A Comprehensive Survey on Load and Resources Management Techniques in the Homogeneous and Heterogeneous Cloud Environment

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Abstract - Resource scheduling is a challenging job in multi-cloud environments. The multi-cloud technology attracted much research to work on it and look forward to solving the problems of vendors lock-in, reliability, interoperability, etc. The uncertainty in the multi-cloud environments with heterogeneous user demands made it a challenging job to dispense the resources on demand of the user. Researchers still focused on predicting efficient optimized resource allocation management from the existing resource allocation policies in multi-cloud environments. The research aims to provide a broad systematic literature analysis of resource management in the area of multi-cloud environments. The numbers of optimization techniques have been discussed among the open issues and future challenges in consideration due to flexibility and reliability in present environments. To analyses the literature work, it is necessary to cover the existing homogenous/heterogeneous user demands and cloud applications, and algorithms to manage it in multi-clouds. In this paper, we present the definition and classification of resource allocation techniques in multi-clouds and generalized taxonomy for resource management in cloud environments. In the last, we explore the open challenges and future directions of resource management in a multi-cloud environment.

Keywords - Cloud, Multi-cloud, Resources Allocation, Load balancing, Energy efficiency.

1. Introduction

Multi-cloud means the distribution of cloud software, assets, and application on many cloud hosting environments. The architecture of Multi-cloud uses two or more private as well as public clouds. Now the user can switch from one cloud to another cloud following prerequisites. Multi-cloud seems like a hybrid cloud actually its different as hybrid always a combination of a public and private cloud but multi-cloud is the mixtures of public and private cloud. A hybrid cloud can be a Subset of multi-cloud. Multi-Cloud provides many benefits as shown in Figure 1. Robust security is one of them. Cloud provides security services in the form of multiple clouds. Users are free from fear of data security. Many researchers still doing work to make multi-Cloud more secure Yangfei Lin et al. [80]. Multi-cloud gives benefits to users in the form of flexibility and scalability. Multi-Cloud is a perfect place for storing and processing the information. Multi-cloud is good for scalability as well as storing as it allows for a business to scale down and up as per requirement. It gives benefits as an organization can invest according to security, protection, and space. Uses of Multi-cloud increased day by day according to the user’s requirement and offer many benefits for attracting users. So organizations always take benefits by comparing services based on the flexibility of payment and other offers given by the company. Mitigating vendor lock-in is another...
Figure 1: Multi-Cloud Technology

Some of the software for management of multi-cloud mentioned in Figure 1 are Jcloud for portability of java application designed in the open-source library of Java. Jcloud is used to access resources from Vcloud, Go grid, etc. Libcloud is a library of Python abstracts the difference between various services interfaces provided by Slice host, Go Grid, Aws, etc. Šcloud allows connectivity of resources of various cloud as AWS, open stack, etc. Simple cloud is a library of Php which allows an interface for storage of file and document and services of the infrastructure of AWS, Azure, etc.[115] The right Scale is a platform for managing the deployment of various cloud , enStratus for handling the consumption of resources on the various cloud. Kaavo handles the workload based on the different cloud as AWS, Terramark, Rackspace, and Eucalyptus. Aeolus is open-source software for cloud management. mOSAIC is open source software for allowing deployment and control of the consumption of infrastructure of various clouds. Optimis is a platform that allows the provisioning of cloud services and management of services of the life cycle. Juliana Oliveira de Carvalho et al. [89][113] described taxonomy about when and how to manage the resources in multiple clouds. The author divide allocation of resources in multi-cloud into two parts first is Pre-Deployment and second is Post –Deployment.

Pre-Deployment: Pre-Deployment means cloud selection and services selection. Due to the facility of Multi-cloud, every cloud provides different services with good offers to cloud users. So the cloud users will always choose cloud as per requirement and benefits. So the user’s application is divided into two
parts i.e. single cloud and multiple clouds, the request which has a requirement of the single cloud is placed on a single cloud and the multiple cloud requirement application is placed on multiple clouds. After cloud selection, the next target is to choose the best VM [114]. So in allocated cloud best VM is selected to fulfill the user requirement in terms of SLA.

**Pre-Deployment:** Migration is the main task that comes under the category of post Deployment. It's a migration of cloud, VM, or service. Cloud migration means users migrate the cloud from one to another as per the requirement of selection. VM’s migrate is to balance the resource utilization on the cloud. Many researchers doing work on the concept of migration for energy consumption. As the data is migrated from one VM to the author when that feels a few VMs can be fully utilized instead of many usages.

Although multi-cloud provides many benefits to cloud users but still having some problem which needs to explore and research on it. To handle the whole working in the case of multi-cloud is very difficult. As user demands increased day by day with a new requirement that belongs to a different cloud. So for that service provider needs good management criteria to handle the whole scenario. Many techniques proposed by researchers to handle the workflow scheduling and resource allocations techniques but many more have to do.

**Structure of the paper:** The structure of the paper is as mentioned below. Section I is an introduction part. Section II is all about a literature survey done in resource allocation techniques, cost reduction and energy efficiency, load balancing, and in a multi-cloud environment. Table related to all techniques of resource management techniques also prepared. Section III Resources allocation techniques classification and taxonomy divided into parts A. Definition and classification of resource allocation techniques. B Evolutionary generalized model for resource allocation management in a cloud environment. Section IV Gap Analysis: open challenge and future direction in a multi-cloud environment. Section V is a discussion regarding the whole work done in this survey. Finally, section VI is the conclusion of the whole work.

2. Literature Survey

Qinglin Qi et al. [22] proposed A Smart Manufacturing Service System Based on Edge Computing, Fog Computing, and Cloud Computing. Due to the high demand of sensor-based data in the field of IoT, the cloud needs high processing speed services. The data is collected from sensors and machines then sent to the cloud after that the response reached the request it results may delay response. So these types of request demand high bandwidth because slow speed services reduce the quality of services. The solution to the above problem is fog computing and edge computing which provides benefits at the local level in terms of storage and processing of user requests.

Heba Saleh et al.[5], Proposed algorithm as large size task is divided into batches of subparts and assigned to available VM for proper resource utilization. The comparison was made with ACO, LBA_HB, and PSO and proves that the proposed method reduces makespan up to 50% and improves the standard deviation and the degree of imbalance.

PeiYun Zhang et al.[53] proposed the task scheduling technique of VM scheduling based on historical scheduling. It works in two stages at the first stage by getting an idea from historical data of resources to demand, VM's are created. At the second stage, the VM's are matched dynamically with tasks and assigned accordingly. The comparison made with Min-Min and Max-min proposed methodology gives better results in makespan and waiting time.

