**A SURVEY ON GREEN CLOUD COMPUTING: GREENER APPROACH**

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## **ABSTRACT**

Green cloud computing is an emerging field of study that aims to minimise the ecological footprint of cloud services. The rapid growth of cloud computing has raised worries about its energy usage and carbon emissions. This review paper examines different approaches to enhance the energy efficiency and environmental sustainability of cloud computing. The key options that were explored include energy-efficient data centres, enhanced virtualization techniques, optimised workload management, and the use of renewable energy sources. These measures are crucial for achieving a balance between the demand for technological advancement and the necessity to minimise the environmental impact of cloud services.

The study explores the technological developments that are propelling the development of environmentally friendly cloud computing. Virtualization, an essential technology in this domain, decreases the quantity of physical servers required, resulting in decreased energy consumption and diminished cooling needs. The evaluation also examines workload management approaches that guarantee efficient utilisation of resources, hence reducing energy wastage. Moreover, the report emphasises the capacity of incorporating renewable energy sources like solar and wind power into data centres to effectively reduce the carbon emissions linked to cloud computing.

To summarise, the paper highlights the obstacles and areas for further investigation in the field of green cloud computing. The statement underscores the necessity for improved measures and technologies to precisely gauge the environmental consequences of cloud services. Furthermore, it necessitates the creation of more advanced algorithms to further improve energy efficiency. The article emphasises the significance of policy frameworks and industry standards in advancing environmentally friendly practices in cloud computing, with the goal of establishing a more sustainable digital future.

**Key Words:** Green cloud computing, energy efficiency, carbon footprint, virtualization, workload management, renewable energy, sustainable technology, data centers, cloud infrastructure, environmental impact.

# INTRODUCTION

Cloud computing has rapidly transformed the storage, processing, and accessibility of data, providing unparalleled scalability, flexibility, and cost efficiency. Nevertheless, the growing popularity of cloud adoption has resulted in a substantial rise in energy usage, so contributing to the escalating carbon emissions of the Information and Communication Technology (ICT) industry. Data centres, which serve as the fundamental infrastructure for cloud services, consume significant quantities of electricity, frequently obtained from non-renewable energy sources. With the increasing worldwide worries regarding climate change, it is imperative to promptly tackle the environmental consequences of cloud computing. The need for reducing carbon emissions in cloud services has led to the emergence of green cloud computing, which focuses on developing and implementing energy-efficient technologies and processes.

Green cloud computing refers to a variety of solutions that focus on optimising the energy consumption of cloud infrastructure. One of the key strategies is the implementation of energy-efficient data centres. These data centres employ sophisticated cooling methods, energy-efficient technology, and intelligent energy management systems to reduce energy usage. Another crucial element of green cloud computing is the utilisation of virtualization technology, enabling the operation of several virtual computers on a solitary physical server. This results in a reduction in the total number of servers needed and a decrease in energy consumption. Furthermore, the implementation of workload management strategies that employ dynamic resource allocation in response to demand is crucial in order to prevent energy wastage on servers that are not being fully utilised.

Although there have been significant developments in green cloud computing, there are still some difficulties that need to be addressed. The absence of standardised measures for quantifying the environmental consequences of cloud services poses challenges in evaluating and contrasting the efficiency of various eco-friendly approaches. Furthermore, the incorporation of renewable energy sources into cloud infrastructure is currently in its nascent phase, as there are technological and economic obstacles that impede its broad implementation. In order to address these difficulties, it is imperative to maintain ongoing research and innovation in the field of green cloud computing, while also establishing strong policy frameworks and industry standards. This study seeks to offer a thorough assessment of the present condition of environmentally-friendly cloud computing, examining the tactics, technologies, and future prospects that can contribute to the development of a more sustainable cloud environment.

**GREEN COMPUTING**

Green computing encompasses the implementation of environmentally conscious techniques within the realm of information technology. The main objective is to decrease energy usage, limit carbon emissions, and encourage the adoption of environmentally friendly materials in IT infrastructure. This method involves maximizing the use of resources, adopting energy-efficient technologies, and enacting policies that help reduce the environmental impact of computer activities.

**CLOUD COMPUTING**

Cloud computing refers to the provision of various computer services, including storage, processing power, databases, networking, and software, through the internet. This architecture enables users to conveniently access and consume resources as needed, without requiring any local infrastructure or hardware. Cloud computing allows for the easy adjustment of resources to accommodate different workloads, resulting in scalability, flexibility, and cost-efficiency. It provides support for a wide range of applications, ranging from data storage to intricate corporate solutions.

**ENERGY EFFICIENCY**

Energy efficiency is a crucial element of green computing, focusing on optimizing the utilization of resources to reduce energy consumption, especially in cloud data centres. This entails the deployment of energy-efficient hardware, the implementation of intelligent workload management, and the utilization of modern cooling systems in order to minimize power consumption. Energy efficiency in cloud environments is achieved by optimizing the performance of servers, storage devices, and networking equipment. This not only decreases operational expenses but also minimizes the environmental impact, resulting in a reduced carbon footprint and promoting sustainable IT practices.

