi, 2016; Sidhu & Singh, 2017; Tripathi et al., 2017; Kumar et al., 2017; Kumar et al., 2018; Lee & Seo, 2016; Liu et al., 2016; Rădulescu & Rădulescu, 2017; Basu & Ghosh, 2018; Al-Faifi et al., 2019; Abdel-Basset et al., 2018; Jatoth et al., 2019) based on MCDM techniques like TOPSIS, Analytic Hierarchy Process(AHP), Analytic Network Process(ANP), rank voting, ELimination and Choice Expressing Reality (ELECTRE), VIKOR and Simple Additive Weighting (SAW) to rank the cloud services in literature. The cloud service ranking based on TOPSIS methods (Kumar et al., 2018; Rădulescu & Rădulescu, 2017) suffers from the rank reversal problem as studied by various authors (Wang & Luo, 2009; Luce & Raiffa, 1957; García Cascales & Lamata, 2012). The rank reversal problem alters the ranking of an optimal CSP into non-optimal CSP on the addition or removal of a CSP in the cloud service repository. This causes the cloud user to lose their trust in cloud service selection tools.

Therefore, in this paper, we have proposed a cloud service selection framework based on RE-TOPSIS method to select the best CSP, which is robust to rank reversal problem and more efficient than TOPSIS based cloud service selection frameworks. The RE-TOPSIS has been used to rank the various CSPs based on QoS provided by them. We have also defined the various metrics of the SMI