IJICTR
International Journal of Information & Communication Technology Research

Volume 11- Number 1 – Winter 2019 (19 -26)

Continuous Double Auction Scheduling in Federated Cloud Services

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Received: 5 May 2018 - Accepted: 3 August 2018

Abstract— **In recent years, researchers have introduced many different mechanisms to improve resource allocation in the cloud. One of these resource allocation methods is market-based resource allocation which exploits different models used in exchanging goods and services. In this research, a two-way auction model is used for allocating cloud resources based on the market model. In the case of federated clouds, as the providers may face a shortage of resources during their operation; therefore, the continuous double auction model is suggested to create a cloud federation environment to support a suitable resource allocation among different providers. In our experiment 1, fixed pricing with Reputation-Aware Continuous Double Auction, Continuous Double Auction, and Market-Driven Continuous Double Auction models will be executed for resource allocation. It shows that both the resource efficiency and the income of the providers are improved in the federated clouds using these models. In experiment 2, with changing the type and number of the requested resources by customers and providers, the proposed federated model is also tested. The results of the experiments show that our proposed model for implementing federated clouds based on the continuous double auction model, in terms of successful allocation rates, resource efficiency and provider revenue, is better than other market-oriented models.**

Keywords- Resource allocation; Cloud federation; Continuous double auction; Double Auction model;

I. INTRODUCTION

Cloud computing is a paradigm of computing, in which computing resources, storage, and online applications are provided as services on the Internet. In fact, in this environment the problem is that the cloud providers aim to provide a set of resources with maximum resource utilization and revenue, and the customer, on the other hand, has a set of needs and wants to get the best service with the most suitable price. Today, service providers are conceiving to respond to the large number of customer requests as a way to maximize their productivity due to maximizing their resource efficiency, the same idea cloud federation has been addressing. One of the strategies for allocating resources in the cloud environment is market-based method, that is, using different market-based models used in trading goods in the real market to exchange and allocate resources to the cloud services. Because of the static and dynamic nature of the cloud-based market approach, it has a high potential for allocating cloud resources. There are different market-based models for resources allocation [1-4].

The main purpose of resource allocation methods is to establish an agreement between the resource provider and the customer by which the provider agrees to provide a capacity that can be used to perform the tasks of customer. The market-based approach introduces the cost and resource pricing as a method for coordination between customers and resource providers [5]. In market-based resource allocation methods, customers often negotiate with a cloud provider about the cloud resources including computing, storage, and software according to the demands and offers in the market. In some researches the balance between offers and demands in cloud market is considered and discussed

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[6]. Since we use auctioning in our proposed method to reach a balance between offers and demands; therefore, we will only explain the auction-based models.

The auction can be divided into three types based on the participants: single auction, double auction and combinatorial auction. Single auction is a mechanism in which only buyers or only sellers can submit offers and demands. Although this auction is a popular market-based model, it often leads to an inefficient resource allocation. However, different models such as the British auction, the Dutch auction, the first auction of the sealed price, the Dutch auction and the auction of Vickrey use the single auction model [3].

In double auction, both providers and customers send their offers, and then the bids are ranked from the highest to the lowest. Sales suggestions start and grow from the lowest price, and purchase orders start and fall from the highest price. In a bid auction, determining the winner depends on a variety of aspects, such as density, resource differentiation and whether resources are homogeneous or heterogeneous [3]. Two forms of double auction are continuous-time double auction and discrete-time double auction. The key features of a discrete double auction are that the list of offerings from providers and customers are collected in certain time intervals and then cleared by the expiration of the time interval for offering. In the case of continuous double auction, customers and providers can continuously submit their offers during the auction period [7-9].

A hybrid auction allows customers and providers to buy and sell a package containing multiple resources and offer only one price per package. This is interesting for customers, as they do not need to be engaged with providers in multiple negotiations for each resource [3].