**VIRTUALIZATION**

Virtualization is a technology that allows many virtual machines (VMs) to run on a single physical machine, effectively sharing its hardware resources. This method improves resource usage by enabling the simultaneous execution of several applications and operating systems, hence eliminating the requirement for extra physical servers. Virtualization reduces energy usage by concentrating workloads onto a smaller number of servers. This leads to more efficient and sustainable computing environments, especially in cloud data centres

**RESOURCE MANAGEMENT**

Resource management encompasses techniques for effectively distributing and overseeing computing resources in cloud environments, with the aim of reducing inefficiency and improving energy conservation. This encompasses the optimization of workload distribution, the scaling of resources according to demand, and the utilization of automation technologies for monitoring and adjusting resource utilization. Efficient allocation and utilization of resources leads to decreased operational expenses, enhanced performance, and supports the long-term viability of cloud computing infrastructures.

**GREEN DATA CENTRES**

Green data centres are facilities designed to prioritize energy efficiency, utilizing advanced technologies and practices to minimize environmental impact. These data centres employ energy-efficient hardware, renewable energy sources, optimized cooling systems, and sustainable operational practices. By reducing power consumption and carbon emissions, green data centres contribute to more environmentally responsible IT infrastructure, supporting the goals of sustainability and corporate social responsibility.

**1.1 OBJECTIVES**

* Green cloud computing aims to deploy cloud services sustainably while minimizing environmental impact.
* The concept emerged in 1987 due to the recognition that IT's significant energy consumption led to supply bottlenecks and accelerated global warming.
* The term "green cloud computing" refers to the ecologically friendly and efficient use of computer resources.
* Cloud service providers adopted "Green Cloud" practices in response to environmental concerns.
* Researchers highlight challenges in ensuring service reliability while minimizing energy consumption and costs.
* Green cloud computing seeks to reduce harmful components, enhance energy efficiency throughout a product's lifecycle, and promote recycling.
* Objectives include reducing environmental impact, ensuring efficient resource use, and promoting sustainability in cloud services.

# LITERATURE REVIEW

**Tajrian, M., Rahman, A., Kabir, M. A., and Islam, M. R. (2023)**

The authors presented a comprehensive analysis of strategies for detecting false news, with a particular focus on the use of machine learning and deep learning techniques. The researchers examined the benefits of using multimodal techniques that combine written, visual, and contextual information to improve the accuracy of detection. These strategies try to tackle the intricate nature of fake news by integrating many sorts of information. The review also discussed other obstacles, such as the adequacy and variety of datasets, which are essential for training efficient models. Moreover, the authors emphasised the necessity for more resilient algorithms that can effectively handle adversarial attacks and adapt to emerging misleading strategies. Their investigation highlights the significance of ongoing innovation in algorithm development and dataset management to outpace sophisticated techniques employed by false news.

**Narra, M., Umer, M., Sadiq, S., and Karamti, H. (2023)** Narra et al. conducted a comprehensive analysis of techniques for identifying misinformation in the context of the COVID-19 outbreak, assessing the efficacy of different machine learning algorithms. The authors emphasised the crucial significance of real-time data processing in effectively managing the rapid dissemination of disinformation. They stressed the necessity of doing cross-platform analysis to capture and combat misleading information across various media platforms. The review examined the utilisation of machine learning algorithms, such as neural networks and ensemble approaches, for the purpose of detecting and eliminating deceptive information. In addition, the authors examined the importance of public awareness and policy measures in addressing disinformation. They contended that educational programmes and regulatory measures are crucial for reducing the influence of fake news during health crises, bolstering public trust, and assuring the spread of precise information. The study emphasises the necessity of employing a comprehensive strategy that integrates technology solutions with societal initiatives to effectively tackle the issues associated with managing infodemics.

**Rathod, D., and Vyas, D. (2022)** Rathod and Vyas conducted a comprehensive analysis of machine learning techniques for analysing sentiments related to drugs. They specifically highlighted the need of utilising natural language processing (NLP) to assess the feelings expressed by patients. Their study examined multiple algorithms, such as Support Vector Machines (SVM), Naïve Bayes, and deep learning models, to assess their efficacy in processing and interpreting patient feedback regarding drugs. The authors explored the potential of these strategies to improve healthcare outcomes by offering more precise and nuanced insights into patient experiences and perceptions. Through the use of NLP, the paper emphasises the capacity of these machine learning methods to detect patterns, emotions, and issues conveyed in patient reviews and social media. Enhanced comprehension of this matter can assist healthcare professionals and pharmaceutical businesses in more efficiently resolving problems and customising their offerings to more effectively fulfil patient requirements, ultimately resulting in heightened patient contentment and enhanced health results.