Xi Liu et al.[29] author proposed a technique to solve the problem of PM resources management in a heterogeneous environment. The strategy-proof mechanism helps to get near the best resources to request. It helps in social welfare indirectly by improving resource utilization.

Ao Zhou et al. [64] the author proposed an approach to minimize the network resources when the primary VM is a failure and needs to be recovering by backup VM. This approach works in three steps first steps include allocate the efficient VM to request and the second step is an optimal solution for backup and the third step is the reassignment of VM. In experiment proposed approach is compared with others and found that it uses fewer network resources than others.

Mauro Gaggero et al.[65] The author talk about today's environment of data center means the VM used to extend the capability of PM. But the most important concept is to place the VM in PM in a more appropriate manner. So the author proposes Model Predictive Control for Energy-Efficient, Quality-
Dynamic voltage and frequency scaling, fuzzy logic. The author's framework proposed to handle a in terms of costs with a scheduling technique but just before the request is ready to execute. For Scientific Workflows in a Cloud Environment. Jyoti Sahni et al. [41] proposed A Cost Fit(MMBF) scheduling. Mian Guo et al. [59] developed the combined method of SJF(Min Min BF) and Min Min Best Gravitational search algorithm the proposed method gives a particular resources for a Sunita Rani et al. [95] Cloud provides with others. Serious issue as makespan can be tolerated but not cost. Mubashar Ehsan et al. [40] developed The concept of Afford, and Secure Virtual Machine Placement technique. The Experiment result shows that it performs best by considering all scenarios. Ali Pourghaffari et al. [38] proposed a Combination of several algorithms as EDF-VD (Earliest deadlines first with virtual deadlines), DVFS (dynamic voltage and frequency scaling), fuzzy logic. The author compare various previous scheduling algorithm and found that this method gives suitable results in terms of response time, communication, transfer cost. Sara Kardani Moghaddam et al. [82] The author analyzes the resources management in cloud computing because it's an important part of the good quality of the cloud. In this article the requirement and limitation of cloud resources management analyzed. Identify the previous approaches for resources management and Gap for future direction also identified. Arash Mazidi et al. [86] design algorithm to work on time and cost-saving during the allocation of required resources by the cloud provider. The author combines many algorithms such as the Monitor Analysis Plan Exchange Knowledge loop for scaling of resources, Google Penalty payment model used to identify the penalty of cost, and evaluate the profit. Abdullah Yousafzai et al. [87] Author talk about difficulties of the cloud resources allocation to the cloud user based on SLA. The heterogeneity and unpredictable nature of cloud users make it more difficult. Many researchers doing work to solve these problems. But a lack of effective review of the work already done in this area is the biggest problem. So the author did a survey that includes strengths and weakness of the previous working techniques so that it will easily help to researches to do effective work in the area of resources allocation. Mohamed Abu Sharkh et al. [92] introduced a solution for resource allocation. The author first formulates the problem than 5 heuristics methods to handle the problem. This method not able to handle the problem properly but gives an idea of the VM allocation process. The proposed method gives a good performance in terms of tardiness of request and blocking percentage of network scenario of multiple clouds. Qi Zhang et al. [37] proposed Harmony: Heterogeneity aware resources Monitoring and management system for performing data capacity provisioning (DCP) in the heterogeneous data center. Experiments are done on Google's trace cluster which includes more than 15000 machines and data in the heterogeneous form. The framework proposed to handle the heterogeneous workload on the heterogeneous data center. The result shows that DCP maintains a balance between energy saving and scheduling delay. P.M. Rekha et al. [94] The Efficient allocation of resources to user requests in cloud computing is an important component as it deals with energy consumption, Qos, and throughput. The author develops a genetic algorithm for an efficient algorithm in the cloud environment. The implementation was done on cloud sim and comparison made with the greedy and simple allocation method and gives better performance in terms of throughput. Moussa Ehsan et al. [40] developed The concept of Afford Hadoop as a co scheduler to just scheduling the task rather than moving data in terms of cost-saving. After studying it founds that cost is a very serious issue as makespan can be tolerated but not cost. So for cost-saving Afford Hadoop scheduler is introduced to for scheduling. The simulation results show that it can save up to 48% cost as compared with others. Sunita Rani et al. [95] Cloud provides a large number of computing facilities to the user without having a personal device. So the get the quality of services its very important to allocate the required resources to the user. So to achieve this author proposed a hybrid algorithm by combining the gravitational search concept with the Ant Colony algorithm. The main idea of this algorithm is of a unique search of particular resources for the incoming task. The comparison made with the Ant colony and basic Gravitational search algorithm the proposed method gives a better result. Mian Guo et al. [59] developed the combined method of SJF(Shortest Job First) and Min Min Best Fit(MMBF) scheduling. The SJF and MIN BF suffer from the starvation problem so to reduce this the concept of SJF RL(Reinforcement Learning based scheduling policy proposed), simulation result shows that this is best in throughput performance. Jyoti Sahni et al. [41] proposed A Cost-Effective Deadline-Constrained Dynamic Scheduling Algorithm for Scientific Workflows in a Cloud Environment. The JIT-C (Just In Time) means scheduling is made just before the request is ready to execute. The proposed methodology compared with the previous scheduling technique but the result shows that it is very cost-effective (34%) and the monitoring control
loop helps to meet deadlines. In the future, the work can be extended by including the cost-effective when the deadline is changed.

Reihan Khorsand et al.[36] Framework based on the MAPE-K control loop for autonomous resources provisioning of multitier application. This framework proposed for multitier data such as web-based, database, and storage data. There are various phases of this framework as Knowledgebase, monitoring base, analysis phase, and planning phase and comparison is made how VM, cost, etc. are required for a different type of data. This algorithm adopts sudden changes and assuring the SLA targets. This approach can be implemented on real cloud infrastructure such as an open stack.

Leila Zohrati et a.[4] presented a Flexible approach to schedule tasks in the cloud computing environment. It is a Combination of max-min and a greedy scheduling method to enhance dynamic scheduling. According to this, the assigned task is first sorted according to Max-min and then assigned VM according to greedy selection. By applying this method value of makespan(completion time of the last job) and waiting time is reduced. The future recommended algorithm can be developed for energy consumption, optimization, and efficiency.

Zahra Ghanbari et al.[55] Review related to various IoT resources and resource allocation techniques. This paper gives overall information related to the IoT resources allocation technique and also getting an idea about research related to various resources allocation algorithms, which source provides how much data.