Recently some researches have done in the field of double auction for cloud resource allocation. They all have considered the problem in a single cloud, and to the best of our knowledge this auction mechanism has not been used to allocate resources in federated clouds. In this research, the problem of using this model in the federated clouds and its mode of operation has been studied.

In [10], an Intelligent Continuous Double Auction (ICDA) model is proposed for the allocation of cloud services. In [11], the Continuous Double Auction method called Market-Driven Continues Double Auction (MCDA) is presented for efficient allocation of cloud services, which gives customers the opportunity to order different resources as a workflow for the use of requested services. This method is inspired by the work presented in [12]. With respect to the rate of successful allocation and utilization of the resources, the factor of enthusiasm was considered which is higher than that of other methods in different workloads. Communication time is much lower than other methods. An online electronic double auction platform in cloud and a continuous double auction mechanism for matching orders and platform-based ease of exchange are presented in [13]. In [14], using the proposed method, the continuous auction model has been improved through the updating of proposals by the auctioneer itself, which is known as the Update Continuous Double Auction (UCDA) method. In [8], a method called the Stable Continues Double Auction (SCDA) was developed on the basis of conventional continuous double bidding to allocate resources in grid computing. In [15], a continuous double auction method called the Parallel Continues Double Auction (PCDA) is proposed for efficient allocation of services in cloud computing using the new parallel sorting algorithm in the auctioneer [22]. It enables the consumers to order different resources as a workflow in order to use requested services efficiently. This method is inspired by the work presented in [12], [21].

The general view of the cloud federation is presented in [16], and the authors discussed about the challenges in the single cloud, and the reasons of acquisition for the federated clouds from economical point of view. In [17], the authors show how the dynamic pricing is suitable for federated cloud computing resources where customers may both use and provide resources. The [18] studies the impact of rational factors in federated clouds by comparing customer satisfaction in a fix-pricing model similar to Amazon in offering some kind of resources in this way.

In this paper, we propose a two-step double auction method in federated clouds that hires the market-driven continuous double auction (MCDA) and CDA models that are optimal models in cloud and grid computing respectively, along with the basic model of Reputation-Aware Continuous Double Auction (RCDA), to compare each of these models with the current fix-pricing model.

In this article, after the introduction, the auction methods are presented in the second section. In the third section the proposed method for bidding in the federated clouds is described. In the fourth section, implementation of the proposed method is described in which we explain the basic steps of the implementation. In the fifth section, the evaluation and analysis of the results from the experiments for the allocation of resources in the cloud federation is presented using double auction model. Finally, in the sixth section of the paper, we will summarize the article and present our suggestions for further researches in this area.

II. AUCTION METHODS

Auctions are the process of trading resources by giving a high bid for auction and selling items to the buyer with the highest bid. In an auction of an object's price, the result of a buyer's competition is based on the rules previously defined by the seller, the auction has a wide range of variables, for example: the seller may advertise a fixed price and send the object to the first buyer interested in selling, or the seller may accidentally take a buyer and negotiate the price with him/her, etc. In all cases of negotiation, the seller always strives to maximize his profit, he wants to sell a product and get the highest possible payment, while the goal for buyer is to buy the product at the lowest possible price. In the real world, auctions are widely used, especially for the sale of goods in a set [2].

The auction can be divided into three types based on the participants and exchanging goods: one-way auction, two-way auction and a hybrid auction.

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A. One-way auction

One-way auction is a mechanism in which only buyers or only sellers can submit offers and requests. In other words, the one-way auction is a one-to-one price negotiation mechanism. Although this auction is the most widely used market model, it often leads to inefficient allocation [3]. William Vickie presents a general classification of one-way auction based on the order in which prices are quoted and the manner in which prices are proposed [7]. In the following, we introduce 4 types of one-way auction which are widely used:

1) English auction

Auction begins at the lowest acceptable price. Each bidder increases his offer until the other person is interested in creating more tenders or offers, until the auction ends and the product will be offered to the bidder who has the highest bid. This auction is also called First-price open-cry [3].