**Narra, M., Umer, M., Sadiq, S., and Karamti, H. (2022)**

Narra et al. conducted a comprehensive examination of feature selection methods for identifying fake news, with a specific emphasis on the COVID-19 epidemic. The study examined the impact of carefully chosen feature sets on the precision and effectiveness of machine learning models employed for detecting disinformation. The authors examined different methodologies for choosing pertinent features, which are crucial for enhancing model efficacy by diminishing interference and concentrating on the most noteworthy signs of false information. In addition, the evaluation examined the wider consequences of disinformation on public health, emphasising how inaccurate information might impact public behaviour and health results during emergencies. The authors also analysed the impact of social media platforms in spreading false information, highlighting the importance of implementing efficient detection systems to counter disinformation and safeguard public health. This research highlights the significance of integrating sophisticated feature selection with strategic interventions to tackle the difficulties presented by false news.

**Mridha, M. F., Keya, A. J., Hamid, M. A., and Monowar, M. M. (2021)**

Mridha et al. performed an extensive examination of deep learning methods for identifying fake news, specifically exploring different neural network structures including Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Long Short-Term Memory (LSTM) networks. The authors investigated the utilisation of these models for the analysis and detection of false information in extensive datasets, evaluating their efficacy in various scenarios. The conversation revolved around the capabilities of CNNs in collecting spatial hierarchies, as well as the abilities of RNNs and LSTMs in managing sequential data. The focus was on how these technologies contribute to enhancing detection accuracy. The review also emphasised the constraints of these models, such as difficulties associated with computational intricacy and data imbalance. The authors emphasised the significance of domain adaptation and transfer learning techniques in improving the resilience of false news detection systems. These methodologies can enhance the ability of models to generalise well across many domains and adjust to shifting techniques of disinformation, hence ensuring more dependable outcomes in detection.

**Carter, M., and Zeadally, S. (2021)** Carter and Zeadally conducted a comprehensive assessment of the effectiveness of different techniques for detecting fabricated content, specifically in the setting of deliberate attacks. Their study examined the robustness of various machine learning and deep learning models, assessing their ability to detect and withstand modified or false content. The authors have discovered critical vulnerabilities in current models, emphasising specific shortcomings that adversaries use to circumvent detection. In addition, they deliberated on possible countermeasures and tactics to improve the resilience of the model, such as integrating adversarial training and creating more flexible detection frameworks. The analysis highlights the crucial necessity for continuous research and innovation in the detection of bogus content to remain ahead of developing dangers. The authors argue that in order to maintain the effectiveness of systems against increasingly complex manipulation techniques, it is necessary to continuously develop detection methodologies to handle the problems offered by adversarial attacks.