Maria A. Rodriguez et al.[16] present EPSM, Dynamic heuristic-based algorithm. This algorithm is proposed for scheduling the workflow in the form of the workflow as a service. The experimental result shows it not only provides quality of services but also provide cost-effective multiple resources sharing.

Syed Hamid Hussain Madni et al.[54] A review based on various resource allocation methods. From these reviews get an idea of various types of resource allocation as AI-based, dynamic, prediction-based, etc. Research work related to this area also explained in this paper.

Mohit Kumar et al.[60] A comprehensive survey for scheduling technique in cloud computing. The author explained resource provisioning and resource scheduling. All techniques such as heuristic, a meta-heuristic, and hybrid technique including limitations and various parameters.

Andrei Tchernykh et al.[61] The author compares many online scheduling algorithms of the cloud for fulfilling the SLA including less energy consumption. The algorithm that analyzed includes energy-aware, speed aware, and knowledge free. Finally, after the experiment author finds out that method which includes minimum information and less computation always gives better results means provides quality of service.

Syed Hamid Hussain Madni et al.[63] This paper compares various algorithms such as FCFS, MIN-MIN, MAX-MIN, MCT, MET based on makespan, cost, degree of imbalance, and throughput. Each algorithm gives different results based on different parameters. After the experiment, it found that MIN-MIN is better in terms of throughput, makespan, and cost. For the degree of imbalance MET always gives better results in a heterogeneous environment in IaaS cloud environment.

Sibao Fu et al.[78] To reduce the problem of communication delay, energy consumption, bandwidth consumption, etc. is an important target with the increasing demand of users. It's very difficult to fulfill the increasing demand of users with limited resources. So the biggest problem in today's network scenario is the joint resources allocation problem. So the handle this problem the AI-based Q-network algorithm proposed. The simulation result shows that this algorithm gives better results as compared to others.

Ali Belgacem et al.[91] designed dynamic resources allocation method. The author talks about the features of the dynamic allocation resources facility of cloud computing but also mentioned that this type of allocation suffers from fault tolerance and energy consumption. So for improvement purposes, the author designed Multi-Objective Antlion algorithms(S-MOAL) to reduces the cost of virtual machines and makespan. Comparison results show that the proposed algorithm gives better results as in terms of makespan.

3. Energy Efficiency and Cost Reduction.

Xuan Xiao et al.[11] proposed a Workload-Aware VM Consolidation Method Based on Coalitional Game for Energy-Saving in a homogeneous environment. The comparison was made with the existing approach i.e. Sercon (server consolidation) IGG (improved group genetic algorithm) ACO (Ant Colony) and CGHO (Cooperative game in the homogeneous cloud). The experiment result shows this method saves energy 32.30% higher than Sercon, 20.03% than CGHo, and 14.28 than IGG(A) on average.
It also has outstanding advantages in load balancing and needs a few more approaches to migrations but less than other approaches.

Neetesh Kumar et al.[56] proposed Scheduling of tasks on Dynamic Voltage Frequency Scaling(DVFS) in a Heterogeneous cluster system. This method works in two phases, firstly used to minimize consumption of energy and green SLA generated between services provided and customers.

Chenxi Qiu et al.[81] The author discussed green cloud computing. Energy is an important parameter for both users and cloud providers. Reduction in energy usages helps to reduce cost and co2. Demand allocation and pricing policies for cloud services brokers and simulation results show our algorithms give the best results in terms of energy-saving and resource utilization.

Shahin Vakilinia[93] talk about the energy consumption of data centers in cloud computing. Energy is the priceless source which mostly consumed by the data center server, cooling, and network server. To save this author develop joint optimization of power consumption of server, communication on the network, and migration cost. The comparison result shows that this technique achieved power saving than others.

Nagma Khattar et al.[98] A survey of energy-efficient techniques. The author also mentioned the previous literature survey focus on the scheduling technique, green computing matrices, etc but in this paper the work done on the complete picture of energy consumption in the cloud. The classification is also done on optimization and energy management techniques. Data collected from journals, regions, conferences. The conclusion shows the energy issues and future challenges.

Taha Chaabouni et al.[100] The author studied various energy management techniques. Proper comparison and classification made between various energy management techniques. After recording all the weaknesses of all strategies the author proposed an energy-saving technique. This policy use median and standard deviation to calculate the upper and lower limit of the threshold. The results show that it saves around 40 % energy than others.

Zhenua Han et al.[66] The author talks about the management of VM in DC. The efficient management of VM helps to reduce the consumption of energy. In this paper dynamic VM management policy i.e. Markov decision process. The experiment results show that the proposed methodology gives better results in terms of power consumption, resource utilization, and VM migration.

4. Load Balancing

R.M.Alguliyev et al.[52] proposed PSO technique for the optimal solution of task scheduling and distributing the load on VM equally. This method work based on migration as overload workload is migrated to under-loaded machines. It provides an equal distribution of tasks and achieved less energy consumption.

Mishab Liaqat et al. [9] Characterizing Dynamic Load Balancing in Cloud Environments Using Virtual Machine Deployment Models. The proposed method work with three methods 1.request handler 2.Global Decision Engine 3.Local monitor engine. An experiment has done based on CPU utilization and execution time result shows 50% less CPU utilization as compared to others.

Mahendra Bhatu Gawali et al.[6] propose a Heuristic algorithm that combined MAHP(modified analytic hierarchy process, BATS(bandwidth aware divisible scheduling, BAR optimization method, LEPT, and divide and conquer approach. After comparison with the existing framework turnaround time and response time is improved. It enhances the utilization of CPU, memory, and bandwidth as in the previous technique only CPU and memory were considered.

Safraz Rampersaud et al.[62] In this paper author talk about the problem of vm VM packing. VM packing problem determines the request VM should be related to PM such that the minimum server should be on. The author suggests an online algorithm to solve the problem of VM packing. Comparison is done with previous algorithms and found that the proposed Sharing Aware online algorithms activate a very less physical server at a time.

Marwa Gama et al.[2] developed OH_BAC(Osmotic hybrid artificial Bee and Ant colony optimization algorithm. Which combine the features of both algorithm but there was a lack of improvement in energy consumption. An experiment done on variable and fixed load experimental result shows that OHBAC improve the energy consumption, SLA violation, number of virtual machine migration when compared with ACO(Ant colony optimization, ABC(Artificial Bee Colony) H_BAC(Hybrid artificial Bee and Ant Colony optimization)

AR Arunaran et al.[20] the author discussed task scheduling as many users demand many resources at a time. Providing all the suitable resources to all requests is not a manual task. Survey on task scheduling
techniques categories is done which helps to understand various types and nature of all types scheduling such as QOS parameter based, Ant colony optimization, PSO based fuzzy-based, and many others. Mohammed Ala’anzy et al. [3] give an idea about the load. Balancing, server consolidation, static and dynamic algorithms. The comparison has shown between various load balancing techniques based on parameters e.g./Hardware threshold, migration overhead, network traffic, and reliability. Pawan Kumar et al. [7] Survey of static and dynamic load balancing based on various parameters. This survey gives an idea about various load balancing techniques, advantages, disadvantages, and various available simulators available for actual implementations.