2) First Price Sealed Bid Auction

In this type of auction, each bidder makes a proposal without any knowledge of the suggestions of other participants. After the offers are received, the product is sold to the bidder at the highest price offered [3].

3) Dutch auction

The auctioneer adjusts the price for the product above the current price. Then, during the auction process, the auctioneer reduces the price until the participants are willing to accept the auctioneer's price or a minimum price set. This kind of auction is also called a descending auction [3].

4) Vickrey Auction

Each proposer makes suggestions without any knowledge of the offer of others. The bidder who makes the bid with the highest bidder takes the auction, but at the price of the second highest bid. Vickrey Auction is widely used in multi-factor computing systems such as resource allocation in the operating system, network bandwidth allocations, and computing heat control in buildings. This type of auction is also known as the second sealed offer price [3].

B. Two-way auction

On a two-way auction, both providers and customers submit their offers and then rank from highest to lowest. Selling offers starts at the lowest price and increases, and purchase offers start and fall at the highest prices. In a two-way auction, the winner depends on different aspects such as density, resource differentiation and whether resources are homogeneous or heterogeneous [3]. Based on the time for submission of offers, there are two types of two-way auction:

1) Two-way discrete time auction

In this auction, all traders move in the unitary phase (predetermined time frame) from initial allocation to final allocation [2, 17]. All transactions are traded in one step at the same price at the end of the time frame [8]. The key features of a discrete two-way auction are that the provider's and customer's offerings are collected at specific intervals and then cleared by the expiration of the offer interval.

One of the most prominent examples of this type of auction is the Walrasian auction. At Walrasian auction, the auctioneer declares the price, and each participant indicates whether he wants to buy or sell with that price. If demand is not equal to the supply, then the bidder changes the price. No deal will happen until the price is found at which the demand is equal to the supply [7].

2) Two-way continuous time auction

On a two-way continuous auction, customers and providers can continuously submit their offers during the auction period. The latest offerings from customers should be lower than any suggestions from the previous offerings of the previous customer and current offer provider. When the offer is equal to or less than the customer's offer, the trade occurs. The winner of the auction will buy the resource for half the price of the lowest offer provider and the most sought-after customer offer [9].

There is no predefined time frame in a continuous time two-way auction. Offers from customers and providers are received continuously. A transaction can occur at any moment, that is, the continuous matching of the offers. Two-way auction is in fact one of the primary means of trading stocks, commodities and derivatives on financial markets such as the London Stock Exchange (LSE) and the New York Stock Exchange (NYSE).

There are different forms of continuous bidding that are specified by various factors. Auction bidding is a simple and strong auction, but it can achieve high productivity. Auction bidding is an open and transparent auction, and rely heavily on the auctioneer's trust in a sealed auction. Above all, it offers the continuous matching of goods. Hence, the need for immediate allocation can be fulfilled [7].

C. Modeling Two-way Auction mechanism

A general two-way auction model used to allocate resources to cloud markets is the basis of all available models and the corresponding model is described here.
Definition 1. Description of the CDA with sequential queue:

$$CDA = (r, P, U, ASK, BID, a_{min}, b_{max}, C, V)$$

r; the type of auction source is CDA.
$P = \{p_1, ..., p_m\}$; a finite set of provider identifiers in which m is the number of providers.
$U = \{u_1, ..., u_n\}$; a finite set of customer ids in which n is the number of clients.
$ASK = \{a_1, ..., a_k\}$; a limited queue of ask, which is a value (price) sent by providers in which k is the number of requests.
$BID = \{b_1, ..., b_i\}$; A limited queue of bids is the value (price) sent by customers in which i is the number of bids.
a_{min}; the lowest current ask in ASK.
b_{max}; the highest current bid in BID.
$C = \{C_1, ..., C_j, ..., C_n\}$; the boundary value set n of the cloud provider. C_j is the price of the provider j which is the lowest ask that he is willing to send.
$V = \{V_1, ..., V_i, ..., V_m\}$; the price limit set for m cloud client. V_i is the price of the client and the cloud, which is the highest bid he is willing to pay.