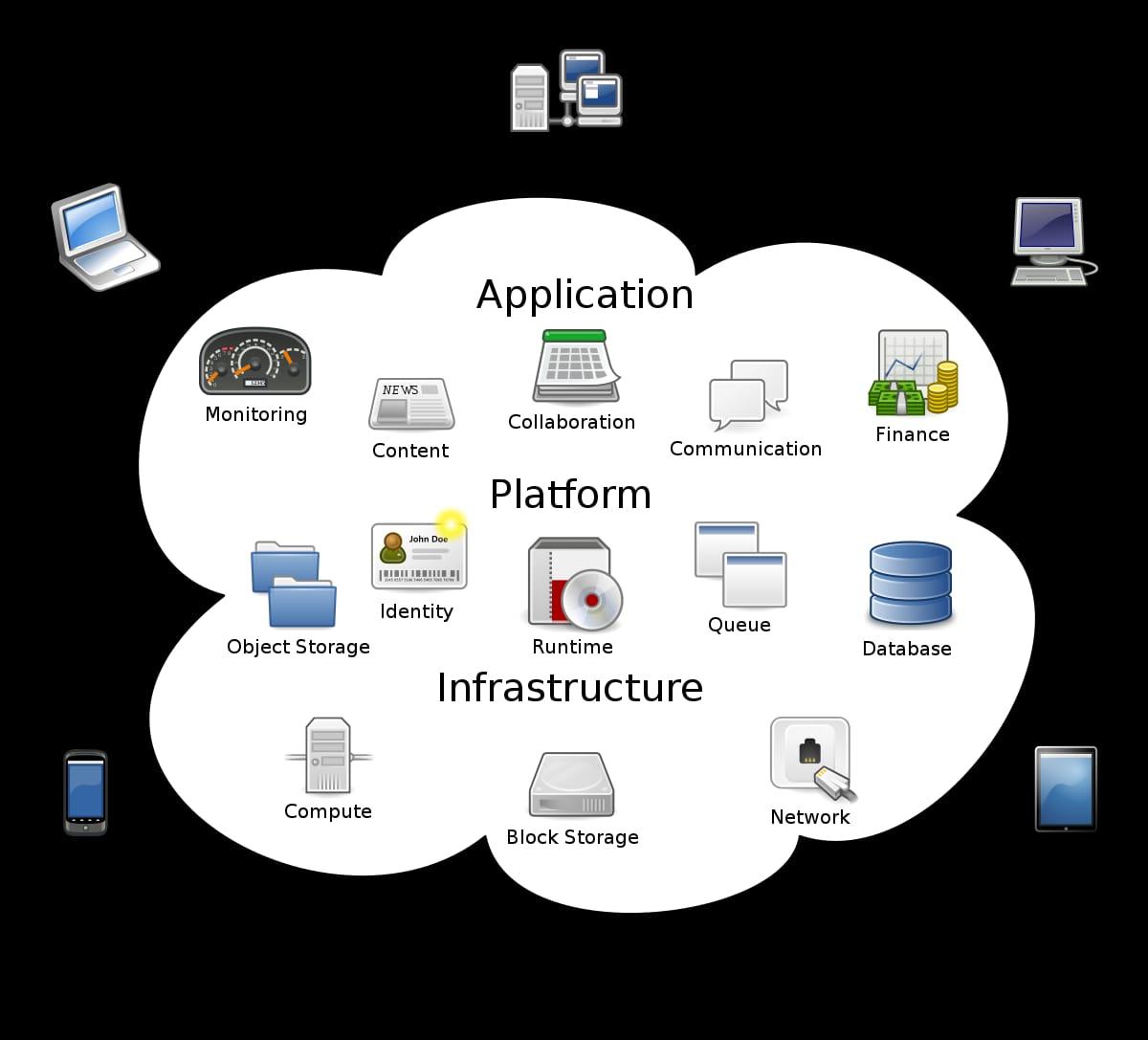
**Kumar, S., and Jha, P. (2020)** Kumar and Jha conducted a review on the utilisation of machine learning methods for identifying instances of insurance fraud in the medical industry. Their study examined multiple algorithms, such as decision trees, Support Vector Machines (SVMs), and deep learning models, to determine their efficacy in detecting fraudulent claims. The authors emphasised the merits of each algorithm in scrutinising intricate datasets and identifying irregularities that suggest fraudulent activity. The importance of feature engineering and data pretreatment in improving the accuracy of fraud detection systems was highlighted. Efficient feature selection and data cleansing can greatly enhance model performance by offering pertinent information and minimising noise. The review also discussed the difficulties associated with imbalanced datasets and emphasised the importance of employing strong validation approaches to assure the dependability of detection systems. Kumar and Jha determined that utilising sophisticated machine learning methods, along with thorough data preprocessing, is crucial for enhancing fraud detection in medical insurance and reducing the occurrence of false positives.

**Patel, M. (2019)** Patel conducted a comprehensive analysis of how logistic regression is used in the detection of credit card fraud. The research emphasised the efficacy of logistic regression in detecting fraudulent transactions owing to its direct methodology and interpretability. Patel explored the potential of enhancing logistic regression models by merging them with other machine learning approaches, such as ensemble methods or feature selection algorithms, in order to enhance accuracy and robustness. The study also examined the difficulties related to imbalanced datasets, a prevalent problem in fraud detection where illegitimate transactions are infrequent in comparison to valid ones. Patel highlighted the significance of meticulous feature selection in order to enhance model performance and minimise the chances of false positives. The review determined that logistic regression is a valuable tool for detecting fraud. However, to optimise detection skills and get better results in real-world applications, it is important to combine logistic regression with advanced approaches and correct imbalances in the dataset.

**Rao, S., and Kumar, V. (2018)** The review study by Rao and Kumar primarily examined energy management strategies in cloud computing, investigating different approaches to minimise energy usage in data centres. The authors investigated the impact of virtualization on enhancing resource utilisation and reducing energy inefficiency through the consolidation of workloads onto a smaller number of physical servers. In addition, they deliberated on dynamic resource allocation systems that adapt resources according to demand, hence considerably augmenting energy efficiency. Moreover, the incorporation of sustainable energy sources was emphasised as a vital approach to diminish the environmental impact of data centres. Rao and Kumar highlighted the difficulties of implementing these strategies in large-scale cloud infrastructures, such as the complexity of managing dynamic resources and successfully integrating renewable energy sources. The study determined that although these solutions have considerable potential for enhancing energy efficiency, it is crucial to address the accompanying obstacles in order to effectively implement them in contemporary cloud systems.

