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Green computing: A study on sustainable and energy-efficient IT practices

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Abstract
The rapid growth of digital technology has made computers, smartphones, and online services crucial for daily life. These technologies enhance productivity and communication but also consume significant electricity and generate electronic waste. Green Computing aims to reduce the environmental impact of information technology by promoting energy efficiency, responsible resource utilization, and proper disposal of electronic devices. This study evaluates user awareness, knowledge, behavior, and perceptions related to Green Computing through a structured questionnaire. The study is based on a sample of 20 respondents, including students and working professionals. Data was analyzed using percentage distribution and average score methods. The findings reveal that while many users practice energy-saving behaviors such as turning off unused devices and using power-saving modes, their awareness of Green Computing remains moderate. The primary barrier identified is lack of awareness. The study concludes that awareness programs and educational initiatives can significantly promote sustainable computing practices and environmental protection.

Keywords: Green Computing, Energy Efficiency, Sustainable IT, E-Waste Management, User Awareness, Environmental Sustainability

Introduction

Information Technology (IT) plays a crucial role in modern society by enabling communication, education, business operations, healthcare services, and government functions. The widespread use of computers, smartphones, cloud computing, and networking technologies has significantly improved efficiency and global connectivity. However, the rapid expansion of digital technologies has also led to growing environmental concerns.

The continuous operation of electronic devices requires substantial electricity for processing, data storage, and charging. Large-scale infrastructures such as data centers operate round the clock and depend heavily on cooling systems, resulting in increased energy consumption and higher carbon emissions. In addition, electronic waste (e-waste) has emerged as a serious environmental issue. Frequent upgrading of devices generates waste containing hazardous materials such as lead, mercury, and cadmium, posing risks to both the environment and human health.

Green Computing has emerged as an effective approach to minimize these impacts by promoting efficient resource utilization, reduced energy consumption, and responsible disposal of devices. Practices such as switching off idle devices, enabling power-saving modes, reducing paper usage, and recycling e-waste contribute to sustainability. Since user behavior plays a critical role, studying awareness and perception is essential for promoting sustainable computing practices.

Literature Review

Previous studies indicate that the IT sector contributes significantly to global energy consumption due to continuous operation of computing devices and data centers. Murugesan (2008) [1] introduced Green Computing as a sustainable approach to IT usage, while Koomey (2011) [2] highlighted the high energy consumption of data centers.

Research shows that energy-efficient hardware and optimized systems can reduce electricity usage. Techniques such as dynamic voltage scaling and efficient resource management improve performance while minimizing energy consumption (Tanenbaum, 2015) [6]. Additionally, virtualization technology reduces hardware dependency and power usage (Barham *et al*., 2003) [3].

User behavior also significantly impacts energy consumption. Darby (2006) [4] emphasized that awareness influences energy-saving actions such as switching off devices. However, Weber (2010) [5] identified lack of awareness as a major barrier to adopting Green Computing practices.

Despite technological advancements, limited research focuses on the relationship between user awareness and adoption of sustainable computing practices, highlighting a research gap addressed in this study.

Objectives of the Study

1. To assess awareness and understanding of Green Computing among users
2. To analyze whether users follow energy-efficient computing practices
3. To identify challenges in adopting Green Computing
4. To examine willingness to adopt sustainable IT practices

Research Questions

- Are users aware of Green Computing?
- What is their level of knowledge?
- Do they switch off devices when not in use?
- Do they use energy-efficient devices?
- What practices do they follow?
- Do they believe Green Computing reduces pollution?
- What challenges exist?
- Are they willing to adopt sustainable practices?

Research Methodology

This study uses a quantitative survey approach. Data was collected using a structured questionnaire distributed via Google Forms to students and working professionals.