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Definition 2. In a CDA, providers submit requests that may reduce a_{min}, while customers submit bids that are likely to increase b_{max} until b_{max} is less than a_{min}.

The moment when b_{max} is greater than a_{min}, a transaction occurs between the provider with the lowest a_{min} of the target and the operator that sent the most b_{max}. Transaction occurs in the mean value of b_{max} and a_{min}. Adaptive b_{max} and a_{min} will be removed from the auction. The period between two successful trades is known as a single round, and this period is non-constant.

Definition 3. The CDA consists of the following steps:

1) CDA starts with $R = 0$, $a_{min} = \infty$, $b_{max} = 0$.
2) The following situation may arise during the auction round:
   a) When the asker sends a value of a:
      1. If $a > a_{min}$ then a enter the appropriate place in *ASK*.
      2. If $a_{min} < a < b_{max}$, then $a_{min} = a$.
      3. If $a \leq b_{max}$ then the provider that chooses a and the customer who sent b_{max} will be selected as the winning bidder and the resource price will be determined $(a + b_{max})/2$.
   b) When the customer sends a bid worth b:
      1. If $b < b_{max}$ then b enters the right place in *BID*.
      2. If $b_{max} < b < a_{min}$, then $b_{max} = b$.
      3. If $b \geq a_{min}$ then the client that sent b and the provider that sent the a_{min} will be selected as the winning bidder and the resource price of $(b + a_{min})/2$ will be determined.
3) Step 2 will be repeated.

for the proposals offered by the provider and the customers which are sent to be rational, the client's offer should not exceed the maximum price he wants to pay and the offer of the provider j should not be less than his minimum resource cost, that is:

$$Cj \leq aj \leq Max \quad (1) \qquad Min \leq bi \leq Vi \quad (2)$$

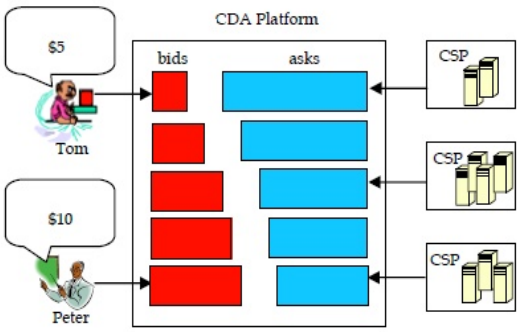


Fig. 1. Two-way bidding scenario in the cloud market [14]

In any step, only one ask or bid can be submitted. In each step t, if a request or bid is sent, then $t = t + 1$, and in each step t, if the asking value of the submitter and the bid submitted by the customer are adjusted, a transaction occurs at the following price:

$$P_t = (a_{min} + b_{max}) / 2 \quad (3)$$

The Fig. 1 shows the scenario of this model in the cloud market.

III. THE PROPOSED METHOD

In our proposed method, there are two auction steps. At the first auction, there are a number of customers and providers who enter into negotiations, according to the two-way auction mechanism, the provider who won the auction will execute the customer's request. The provider enters into a second auction, if it fails to fulfill the customer request due to the lack of resource. It will enter into negotiations with providers in the federated clouds under a double auction mechanism to receive the requested resource. The first stage, which is between customer and provider in a single cloud, has been implemented in some researches that have been conducted in the cloud environment so far, and we have focused on the second auction that occurs among providers in the federated clouds.