# METHODOLOGY

**3.1 Cloud Computing**



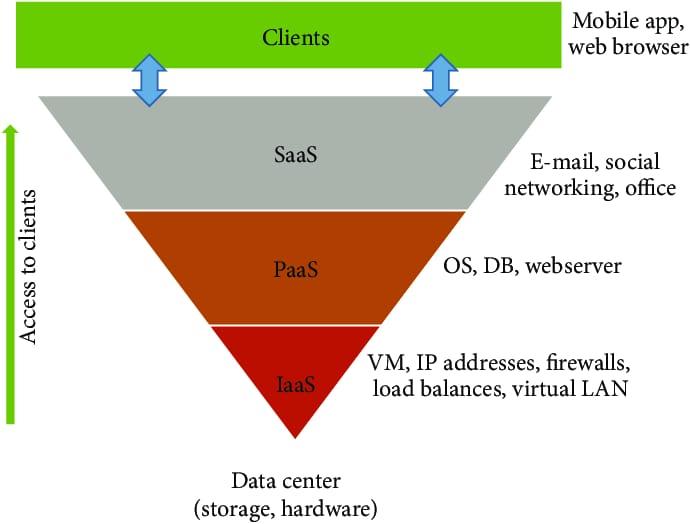
**Fig 3.1. Cloud-based Software.**

This subsection will explain Fig 3.1 cloud computing, outline its many service models (IaaS, PaaS, and SaaS), and define cloud computing. We'll also talk about the environmental aspects of cloud computing and green cloud computing

**3.2 Fundamentals of cloud computing**

Think about the fact that our home computer's actual server houses family photos. Imagine now that the server is housed in a large internet-connected data canter. Via the internet, photos can be accessed by digitally connecting to the server instead of physically plugging it into the computer. Computing defines could services as "a model for providing ubiquitous, practical, on-demand services." This is a simplified explanation of what services could entail. Who is the main difference between the models for? They have supplies. As the terms suggest, the community cloud is available for use by a collection of organizations with related goals, whereas the private cloud is only available for private use. A larger range of companies can access the network through the public cloud.

A combination of two or more of the deployment strategies is known as a hybrid cloud. The five features are what distinguish a cloud service, hence for a service to be classified as a cloud service, it must include each of the five criteria listed below in the Fig 3.2 has SPI model.



**Fig. 3.2. SPI Models**

* 1. **In-demand Self-Service**

When they choose to, the customer can manage the capabilities on their own. Without the need to speak to the company offering services.

**3.4 Wide-ranging Network Access**

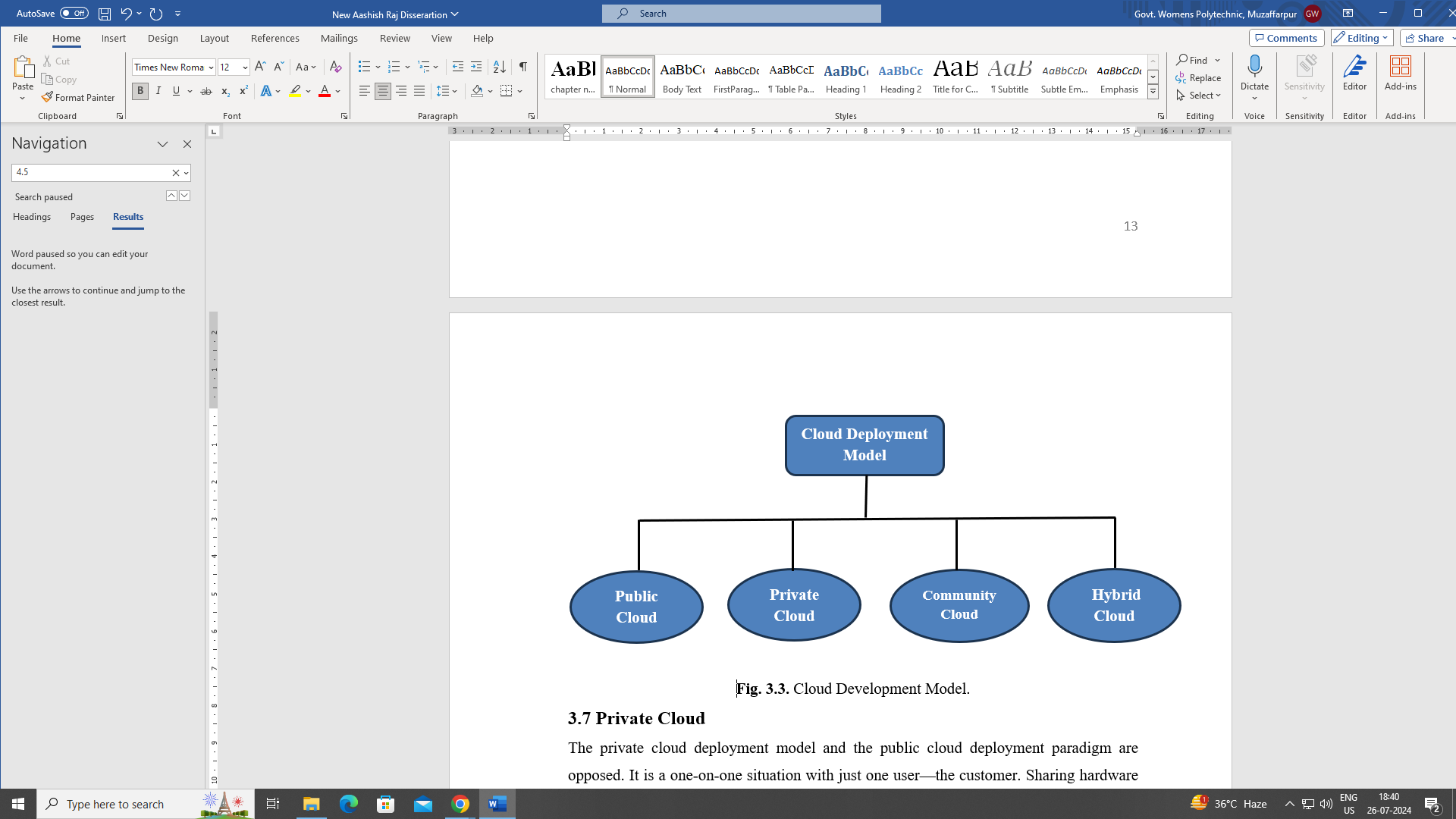
Access to the offered capacities is made possible by a network, specifically the internet, allowing for remote access.