J. Octavio Gutierrez-Garcia et al. [15] Collaborative Agents for Distributed Load Management in Cloud Data Centers using Live Migration of Virtual Machines. The resources which deal with heavy load i.e over-utilized are balanced by shifting on underutilized resources. Shang-Liang Chen et al. [17] CLB: A novel load balancing architecture and algorithm for cloud services. The algorithm applies to a virtual web server and a physical server. Experiment results show that the load balancing performance can be achieved if the user logged in the same time.

Einollah Jafarnejad Ghomia et al. [19] focus on the Survey of various load balancing techniques such as Hadoop MapReduce load balancing, Natural phenomenon based load balancing, agent-based load balancing, general load balancing categories. Heba Nashaat et al. [21] Smart Elastic Scheduling Algorithm (SESA) and an Adaptive Worst Fit Decreasing Virtual Machine Placement (AWFDVP) algorithm proposed to reduce the migration for reducing energy consumption and resources utilization.

Junwu Zhu et al. [26] Virtual machine migration method based on load cognition. The proposed method works in two steps in the first step the VM is selected for migration based on resource utilization and in the second step the targeted VM is selected for migration. The experiment result shows that the algorithm is very efficient and generates 35% traffic less than a random algorithm.

Nagamani H et al. [33] allocating the suitable resources to a particular request is the basic demand of any users so that Qos can be achieved for these important parameters are bandwidth and execution time. Sometimes increasing demand for resources leads to the overloaded machine. At the time of overload, there is a need to migrate some data to the other machine. So the author Proposed model for resources management using VM migration.

Chitra Devi et al. [35] when users request the resources in static or dynamic nature that time first task is to allocate and the suitable resources with an equal load on the VM so that not a single VM should be overloaded or underloaded. IWRR (Improved Weighted Round Robin) is more suitable in homogeneous and heterogeneous as compared with RR and WRR.

Sara Tabaghchi Milan et al. [49] This paper gives an overview of the nature-inspired and meta-heuristic technique used in load balancing. The author compares 14 categories of optimization techniques found that ACO, GA, and BCO best algorithms for proper utilization of resources.

Amanpreet Kaur et al. [58] proposed a Framework for load balancing and predicting the overloaded and underloaded machines. Predicting earliest Finish Time (PEFT) and ACO &BAT results show that BAT includes less makespan and reduce total cost than ACO.

Altaf Hussain et al. [1] proposed RALBA(Resources Aware Load balancing algorithm. Increased resource utilization and machine level workload up to 99.3% and 99.4% than others with the same workload. The author suggests that it needs to enhance the functionality of RALBA to deal with the SLA parameter.

Seyyedeh Monireh Ghasemnezhad Kashkooli et al. [99] Load balancing is an important task to maintain flexibility and scalability in the cloud computing environment. Balance the load deals with improvement in various parameters. So the author proposed algorithm by combining the Imperialist competitive algorithm and Firefly algorithm to works better in case of load balancing. The results show that the proposed method gives a better response in terms of makespan, scalability, and speed of planning. Patricia T.Endo et al. [101] Talk about the various services provided by the cloud services provider. Also, talk about the various challenges faced by the services provider in case of scaled-down and up the cloud requirements. Many services such as redundancy, load balancing, and checkpoint can be uses to improve service availability. This survey gives a systematic review of the solution in cloud computing.

5. Multi-cloud Environments
Rajeev Kumar Bedi et al. [71] The author proposed the approach for the efficient storage of mobile users using multi-cloud. The proposed system gives better resource utilization in terms of battery, uses of data,
and CPU. This works also useful in terms of load balancing as the load can be shifted from one to another load.

Carlos Guerrero et al.[73] in this paper the author works to reduce the cost, time, and overhead of network latency at the time of allocation of the container in VM to cloud provider in multi-cloud. In this, the author uses a genetic algorithm NAGA-II for solving multi-objective problems. The comparison made with the greedy algorithms proposed method gives 300% improved results.

Nicolas Ferry et al.[72] This paper proposed the Cloud Modeling framework used for the design and management of the multi-cloud. It supports load balancing in multi-cloud and provides the run time environment to work of all applications by coordination. It also simplifies the migration of a task from one cloud to another cloud.

Mohammad Masdari et al. [90] present a survey and overview task and workflow scheduling in a multi-cloud environment. It makes the classification of schedule based on a cloud environment, key features, and architecture.

Sanjaya K. Panda et al.[45] Author presented three algorithms named Min Min batch, Max-Min bath, Min Min Max Min batch to work with the multi-cloud environment. The idea of multi-cloud scheduling is handled with the help of these algorithms including the concept of matching, allocating, and scheduling. The simulation results show that the proposed method gives better makespan, cloud utilization, and throughput.

Juliana Carvalho et al.[89] said that multi-cloud gives a large number of benefits to the cloud user but the portability and interoperability still a challenging issue. The author investigates various resources management techniques. In this author analyze various resources management and find out a solution to this problem from the user's perspective. Three taxonomies proposed for future direction.