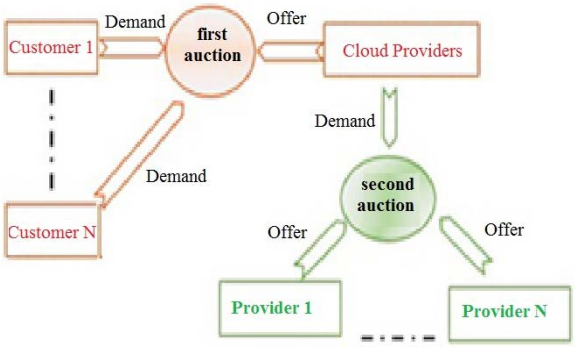


Fig. 2. Conceptual Model of Research

In models implemented in the cloud environment, only providers allowed to receive customer requests that have enough available resources for the customer needs. Hence, we will not be confronted with the implementation of these models in the cloud environment with providers who are facing shortage of resources, and the provider who won the auction will have any number of resources that the customer has requested. While in the cloud federation, we deal with providers that do not have enough resources to respond to customer service requests, and should lease the amount of resources they need from other providers in the cloud. In order to implement the federated environment of clouds and to achieve such providers, we implemented double auction models of cloud environments based on our proposed model. In our proposed model, in addition to providers with more or equal number of customer demand, providers who have fewer resources than the customer demand are allowed to participate in the auction model to provide a customer service request. So if they win in the auction models and fixed pricing model in the cloud environment, it can participate in the federated clouds and receive the resource from other providers.

IV. IMPLEMENTATION

The main goals of the market-based resource allocation systems are the provider's revenue, the successful allocation rate, and resource efficiency that is addressed in this research. In order to have feasible implementation of the proposed model, in this study, we consider two steps.

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Step 1 – Implementation of the Selected Auction Models and Fixed Pricing in the Cloud:

As mentioned earlier, in online bidding and fixed pricing models that are implemented in the cloud, only providers are allowed to participate that own equal or more number of their resources than the number of customer resources required. In this step, we are going to put into the cloud environment the models that we have chosen to implement the proposed method on this basis.

Step 2: Implementation of the proposed model in Federated clouds

To implement the model in Federated clouds, after implementing fixed-price and auction models in the cloud, we will have providers with fewer resources than the number of resources customer requested. Since by implementing such selected models in cloud environments we miss such providers. Therefore, the first step is to select the proposed model based on the most appropriate model in step 1, which is selected based on the best resource efficiency, profit margins and successful allocation rates, in order to obtain providers with resource shortages. Then in the Federated Clouds we could have providers with a shortage of resources and also providers with additional resources in each of the cloud-based models. Finally, we compared the rate of resource efficiency, income of providers and successful allocation rates in each of the models to see if, in which of the selected models we would have improvement compared with the fixed pricing model in this environment [23]. In Fig. 2, P1 ... Pn represents the providers with equal or more resources than the number of resources customer needs and P1 ... Pm are providers that have fewer resources than the number of resources customer needs. U1 ... Un also represents the customers in the cloud environment. The limitations of selection for a provider that demands resources is as follows:

- The amount proposed by the provider for the resource is less than suggested amount of the customer.
- The resource that the provider currently has is at least 1000 seconds busy from the current moment.
- The number of resources that the provider needs to be provided is at most 1.