**3.5** **Measured Service**

Cloud computing is dependent on self-service that is in great demand and is facilitated by data centres, which are crucial as consumption grows. Both data centres and consumers necessitate ample electricity and internet connectivity in order to establish connections with cloud services. The cloud service is characterized by transparency, as it is closely observed and controlled by both suppliers and users. Nevertheless, cloud services exhibit a high level of reliability in situations when providers have no control over variables such as internet connectivity and power supply. The NIST-defined service models (SaaS, PaaS, IaaS) categorize the different levels of cloud integration. Infrastructure as a Service (IaaS) provides users with the ability to access and utilize scalable and automated computing resources. This includes hardware, storage, and virtual machines, without the need to handle any physical hardware-related problems.

**3.6 Cloud Deployment Model**

An Open Cloud the public cloud provides systems and services that are accessible to everybody. Because it is available to all users, the public cloud may not be as secure. When cloud infrastructure services are made publicly accessible online to the public or important business associations, it's known as a public cloud



**Fig 3.3. Cloud Deployment Model.**

**3.7 Private Cloud**

The private cloud deployment model and the public cloud deployment paradigm are opposed. There is simply one person involved—the customer—and the scenario is one-on-one. With this model, sharing hardware with others is not necessary. A private cloud differs from a public cloud in that all the hardware is managed differently. It also goes by the term "internal cloud," which describes the capacity to access services and systems inside a particular group or organization.

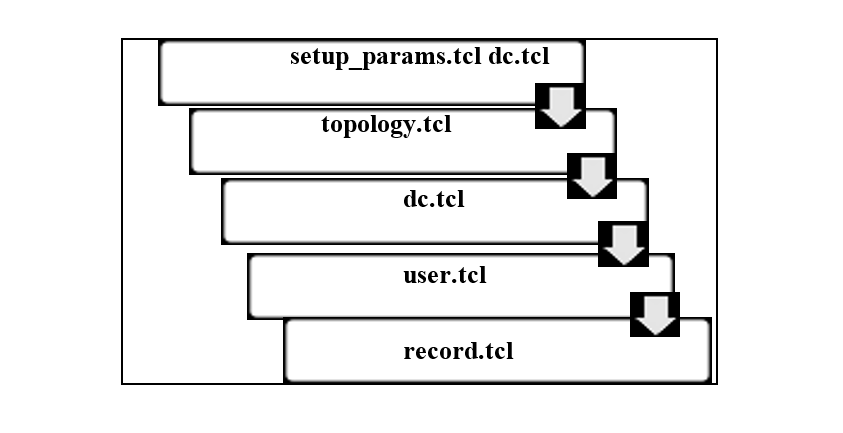
**3.8 Hybrid Cloud**

Hybrid cloud computing combines the greatest features of public and private cloud computing into a single private software layer. With a hybrid option, you may take advantage of the cheaper public cloud prices and host apps in a safe environment. This deployment approach transfers data and applications between clouds.

**3.9 Community cloud**

The solution facilitates the availability of shared services by numerous organizations through the consolidation of resources from several cloud platforms. Administered by a coalition or external institution, it provides support for common infrastructure for organizations facing comparable difficulties. This study utilizes an enhanced cloud simulator derived from a network simulator, incorporating both C++ and TCL programming languages, to advocate for the adoption of Infrastructure as a Service (IaaS) through the implementation of environmentally-friendly practices in cloud computing. The simulator minimizes operational expenses and maximizes earnings by optimizing the architecture of the data centre with a high-speed setup consisting of three tiers. Tests utilizing algorithms such as Round-Robin, Network-aware scheduler, and green scheduler assess the effectiveness of virtual machine load, data centre load, and energy usage in green cloud computing environments.