**TABLE 1**
SUMMARY OF RELATED WORK TO RESOURCES MANAGEMENT TECHNIQUE IN CLOUD/MULTI-CLOUD ENVIRONMENT.

| Sr. No | Reference No. | Technique | Findings | Homogeneous/Heterogeneous | Cloud/Multi-cloud | Tool | Future work |
|--------|----------------|-----------|----------|---------------------------|------------------|------|-------------|
| 1      | Aida A. Nasr et al.[68] | Water Pressure Change Optimization (WPCO) | This technique can distribute tasks at available resources with low complexity of time. | Homogeneous | Cloud | Cloud Sim | This technique may be used for improving performance based on another parameter. |
| 2      | M. Senthil Kumar et al.[69] | Hybrid Genetic-Particle Swarm Optimization (HGPSO) algorithm | It decreases execution time and improves the rate of availability of resources for various tasks. | Homogeneous | Cloud | Cloud Sim | More Qos parameters can be considered to improve task allocation. |
| No. | Authors | Title | Methodology | Performance | Environment | Cloud Simulator |
|-----|---------|-------|-------------|-------------|--------------|-----------------|
| 3   | Pradeep Singh Rawat et al. [70] | Optimization technique based on BB-BC (Big Bang, Big Crunch) | It outperforms in terms of cost and time to fulfill the request on the cloud. | Homogeneous Cloud | Cloud sim 3.0 |
| 4   | Yiqian Xia et al. [27] | Daphne: A Flexible and Hybrid Scheduling Framework in Multi-Tenant Clusters | Daphne improves the throughput of 17% for resource allocation in a heterogeneous environment. | Heterogeneous Cloud | In the future, the job should be classified automatically by using machine learning and resource prediction should also be increased. |
| 5   | Haitao Yuan et al. [28] | Time aware task scheduling algorithm | TATS provides more profit and throughput for fulfilling the request in a heterogeneous environment. | Heterogeneous Cloud | Trace driven simulation |
| 6   | Jean Pepe Buanga Mapetu et al. [12] | Heuristic Cloudlet Allocation (HCA)/Approach | It provides high load balance; minimize makespan and proper resources utilization. | Homogeneous Cloud | In the future, work should be other types of taking benefits of green data centers and investigation of failure and repair effects. |
| 7   | YoungJu Moon et al. [96] | A slave ants based ant colony optimization algorithm | schedule the task and allocate the resources efficiently in cloud computing. | Homogeneous Cloud | In the future it should be implemented in a Heterogeneous environment and cost can be determined. |
| 8   | Dinesh Komarasa my et al. [51] | SHARP (ScHeduling of job and Adaptive Resource Provisioning) algorithm | This approach gives better results for fulfilling the SLA requirements | Both Cloud | The SHARP approach can also be used in e-learning as automatic manage and schedule the workload |
| 9   | Lei Wei et al. [31] | Skewness avoidance multi-resource allocation (SAMR) | This method reducing active PM in the data center by 45% and 11% as compared with others. | Heterogeneous Cloud | |

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*S[table of contents]*
|   | Authors                          | Title                                                                 | Benefits                                                                 | Environment                                                                 | Future Work                                                                 |
|---|---------------------------------|-----------------------------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|
|10 | Sonam Seth et al.[34]           | Dynamic heterogeneous shortest job first (DHSJF)                      | It provides less makespan, low energy consumption during resources allocation | Heterogeneous Cloud simulation                                              | In future research can be planned on resource utilization of VM placed on the same physical machines by reducing SLA violation and improvement in resources conflicting by VMs. |
|11 | Ashwin Kumar Kulkarni et al.[10]| Context-Aware VM Placement Optimization Technique                    | It helps in energy and cost-saving                                        | Heterogeneous Cloud simulation                                              | In future research can be planned on resource utilization of VM placed on the same physical machines by reducing SLA violation and improvement in resources conflicting by VMs. |
|12 | J.V. Bibal Benifa1 et al.[18]   | Efficient Locality and Replica Aware Scheduling (ELRAS) Strategy      | More suitable in a heterogeneous environment with the application of CPU bound, I/O bound, and mixed-mode | Heterogeneous Cloud Amazon EC2 environment with Hadoop environment          | In the future, this algorithm can be combined with the auto-scaling application. |
|13 | Avinab Marahatta et al.[25]     | Energy-aware fault-tolerant dynamic scheduling scheme (EFDTS)         | This algorithm provides better utilization, energy consumption, mean response time and better fault tolerance | Homogeneous Cloud cloud simulation                                            | In future work should be done on how the task is assigned with a complementary feature. So the prediction should be made how to use incoming packets                  |
|14 | Carlos Guerrero et al.[32]      | Non-Dominated sorting genetic algorithm-II for multi-objectives optimization | This technique reduces overall energy consumption improvement 1.9% and better resources and files availability average 170.38% and 407.41%. | Homogeneous Cloud                                                             | In the future, this technology can be extended by considering the concept of fault tolerance. |
|15 | Shanchen Pang et al.[39]        | Spacing multi-objective antlion Algorithm.                           | Results show a better result of the proposed methodology in terms of energy consumption. | Homogeneous Cloud                                                             | In the future, this technology can be extended by considering the concept of fault tolerance. |
| ID | Authors | Title | Approach | Use Case | Implementation | Summary |
|----|---------|-------|----------|----------|----------------|---------|
| 16 | Fahimeh Farahnakia et al.[42] | UP-VMC (Utilization prediction virtual machine consolidation) | works by knowing the future resources required to meet SLA requirements | Homogeneous Cloud | CloudSim | In the future, this work can be done by considering scalability, by using a different threshold, using open stack cloud or network resources utilization and by optimizing traffic. |
| 17 | Sambit Kumar Mishra et al.[97] | An adaptive task allocation technique. | The proposed algorithm is more efficient in energy | Heterogeneous Cloud | CloudSim 3.0.3 simulator | It can be further implemented for task preemption based on priority. |
| 18 | Saad Mustafa et al.[30] | MPBED (minimum power best fit decreasing and MCBFD (maximum CPU capacity best fit decreasing) | It helps to choose minimum migration time so that performance degradation can be improved. | Heterogeneous Cloud | CloudSim | In the future by using these techniques work can be done based on network load, load balancing, fault tolerance, and load balancing. |
| 19 | Ahmad M.Manasrah et al.[8] | Hybrid GA-PSO Algorithms | It helps to reduce the makespan and processing cost during workflow scheduling. | Homogeneous Cloud | WorkflowSim | In future work should be extended from more than one data center to heterogeneous. The workflow should also be considered in two levels first at services broker level and second at VM in DC based on the size of the task and speed of each VM. |
| 20 | Yu Liu et al.[43] | DeMS: A hybrid scheme of task scheduling and load balancing in computing clusters. | This technique reduces response time in case of a parallel job. | Homogeneous Cloud | | Future work is real-time framework scheduling including network delay and migration time. |
|   | Authors                  | Algorithm/Approach                                                                 | Details                                                                 | Environment | Language | Future work                                                                 |
|---|--------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------|----------|-----------------------------------------------------------------------------|
| 21 | V. M. ArulXavie r1 et al. [57] | Metaheuristic chaotic algorithm                                                   | It helps to find out the best optimal solution by minimizing makespan and proper utilization of resources. | Homogeneous | Cloud    | Future work should be based on other parameters such as reliability and security. |
| 22 | Aneena Ann Alexander et al. [47] | Cuckoo-Search algorithm                                                           | This is load aware allocation policy that reduces the makespan and total cost. | Cloud       | Cloud Sim | It should be implemented in workflow engines so that they can be used in real-time applications. |
| 23 | Yanhua Cao et al. [48]     | Online cost-rejection rate scheduling strategy (OCS).                              | This algorithm maintains a tradeoff between cost and rejected resources. | Cloud       | Cloud Sim |                                                                              |
| 24 | Mohammed Joda Usman et al. [14] | Energy-oriented Flower Pollination Algorithm (E-FPA).                             | E-FLP helps to reduce energy consumption during VM allocation.           | Heterogeneous | Cloud    | To consolidate the data resources multi-objective E-FPA will be used.           |
| 25 | Antonio Pietrabissa et al. [77] | The multi-cloud resource allocation algorithm.                                   | It Manages the resource requests to maximize the CMB (Cloud Management Broker) revenue over time. | Multi-Cloud  | Multi-Cloud |                                                                              |
| 26 | Juliana Carvalho et al. [79] | Dynamic Selecting Approach for Multi-cloud Providers.                            | Best to allocate the resources to the request by ranking in a heterogeneous environment. | Heterogeneous | Multi-Cloud | Develop the provider selection process using the Knapsack problem and compare it with this approach. |
| 27 | Yangfei Lin et al. [80]    | Multiple-replica integrity auditing schemes for cloud data storage.               | Helps in storing secure data on the cloud.                              | Multi-Cloud  | Multi-Cloud | The observed gap and challenge can help to start the new research.            |
| 28 | Seungmin Kang et al. [83]  | Dynamic Scheduling Strategy (DSS).                                                | Helps in load balancing and node availability prediction.               | Multi-Cloud  | Multi-Cloud |                                                                              |
6. Resources allocation techniques classification and taxonomy