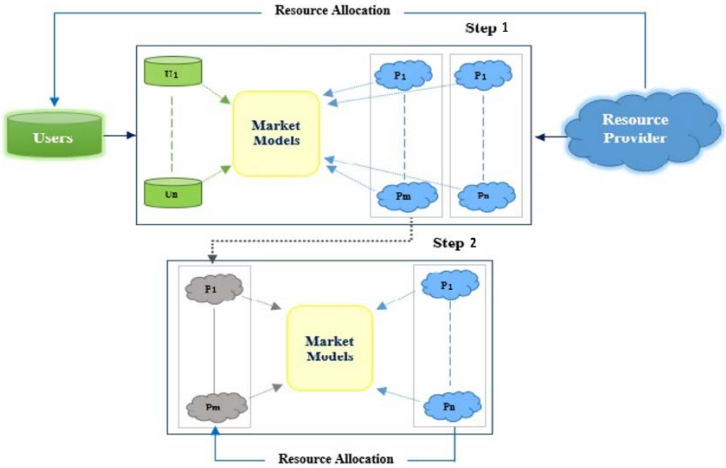


Fig. 3. The Implementation of the model

V. EVALUATION AND ANALYSIS OF RESULTS

In this section we explain the method of evaluation. To set up the evaluation, we consider 100 and 150 customers, a resource service request is made up of a maximum of 3 types of resource and the number of each type of resource, up to a maximum of 3, and for 30 providers. The service request, including a maximum of 1 resource type, up to a maximum of 3 for Cloud and 1 for federated clouds. For simulation, we have configured 12 cloud datacenters in CloudSim tool. Each cloud consists of 45 physical hosts, which are evenly divided between three different host types with 12 to 24 CPU cores. All 15 modeled datacenters provide computational services with different VM settings.

We evaluated to show whether providers by participating in selected models, if implemented in the cloud environment, would receive the most allocations, profits and efficiency for their resource, or if they participated in Cloud Federation. Regarding the implementation process mentioned in the previous section, in each of the experiments, first, we have the implementation of the first step: the selected auction models and fixed pricing in the cloud; then, we have the implementation of the second step: the proposed model for the federated clouds.

A. *Experiment 1*

In this experiment, with the implementation of step one, fixed pricing, RCDA, CDA and MCDA models is executed respectively. After completion of execution for each model, in the final output, the amount of busy time of resource for each provider, and the final price of resources for various customers, as well as the total number of successful customers, will be determined. The summary of the output results from this step is presented in Table (1).

TABLE (1): OUTPUT RESULTS- STEP 1 EXPERIMENT 1

Cloud	Successful Allocation (%)	Price ($)	Resource Utilization (s)
Fix_Price	34	267	73803

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RCDA	41	311	94671
CDA	49	403	126001
MCDA	60	524	189331

The results obtained in step 1 indicate an increase in the number of customers who have been able to get all the resources in their resource package and also increase in the efficiency of the provider resources in each of the models compared with the fixed pricing model.

Since MCDA and CDA models provide client and provider with suggestions that are more reasonable and also at a market equilibrium, so the number of customers who will be able to access all their resources in these two models is higher than the other two models. So providers will earn more revenue from leasing resources.

According to the analysis of the results obtained in this step, among the existing models, which can provide the most successful allocation rate, revenue and efficiency for the resource of the providers in the cloud environment than the fixed pricing model, the MCDA model has gotten the best results. Therefore, for the implementation of the federation, in step two, we propose the implementation of our proposed model based on the MCDA model called Federated MCDA (FMCDA).

By implementing the FMCDA model in the second step, it turns out that after the end of some rounds of the auction, we will find providers who are faced with a lack of resources. At this moment, these providers negotiate with the implementation models in step one to get the federated resources with providers who have an idle resource. The reason for using cloud models is that, in a federated environment, providers who intend to provide resources to another provider must be sure that the number of resources to be provided is equal to the number of resources that the customer (the provider) needs, so we need to use cloud environments in the federated environment to exclude providers who are lacking resources. Implementing this step can be done in different scenarios. In the following, we will look at how much successful allocation, revenue, and utilization for cloud and federated providers will be achieved if federated cloud providers participate. The summary of the output results in this step is presented in Table (2).

TABLE (2): FMCDA OUTPUT OUTPUTS

Federated Cloud	**Successful Allocation (%)**	**Price($)**	**Resource Utilization (s)**
FMCDA_ Fix	79	573.05	225504
FMCDA_ RCDA	79	576.3	230018
FMCDA_ CDA	81	613.85	255627
FMCDA_ MCDA	81	617.35	257318.76

Based on the results obtained in the final output, both MCDA and CDA models have the same percentage of improvement in the successful allocation rates as the fixed pricing and RCDA. The successful allocation rates in the Fix and RCDA models are 79%, because in both models, only 2 out of a total of four providers that are facing resource shortage have succeeded -to get their resources.