**3.10 Working of a green cloud simulator**

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**Fig 3.4 Working of a green cloud simulator**

1. The information regarding servers, switches, and jobs is contained in the setup-params. tcl file.
2. Topology.tcl: this file creates the topology of the data center network.
3. dc.tcl: It facilitates the creation of virtual machines and data center servers.
4. User.tcl: This file describes how different cloud users should behave.
5. Record.tcl: It facilitates the configuration of runtime parameters.

**3.11 Algorithm used**

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**Table 3.1 Algorithms utilized in data centers to monitor energy consumption**

**3.12 Network-Aware, Energy-Efficient Datacenter Scheduling Algorithm (DENS)**

It accomplishes stability in the data centers power consumption. Aside from that, this collection of guidelines focuses on character activity environments and has a simple, distinctive design.

**3.13 Round Robin (RR) Scheduling**

To maintain the same workloads across all of the available Virtual Machines (VMs), the Round Robin Scheduling method is employed for load balancing.

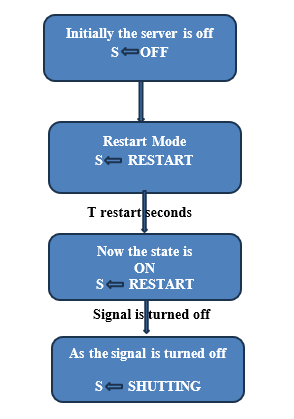
**3. 14 Green Scheduler**

The servers will grow to become on as the load increases, and as the load falls, the servers may become off. As a result, just the servers that are now in use will become on, which also minimizes power consumption and data center stress.

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**Table 3.2 System requirement**

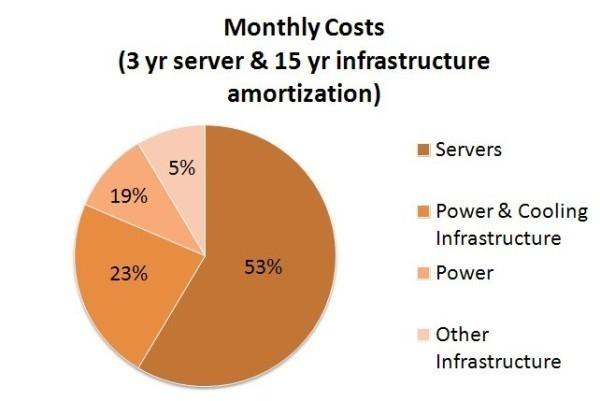


**Fig.3.7 Algorithm for Green Scheduling**

# RESULT

# NANO DATA CENTERS

This platform is entirely cloud-based and ought to have a distributed design. They state that a large number of data centers that are 30% smaller than typical data centers contribute to a 30% decrease in energy consumption. They are distributed globally and are linked together. Because of their portability, they can be used for brief periods of time or in a range of settings, including isolated ones. They shorten response times, which helps to decrease downtime



**Fig:4.1 Energy uses per part**

**PARAMETERS PER As Week/Month/Year**

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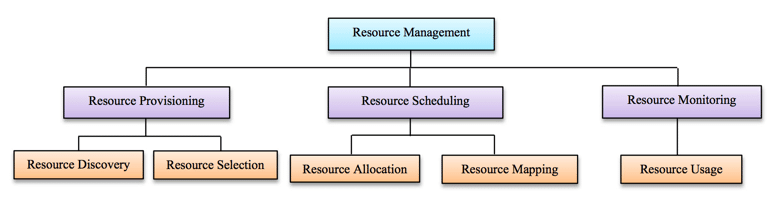
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**Table 4.1 Parameter Per/Week/Month/Year**

Tranquil PCs are very helpful in reducing carbon emissions. By using the architecture of cloud computing there's a sizable emission of carbon because of all data centers energy consumption and power uses. A previous paper study said that approx. 60kg of carbon is produced by desktop PCs per year in data centers

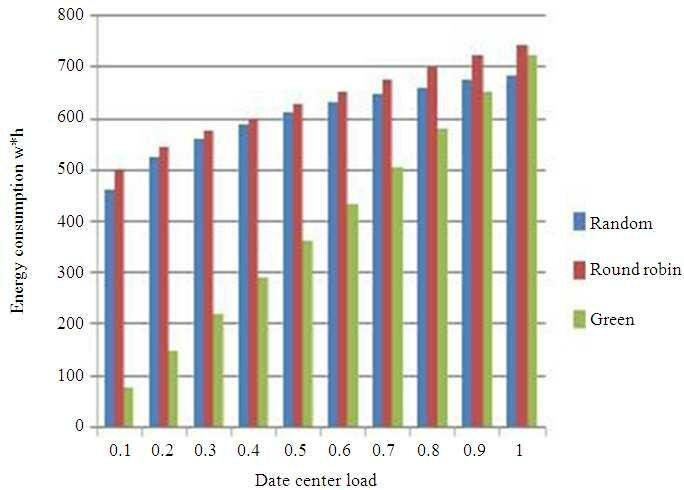
**Dynamic Migration Algorithm**

This algorithm is very helpful in decreasing power and energy consumption as well as decreasing carbon dioxide emissions. Resource utilization energy also increases but it takes a long response time, and migration costs exceed time