6.1 Definition and classification of resources allocation techniques.

In simple terms allocation means to provide the required things on demand. Same as resource allocation means to assign required resources to particular request in cloud computing. Cloud provides every type of service in the form of IaaS, PaaS, and SaaS. The demand for resources may be different from all types of requests. Providing every type of service to the user is a big challenge because during the allocation the main concepts are efficient utilization of resources. Efficient utilization includes less cost, energy efficiency, proper utilization of time, etc.

6.2 Cost-based allocation of resources: Cloud services provider provides services to the user and users want these services at the minimum cost. Cost includes expenses of users, cost of resources, and provider profit. Good resource allocation plays an important role to achieve this.

6.3 Energy-based allocation of resources: Energy consumption in the data center is an important factor which consumes in term of Air conditioner and other cooling sources. So the energy can be saved by migrating the data on less-used servers or by using efficient techniques. So the resources should be allocated by keeping in mind the concept of energy is an energy-based allocation method.

6.4 Load based allocation of resources: Balancing load means to manage the load on resources in the data center so that all resources can work efficiently. Efficient resource allocation based on load always gives good results.

6.5 Utilization based allocation of resources: Proper utilization of resources in the data center is base for the success of cloud computing. In case the users request in heterogeneous form is a challenging issue for the cloud to allocate resources efficiently.

6.6 Time-based allocation of resources: The duration of using any resources in the cloud data center is an important concern. The allocating the resources based on the total execution time of the request helps in the high utilization of cloud resources without any delay.

6.7 VM based allocation of resources: Allocating the VM based on cost and Speed of VM falls in this category. As dynamic nature of request migrates the VM as per cost and energy efficiency requirement.

6.8 Nature and Bio-inspired based allocation of resources: To generate an optimization solution the basis of the nature of the task always gives the best results. Many researchers generate many resources allocation techniques based on the nature of any request that always considered in the category of nature and bio-inspired allocation of resources.

6.9 Hybrid based allocation of resources: Hybrid based allocation the combined form of allocation more than one base. The user’s requirement may vary or it may depend based on more than one requirement that type allocation is the part of this category.

6.10 SLA based allocation of resources: SLA is a service level agreement between cloud users and services providers. The entire thing signed at SLA is necessary to fulfill at the time of resource allocation to get good results.

6.11 Power-based allocation of resources: Power includes the heat produced, energy utilization in the data center. As the size of the data center increased the same as load, Co2 and heat are increasing day by day. At the time of allocation of resources, the power is the important concept should keep in mind.

6.12 QoS based allocation of resources: It includes allocation of resources based on good throughput, reliability, SLA, etc. for both users and cloud providers. At the time of allocation must consider the quality to avoid failure, resources non-availability, and SLA violation.

6.13 Dynamic and adaptive based allocation of resources: In the field of IoT the requirement of the cloud users is dynamic. To fulfill the dynamic type requests are the biggest challenge for a service provider. So the allocation of the resources is changed as per dynamic nature.

6.14 AI-based allocation of resources: Artificial Intelligence-based resources allocation includes the event triggered, reinforcement learning, and power allocation based algorithms. In this, the requirement of the users is observed based on the learning process, and resources are allocated based on the requirement.
6.15 **Priority-based allocation of resources**: The completion of any request passes through many phases as some resources are much important to do the task. The allocation of the most important resources at first is the priority-based allocation of resources.

6.16 **Optimization-based allocation of resources**: Assigning the best resources by keeping in mind the concept of speed, cost, energy, throughput, etc is the optimal allocation of resources.

Figure 2. Classification of resources allocation techniques.
7. An evolutionary generalized model for resource allocation management in a cloud environment.

The whole process to complete a request in cloud computing is shown in the following Figure. It divided into two phases. The phase 1 task information and workflow analyzer and Phase 2 resources management module. In phase 1 client submits the request to the cloud including requirement then the workflow analyzer analyzes the user demand based on requirement and checks with the cloud resources manager and sends back the resources provisioning result if the required resources are available.[102][103].

Phase 1: Task Information and workflow Analyzer

- Cloud User/Client
- Workload Details
- Analyze workflow and workload
- Workload Information
- Resources provisioning agent / SLA Resource Negotiation
- Resources

Phase 2: Resource Management Module

- Submit Workload
- Resource De-Allocation Module
- VM Resources Pool
- VM Reserve Resources Pool
- Multi-Objective Resource Allocation Approach
- Multi Criteria Decision Analysis + Task Scheduler
- Check workload Status
- Resource Manager
- Utilization Manager
- Resources automatically scaled back
- Ready for new allocation
- More Demands for resources
- Resources Rescheduling
- Execute Workload
- Schedule Workload
- Assign Resources
- Resources mapping

Figure 3. Summarize the model for resource allocation in the cloud environment.