What is visible in Chart (1) is the superiority of the FMCDA model to the MCDA cloud model. As the federated clouds are concerned with reducing the time lag of resources and thereby increasing provider revenue, and as the MCDA model is better than CDA in these two cases, the MCDA model is the best option for providers of services. So in the federated clouds, it is better in terms of resource efficiency and the income of the providers and successful allocations. The FMCDA model, even with the federated fixed pricing model, which is the worst federated model in this test, has been able to provide the highest allocation, productivity and revenue for cloud providers over the cloud's MCDA model.

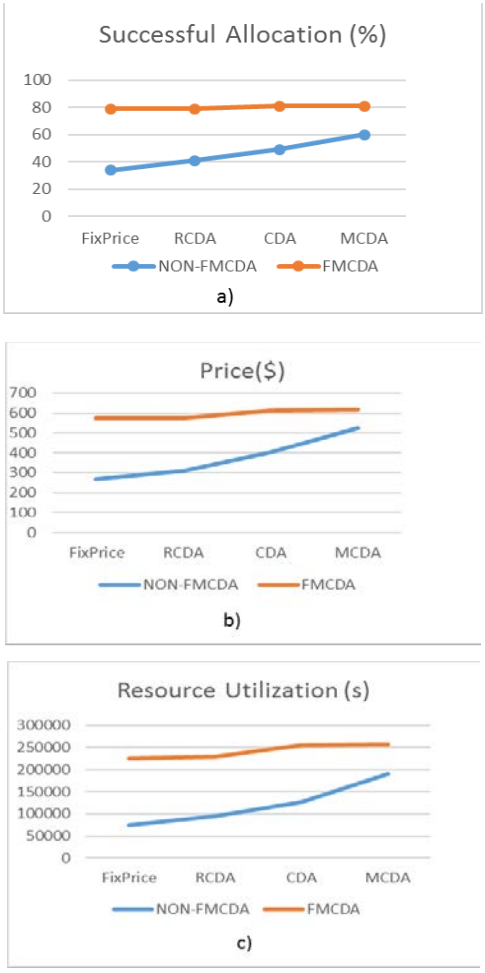


Fig. 4. Improvements by federated models compared to the MCDA model

B. *Experiment 2*

In order to evaluate and analyze the performance of the proposed model, we conducted two tests with 150 customers and 30 providers. Given the changes for values of the initial parameters after each round, the results of experiment 1 may not be the same in other implementations. In this experiment, the comparison between the models is done in several iterations with a lot of customer requests to see if in other executions, with the change in the type and number of resources requested by customers and providers, our proposed

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federated model will have better performance than the MCDA model in the cloud?

So, in this experiment we selected 10 executions in which the maximum number of customers was able to access all their resources at least in one of the models in the cloud. The average outputs of Step 1 for each of the implemented models in the cloud in 10 rounds of execution on the basis of successful allocations, resource efficiency, and revenue providers are shown in Table (3).

TABLE (3): AVERAGE RESULTS OF CLOUD MODELS IN 10 ROUNDS OF EXECUTION IN STEP TWO OF EXPERIMENT

Cloud	Successful Allocation (%)	Price ($)	Resource Utilization (s)
Fix_Price	38.3	636.5	320662.6
RCDA	42.5	736.3	377161.2
CDA	51.8	881.2	440938.3
MCDA	59.2	940.6	487082

According to the results of Table 3, the model with the most improvements for all three objectives of the study is the MCDA model with an average of 53.7% in the successful allocation rate, 55% in the resource efficiency rate and 63.3% in the provider's profit compared with the Fixed pricing model in 10 different run times. CDA and RCDA models and fixed pricing are in next rankings.