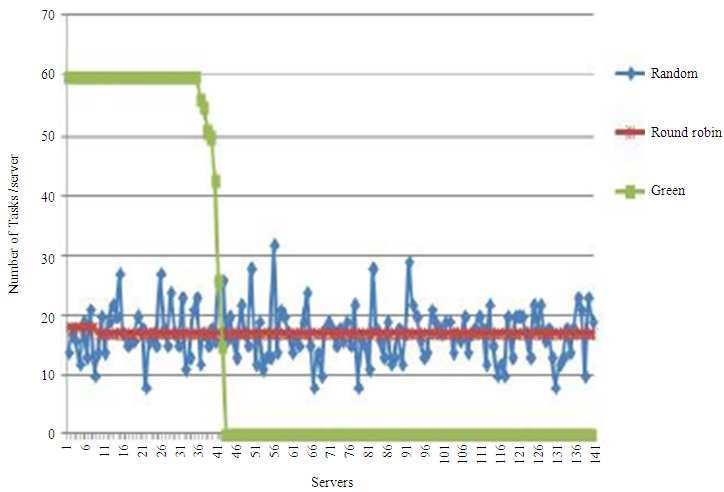
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**Fig:4.2 Resource management**

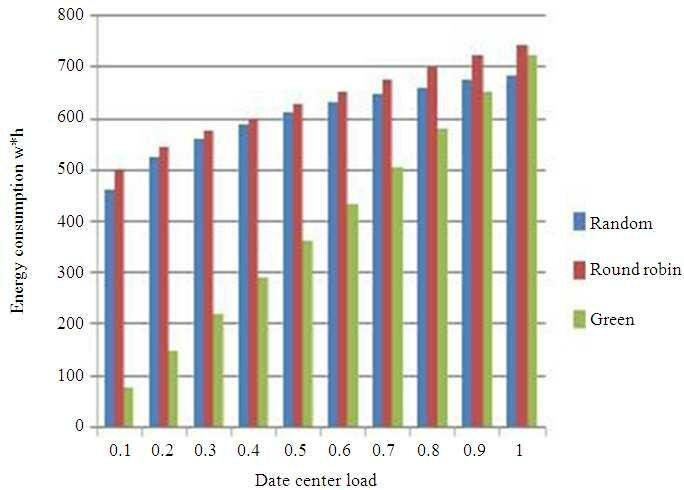
Cloud computing aims to leverage virtualization benefits while addressing the needs of diverse development platforms and cloud environments. Research continues to tackle unresolved issues and emerging challenges, such as SLA satisfaction, cloud data security, energy management, and interoperability. An unskilled cloud simulator evaluated different scheduling algorithms: Round-Robin, DENS, and Green Scheduler. The Round-Robin algorithm was the least energy-efficient, distributing load evenly across servers, while DENS used less power due to better task distribution. The spherical robin scheduling also affected server load distribution. The simulator's tests indicated that DC load varied from 10% to 100% and highlighted that, while Round-Robin balances visitor loads, DENS and Green schedulers result in higher information center load.



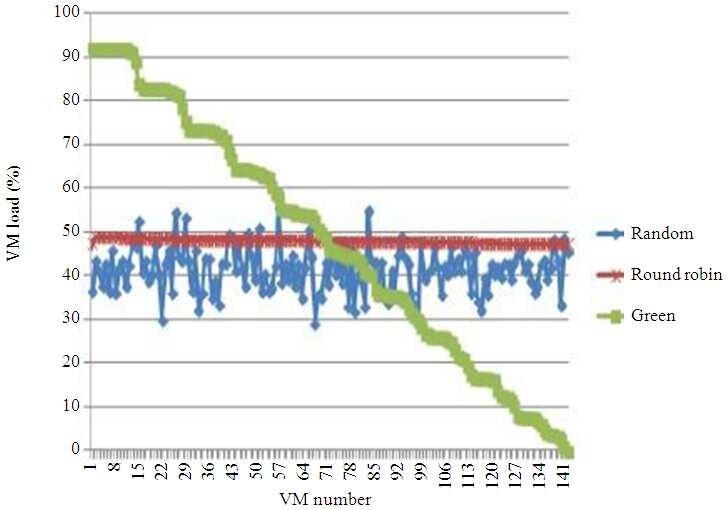
**Fig. 4.3 The amount of energy used at certain DC loads**



**Fig.4.4 Distribution of tasks among 144 distinct servers**



**Fig.4.5 DC load under various scenarios**



**Fig.4.6 The average load of the virtual computer at various input loads**

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