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# Towards Sustainable Cloud Computing: Limitations of Revenue-Optimized Resource Scheduling Policies

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**Abstract- Cloud computing has become an essential platform for delivering scalable and on-demand computational services. However, most existing cloud resource scheduling policies are designed primarily to maximize provider revenue and infrastructure utilization, often neglecting sustainability concerns such as energy efficiency, carbon reduction, thermal management, and fair resource allocation. This paper critically examines the limitations of revenue-optimized resource scheduling policies in cloud computing environments. The study evaluates traditional scheduling techniques including First-Come-First-Serve (FCFS), Round Robin, Priority Scheduling, and profit-aware heuristic scheduling approaches. Major issues identified include excessive power consumption, increased carbon emissions, resource starvation, thermal imbalance, and reduced long-term infrastructure sustainability. To address these limitations, a Sustainable Multi-Objective Scheduling Framework (SMOSF) is proposed that integrates energy efficiency, QoS maintenance, fairness, and profitability objectives. Comparative analysis demonstrates that sustainability-aware scheduling policies can significantly reduce energy consumption and environmental impact while maintaining acceptable service quality and operational profitability. The proposed framework contributes to the advancement of green cloud computing and sustainable data center management.**

**Keywords – Sustainable Cloud Computing, Resource Scheduling, Green Computing, Revenue Optimization, Energy Efficiency, Carbon-Aware Scheduling, Cloud Resource Allocation, Multi-Objective Optimization, QoS, Data Center Sustainability.**

## I. INTRODUCTION

Cloud computing has revolutionized the modern computing paradigm by providing scalable, flexible, and cost-effective computing services over the internet. Organizations increasingly depend on cloud infrastructures for data storage, application deployment, artificial intelligence, business analytics, and digital transformation initiatives.

To maximize infrastructure utilization and revenue generation, cloud service providers employ various resource scheduling and allocation strategies. Most existing scheduling policies are designed with objectives such as maximizing throughput, minimizing SLA violations, and increasing economic profit. Although these approaches improve operational efficiency and provider profitability, they often overlook environmental sustainability concerns.

The rapid growth of hyperscale data centers has resulted in increased electricity consumption and carbon emissions worldwide. Energy-intensive cloud infrastructures contribute significantly to environmental degradation and operational costs. Consequently, sustainable cloud computing has emerged as a critical research area focused on balancing performance, profitability, and environmental responsibility.

Traditional revenue-oriented scheduling mechanisms often prioritize high-paying workloads and aggressive resource consolidation, leading to excessive energy consumption, thermal hotspots, hardware degradation, and unfair resource distribution. Such limitations highlight the necessity for sustainable scheduling frameworks that integrate economic and environmental objectives simultaneously.

This paper critically analyzes the limitations of revenue-optimized cloud scheduling policies and proposes a sustainable multi-objective scheduling framework suitable for future green cloud infrastructures.

## II. LITERATURE REVIEW

Several researchers have explored resource allocation and scheduling mechanisms in cloud computing environments.
Early scheduling algorithms such as FCFS and Round Robin primarily focused on task execution efficiency and fairness. Later approaches introduced priority-based and profit-aware

scheduling mechanisms to improve revenue generation and SLA compliance. Energy-efficient scheduling techniques including Dynamic Voltage and Frequency Scaling (DVFS), virtual machine consolidation, and thermal-aware scheduling were proposed to reduce data center power consumption. Green cloud computing models further introduced carbon-aware workload migration and renewable-energy-based resource management strategies.

Beloglazov and Buyya proposed energy-efficient resource management models for virtualized cloud infrastructures. Their work demonstrated that VM consolidation can significantly reduce power consumption. However, excessive consolidation may lead to SLA violations and performance degradation. Profit-oriented scheduling approaches prioritize high-value workloads and maximize infrastructure utilization. While these models improve provider income, they often ignore fairness and sustainability considerations.

Recent studies emphasize the importance of multi-objective optimization in cloud scheduling. Researchers have suggested combining QoS, energy efficiency, and operational cost minimization into unified scheduling frameworks. Nevertheless, many existing solutions still lack balanced integration of sustainability metrics with profitability objectives.

## III. RESEARCH GAP

Existing cloud scheduling research mainly focuses on either revenue optimization or energy efficiency independently. Limited studies comprehensively address the following aspects simultaneously:

- Revenue maximization
- Energy-efficient scheduling
- Carbon emission reduction
- QoS maintenance
- Fair resource allocation
- Long-term infrastructure sustainability

Most profit-driven scheduling models prioritize short-term economic gains while neglecting environmental impact and infrastructure health. Similarly, certain energy-aware approaches reduce power consumption but compromise response time and SLA compliance.
Therefore, there is a significant need for a balanced sustainable scheduling framework that integrates profitability, environmental sustainability, and operational efficiency in cloud environments.

## IV. PROPOSED FRAMEWORK

This paper proposes a Sustainable Multi-Objective Scheduling Framework (SMOSF) designed to overcome the limitations of traditional revenue-oriented scheduling approaches.