After the implementation of the step one, it is time for implementation of step two. With the implementation of the FMCDA model, in the second step, the FMCDA-MCDA model, with a 1.86 percent improvement in cloud-federated cloud allocations, 3.9 percent for cloud and federated providers, and 4.6 percent for cloud and federated cloud providers, has been able to have improvement in Successful allocations, revenue and efficiency of provided resources for both cloud and federated providers compared to fixed pricing model.

Fig. 5 shows the percentage of improvement of FMCDA_CDA, FMCDA_RCDA and FMCDA_MCDA models compared to MCDA in this experiment. This figure shows the superiority of the FMCDA model to the MCDA model both in terms of utilization, both in revenue and in resource efficiency of providers.

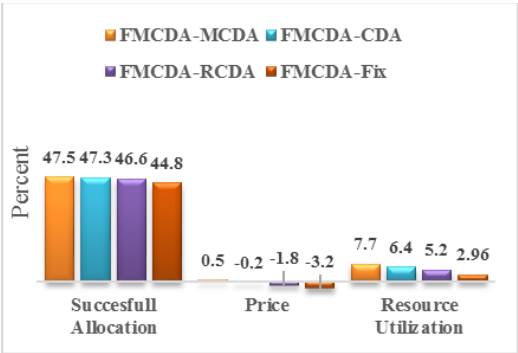


Fig. 5. The average improvement of federated models compared to the MCDA model in the two experiments

Unlike experiment one, in which all four federated models have had the best performance compared to the MCDA model, the MCDA model is among the four federally implemented models, which has been able to improve both productivity and revenue and resource efficiency of providers. While the improvement of other models was only at a successful allocation rate and resource efficiency rate, but in the provider's revenue, we saw a downward trend, with the highest decline relative to the fixed pricing model of 3.2%, and the lowest is the CDA model with 0.5%. The main reason isthe lower rate of successful allocation of CDA, RCDA and fixed pricing models compared to the federated MCDA model. So that the lower the rate of successful allocations, in addition to increasing the amount of fines by the providers, the amount of cost that the customer's providers received would be deducted from the revenue earned from the failure of the service request. Since the MCDA model has the lowest failure rate in the cloud federation, the amount of fines and deductions received from the customer service providers has not been such as to reduce the revenue of the providers in the FMCDA model.

VI. CONCLUSION

What federated providers exploit in cloud federation environment, in other words, what model of a two-way auction will use to provide resources to bring the most revenue, utilization, and successful allocations to cloud and federated providers. It was a subject that we mentioned in this research.

After the federated implementation of the clouds in the experiments, we evaluated the results of continuous bidding and fixed pricing in the federated auction, and then evaluated our proposed model and the best double auction model, to find out that providers by participating in the auction model chosen as the best model in the first step will obtain the highest allocation, revenue and utilization for their resource, or if they participate in the Federated clouds based on a model that we proposed.

The results of the experiments show that the MCDA model excels in the cloud as well as in the federated clouds, even with the increasing number of customer resource requests. With the comparison that was made between the provider at the MCDA auction in the cloud and the MCDA auction in the federated clouds, it was found that providers providing clouds through the MCDA auction will get the most out of their resources, and earn more income. Customers who take part in the MCDA auction will receive all of needed resources with more rate thanother models. In addition, if cloud providers intend to participate in federated clouds in order to be able to maximize revenue and resource utilization in case that they accept a customer's request through a MCDA auction, they will also get resources for the customer's through the MCDA auction, they will earn the most revenue and utilization from participating compared with other models in the federated clouds.

Since the increasing the utilization of resources is important in the cloud as well as the federated clouds, it is proposed to improve the proposed method due to the consideration of the factor of the time the resource is going to be used by the cloud provider to determine the amount of money they are proposing to provide the resource in the MCDA model. In fact, the provider

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prefers to deliver his resources to client with the longest time to use because the requests that have the most running time could increase the amount of resource utilization for the provider and, on the other hand, allows the provider to lease its resources with a better deal in the next situation.

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