Phase 2 Resources management Module which includes the whole process of allocating the resources to the particular request. The client submits the workload to the resources management module. It is divided into 3 parts multi-objective resources allocation approach, multi-criteria decision analysis, and task scheduler and the third is resources de-allocation module. In the first part, the resources are allocated to request from the resources pool then in second part workload status is checked if the required resources are greater than the provided resources then it demands more resources from the resources pool. After the task completed the resources are de-allocated and again shifted in resources pool now resources are ready for next uses.[111].

8. Gap Analysis: Open challenge and future direction in a multi-cloud environment

8.1 Service level agreement (SLA): SLA an agreement between cloud users and cloud providers based on the requirement of request. Earlier it was the biggest issue in cloud computing to fulfill the SLA. Saurabh Kumar Garga et al.[24] develop an SLA based approach for heterogeneous workload in a cloud data center. It also enhances resource utilization. SAAD MUSTAFA et al.[30] proposed SLA-Aware Best Fit Decreasing Techniques for Workload Consolidation in Cloud. It reduces the SLA violation and energy consumption by reducing VM migration. Fahimeh Farahnakan et al. [42] present UP-VMC (Utilization prediction virtual machine consolidation) is proposed to reduce SLA violation and Proper resource utilization. Altaf Hussain et al.[46] developed SLA-RALBA: a cost-efficient
and resource-aware load balancing algorithm for cloud computing. This approach gives a much better result than previous techniques to fulfill SLA in terms of reducing makespan, cost, and energy consumption. Multi-cloud provides services to the user in the form of multiple clouds. As the user's requirements increasing day by day SLA requirement and SLA violations also increased as this agreement is done with more than one service provider. To handle these SLA violations is the biggest challenge in multi-cloud although many authors cover many parameters of SLA as Sanjaya K. Panda et al.[107] proposed SLA-MCT and SLA-Min-Min for a heterogeneous multi-cloud environment. This approach reduces makespan and cost as much as possible but not very efficient to improve the performance and lack of reliability. So in future SLA should be kept in mind as an important parameter to make multi-cloud more successful.

8.2 Resources allocation: Resources allocation means assigning the resources to particular requests based on requirements is a very challenging task. Much research makes it easy in case of a single cloud as Mahfoudh Saeed Al-Asaly et al.[44] talk about the dynamic nature of resource demand which is difficult to handle. Automatic provisions of resources by analyze resources using deep learning, making a decision using fuzzy logic. Deep learning used for future workload prediction and fuzzy logic to decide based on workload prediction. The result shows that our proposed methodology is better in cost reduction, decrease SLA violation, and resource utilization. Zijun Zhang et al.[84] design a posted price for resource allocation. The author investigates many posted price algorithm and design best algorithm declared a fixed price for the resources allocation per unit time. Then it implemented various resources types and limited occupation duration. It proves good performance as compared with previous algorithms. Zhe Liu et al.[85] The author presents an algorithm to handle the heterogeneous request of the user. The author divide request into two parts the private cloud will handle the routine request and the public cloud to handle the sudden incoming request. Stackberg Game Model used to allocate the request in a suitable cloud. The proposed model is time efficient and gives an optimal solution. Chunlin Li et al.[88] Present an algorithm for resource allocation in Software as a service. The main target of every type of allocation is to satisfy the user's request and provide benefits to the cloud provider. The proposed method is only for SaaS users, SaaS providers, resources provider. The presented algorithm is a resource allocation algorithm for the SaaS cloud application. The experimental results show that this algorithm gives good performance than others. Some authors work in resource allocation multi-cloud but problems not fully solved. Lijin P[75] Proposed Game theory-based algorithm to allocate the resources and method to predict the user requirement. Antonio Pietrabissa et al.[77] Proposed Markov Decision Process modeling based algorithm for resource allocation. Tamanna Jena et al.[108] Genetic Algorithm-based Customer-Conscious Resource Allocation and Task Scheduling in multi-cloud computing. This approach gives high scalability, makespan, and customer satisfaction but suffers from a lack of energy consumption, latency, and cost.

8.3 Workflow and task scheduling: Workflow scheduling is an important term to handle because users request increasing day by day. In cloud computing workflow is easy to handle as much researches works on it. Ahmad M. Manasrah et al. [8] proposed Workflow Scheduling Using Hybrid GA-PSO Algorithm in Cloud Computing. This approach reduces the makespan and processing cost. Yong Zhao et al.[23] developed A Service Framework for Scientific Workflow Management in the Cloud. Indrajit Gupta et al.[50] Efficient Workflow Scheduling Algorithm for Cloud computing system: A Dynamic Priority-Based Approach. Zong-Gan Chen et al.[67] Multi-objective Cloud Workflow Scheduling: A Multiple Populations Ant Colony System Approach. Many authors work in the area of multi-cloud for workflow scheduling. Sanjaya K. Panda et al.[109] Present four task scheduling algorithms, called CZSN, CDSN, CDN, and CNRSN for heterogeneous multi-cloud environments increase resource utilization but lack to work on transfer and execution cost. MAZEN FARID et al.[104] A multi-objective scheduling algorithm with fuzzy resource utilization (FR-MOS) for scientific workflow. This approach reduces cost and makespan including reliability but suffering from the problem of fault tolerance and energy consumption. Seungmin Kang et al.[83] proposed a Dynamic scheduling strategy (DSS) for load scheduling in multi-cloud. Bing Lin et al.[105] Multi-Clouds Partial Critical Paths with Pretreatment (MCPCPP) for handing workflows in Multi-clouds is proposed. This approach minimizes cost. But lack of reducing the time utilization.

8.4 Hybrid/Multicloud environments: Allocate the resources and task scheduling in the single cloud is easier but when the user's requests belong to different cloud it's the biggest challenge to manage. Allocate the required cloud for a particular request becomes a target for researchers. Many researchers
work on various approaches to this issue but still have many hurdles. Leonard Heitig et al.[110] presented the Biased Random Key Genetic Algorithm for optimized selection of services from a suitable cloud in multi-cloud. It reduces the cost and execution time of the request. Xin Chen et al.[103] online request scheduling and resource provisioning (RSRP) algorithm. As every cloud has its own VM and pricing scheme but users request are dynamic so this approach is proposed to cost-efficiently handling resources scheduling and provisioning. Peini Liu et al.[76] Generalized Nash Equilibrium Model of the Service Provisioning Problem in Multi-cloud Competitions to handle the situation when users' requirements changed frequently. But this approach is not verified on the real data set. Juliana Carvalho et al.[79] Simple Additive Weighting method for ranking the cloud provider. Although many authors doing efforts to make multi-cloud storage. In future unified platform can be used to support different resources type in different CSP.