The framework integrates multiple optimization objectives including:

- Energy efficiency
- Carbon-awareness
- QoS optimization
- Fair workload distribution
- Provider profitability

Framework Components
1. Energy Monitoring Module
Continuously tracks server power consumption and workload energy utilization.
2. Carbon Awareness Engine
Analyzes regional carbon intensity and allocates workloads to environmentally efficient data centers.
3. QoS Optimization Layer
Ensures SLA compliance, response time optimization, and workload stability.
4. Fair Resource Allocation Module
Prevents resource starvation and maintains balanced workload distribution among users.
5. Profitability Analyzer
Monitors provider revenue while ensuring sustainable operational constraints.
The framework employs multi-objective optimization techniques to achieve balanced cloud scheduling decisions.

## V. ARCHITECTURE DIAGRAM

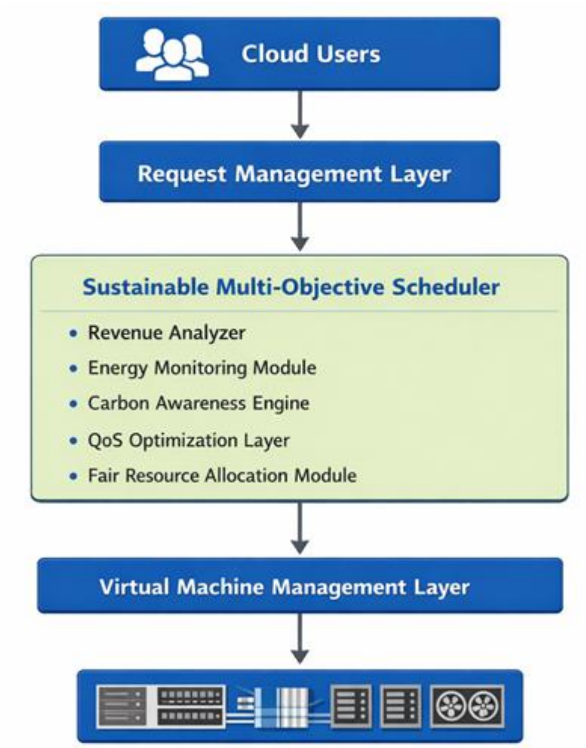


Figure 1: Sustainable Cloud Scheduling Architecture

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## VI. METHODOLOGY

The study adopts a comparative analytical methodology to evaluate traditional revenue-optimized scheduling policies and the proposed sustainable scheduling framework.

Scheduling Policies Evaluated

| **Scheduling Policy** | **Primary Objective** |
|---|---|
| FCFS | Simplicity |
| Round Robin | Fairness |
| Priority Scheduling | Revenue Maximization |
| DVFS Scheduling | Energy Efficiency |
| Heuristic Profit Scheduling | Provider Profit |
| Proposed SMOSF | Sustainability Balance |

**Evaluation Parameters**
The following metrics are considered:

- Energy consumption
- CPU utilization
- SLA violation rate
- Carbon emissions
- Average response time
- Resource fairness index
- Operational cost

Simulation Environment
The analysis may be implemented using:

- CloudSim Toolkit
- MATLAB simulation
- Synthetic cloud workloads
- Heterogeneous cloud server configurations

## VII. COMPARATIVE RESULTS TABLE

Scheduling Policy Energy Consumption SLA

| Scheduling Policy | Energy Consumption | SLA Violations | Fairness | Carbon Emission |
|---|---|---|---|---|
| FCFS | High | Medium | Medium | High |
| Round Robin | Medium | Medium | High | Medium |
| Priority Scheduling | Very High | Low | Low | Very High |
| DVFS Scheduling | Low | Medium | Medium | Low |
| Heuristic Profit Scheduling | High | Low | Low | High |
| Proposed SMOSF | Low | Low | High | Low |

## VIII. DISCUSSION

The comparative analysis reveals that revenue-oriented scheduling policies improve short-term provider profitability but significantly increase energy consumption and environmental impact.

Priority-based scheduling mechanisms often create workload imbalance and resource starvation for low-priority users. Aggressive server utilization also contributes to thermal imbalance and hardware degradation. Energy-efficient approaches such as DVFS reduce power consumption but may occasionally affect response time under dynamic workloads. The proposed Sustainable Multi-Objective Scheduling Framework successfully balances economic and sustainability objectives. The framework reduces energy consumption and carbon emissions while maintaining acceptable QoS and fairness. The findings suggest that future cloud infrastructures should adopt sustainability-aware scheduling mechanisms rather than purely profit-driven models.

## IX. CONCLUSION

Cloud computing continues to expand rapidly, increasing the importance of sustainable infrastructure management. Traditional revenue-optimized resource scheduling policies mainly focus on maximizing provider profitability and SLA compliance while neglecting environmental sustainability and long-term infrastructure efficiency.

This paper critically analyzed the limitations of profit-driven cloud scheduling approaches and identified major issues including excessive energy consumption, carbon emissions, thermal imbalance, and unfair resource allocation.To address these challenges, a Sustainable Multi-Objective Scheduling Framework (SMOSF) was proposed. Comparative analysis demonstrates that sustainability-aware scheduling significantly improves energy efficiency, reduces environmental impact, and maintains service quality without severely affecting provider profitability.Future cloud computing systems should integrate sustainability objectives into scheduling policies to support environmentally responsible and economically viable cloud infrastructures.

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