8.5 Reliability: Reliability is an important issue in cloud computing to make customers more confident and satisfied. The reliable concern with the SLA, Qos, Proper resources allocation, and secure storage so that customers can store their data without any fear. Yangfei Lin et al.[80] The author discussed the security of data storage in a multi-cloud cloud. The data storage in multi-cloud is not fully secured so security should be provided such that the users can save data confidently without worrying about the cost. The author proposed a system model and problem formulation of the Multiple replica integrity auditing schemes. Muhammad I.H. Sukmana et al.[74] proposed a Unified multi-cloud storage resource management platform. It helps the user to securely create, delete, and update cloud resources storage. In future unified platform can be used to support different resources type in different CSP.

Although many authors doing efforts to make multi-cloud cloud reliable still there is a lack of reliability in multi-cloud.

8.6 Interoperability: Interoperability in cloud computing means moving from one cloud to another cloud on the bases of the requirement of applications. It also means that the application running on the various clouds might share the common which needs to be improved to get more efficiency. Kiran Bir Kaur et al.[112] discussed that like other challenges, interoperability is another challenging issue in terms of security, identity management, etc.

TABLE 2
SUMMARY OF GAP ANALYSIS AND FUTURE DIRECTION IN RESOURCES MANAGEMENT IN MULTI-CLOUD ENVIRONMENT

| Approach                  | Techniques                                      | Selection Factor                  | Issues and Challenges                  |
|----------------------------|-------------------------------------------------|-----------------------------------|----------------------------------------|
| Service level agreement (SLA) Sanjaya K. Panda et al.[107] | SLA-MCT and SLA-Min-Min for a heterogeneous multi-cloud environment. | This approach reduces makespan and cost. | This approach is not very efficient to improve performance and reliability. |
| Resources allocation Tamanna Jena et al.[108] | Genetic Algorithm-based Customer-Conscious Resource Allocation and Task Scheduling | This approach gives high scalability, makespan, and customer satisfaction | It suffers from a lack of energy consumption, latency, and cost |
| Workflow and task scheduling Sanjaya K. Panda set al.[109], MazenFarid et al.[104], | Present four task scheduling algorithms, called CZSN, CDSN, CDN, and CNRSN for heterogeneous | It increases resource utilization | lack of work on transfer and execution costs. |
|                            | A multi-objective scheduling algorithm with fuzzy resource utilization (FR-MOS) for scientific workflow. | This approach reduces cost and makespan including reliability. | suffering from the problem of fault tolerance and energy consumption. |
9. Discussion
Section I is the introduction of all about multi-cloud, why people attracting about multi-cloud. The structure of this literature survey also mentioned in this section. Section II is of literature survey which is divided into four parts i.e. resource allocation using optimization techniques, Energy Efficiency and Cost Reduction., load balancing, and multi-cloud environment.

In resource allocation using optimization techniques, the authors discussed resources and task scheduling in a homogeneous and heterogeneous environment. Provide various techniques to make a better environment in terms of resource allocation and experiment result discussed which shows how a particular technique helps o improve in terms of factors it may be makespan, resources utilization, throughput, flexibility, etc.

The most important factor in the cloud environment is energy. Because saving energy helps to save costs as well as to make a better environment. In Energy Efficiency and Cost Reduction the author discussed the various energy-saving techniques and mentioned how much energy can be saved by using a particular technique. Every author tried to give better result by comparing with the existing techniques.

Balancing a load in a better way is the biggest challenge in the cloud environment. The need for load balancing is only to uses the required VM by transferring load from one machine to another machine so that energy and cost can be saved. All writers load balancing subsection discussed the different techniques for balancing the load and related factors improvement is mentioned.

Working in a multi-clouds makes users’ life easier. The author’s main focus on architecture, component, security, and various storages mechanism used in multi-cloud. Various techniques of resource allocation, security, storage, and dealing with homogeneous and heterogeneous users request in a multi-cloud environment discussed in a multi-cloud environment subsection.

Table 1 having all the information on techniques and algorithms proposed by various researchers in the field of resource management in multi-cloud. The future work suggested by researchers is also discussed in this table. Figure 2. shows all about the criteria of resource allocation in a cloud computing environment.
Furthermore, Figure 4. Exhibits an evaluation factor in the above-discussed modules of a cloud computing environment. These factors are resource utilization, energy-efficient, throughput, migration management, and cost. The comparison made on the above modules based on these factors and the final result we have found that very fewer researchers focus on these parameters in a multi-cloud environment. As multi-cloud makes user’s life easier and faster, in future these parameters should be considered in research work.

This survey provided a detailed and comprehensive literature on Cloud, Load and Resources management techniques, Cloud applications which may have direct or indirect impact over the cloud load and resource management [116-117]. The quality of data routing QoS from various applications [118-120] have been affected due to the Cloud load and resource management. Global Software Development GSD and other software development methodologies [121-124] uses the Cloud resources, and they require better load and resource management at the Cloud to complete the transactions smoothly. Cloud uses different security mechanisms [125] which are conventional, multi approach, and federated to keep Cloud secure and avoid any delay in its operations. Several applications are sharing the resources of Cloud including health, UAV, monitoring, VANET, roadside traffic, users’ locations based, etc. [126-130] applications. A great number of research is available related to the Energy aware task allocation for multi Cloud networks as well [131], where researchers are considering the task allocation in optimized way to manage the energy resources of cloud sources. At the same time a great number of load balancing algorithms [132-137] are proposed by the researcher to optimize the cloud resources. Since the load balancing and resource management of cloud has significant, hence a great number of researches is available related to this.

10. Conclusion
This paper is a systematic review of resources optimization techniques, energy-saving, loads balancing techniques, and algorithms used by various researchers and the performance of these techniques. We observe that most of the work in this survey is done based on homogeneous users’ requests and environment, few researchers considered the resource allocation in a heterogeneous environment. All the techniques of resources management including future work is represented in the form of a table. After studying literature related to resource allocation in the cloud computing environment, prepared an evolutionary generalized model for resource allocation management in a cloud environment also gap analysis and future challenges will help the researchers to do efforts in the area of multi-cloud. We
compare collected data based on some parameters such that resource utilization, energy efficiency, throughput, cost, migration management and we find that researchers discussed very less about these parameters in a multi-cloud environment. It is recommended for future research that the research needs to be based on an above-discussed parameter in the multi-cloud environment including heterogenous users' requests. The collected data will helps the researchers to work in the field of resource allocation, load balancing, energy efficiency, and multi-cloud environment.

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