Data Collection

- Sample Size: 20 respondents
- Sampling Method: Random sampling
- Nature of Data: Primary (self-reported)

Data Analysis Method

- Percentage analysis was used to study response distribution
- Average rating method was used for awareness levels
- Charts were used to visualize trends

Scope of the Study

- Focuses on awareness and adoption of Green Computing practices
- Includes students and working professionals
- Examines behavior and challenges related to sustainable IT use

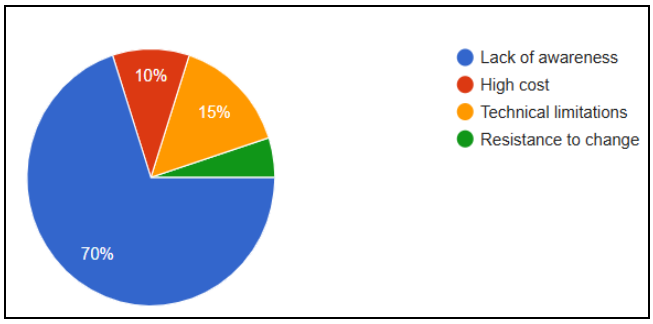


Fig 1: Awareness of Green Computing

Data Analysis and Interpretation

1. Awareness of Green Computing Approximately 65% of participants reported being aware of Green Computing, while 35% were uncertain or unaware. This reflects moderate awareness among users.
2. Knowledge Level The average knowledge rating was 2.9 out of 5, indicating that most participants have only basic knowledge of the concept.
3. Switching Off Devices Around 75 to 80% of respondents reported turning off devices when not in use. However, most users do this mainly to lower electricity bills rather than for environmental reasons.
4. Use of Energy-Efficient Devices More than half of the participants reported using energy-efficient devices, while several selected "maybe," suggesting limited awareness of device energy ratings.
5. Green Computing Practices Followed Common practices identified among participants include: - Using power-saving mode - Reducing paper usage - Using cloud storage - Participating in virtual meetings These practices help decrease energy consumption and environmental impact.
6. Environmental Impact Perception About 70% of respondents believe Green Computing helps reduce environmental pollution, showing positive attitudes toward sustainable technology.
7. Importance in the IT Industry The average importance rating was 3.9 out of 5, indicating that users regard Green Computing as significant for future technological development.
8. Challenges in Adoption The main challenge identified was a lack of awareness. Other challenges included technical limitations and costs.
9. Willingness to Adopt Approximately 80% of respondents expressed a willingness to adopt more Green Computing practices if given proper knowledge and guidance.

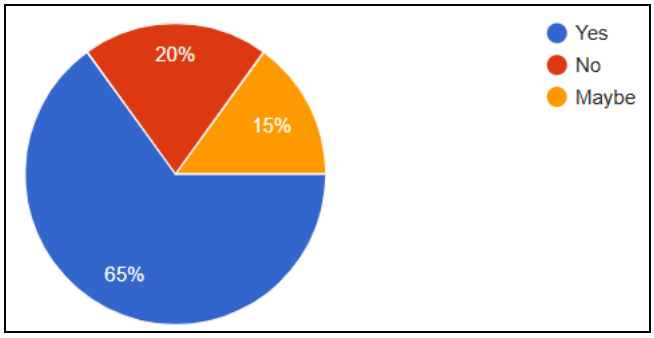
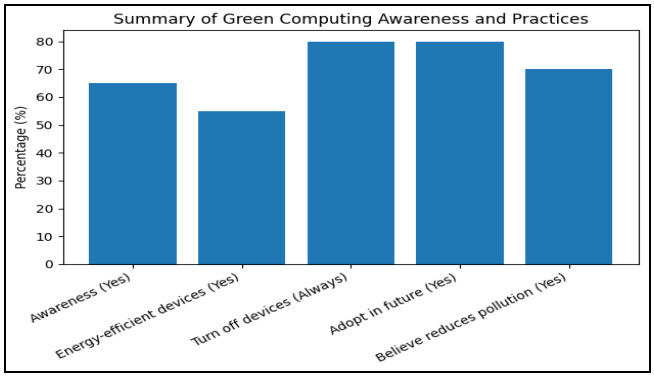


Fig 2: Challenges in Adoption



Hypothesis

H1: Positive relationship exists between awareness and adoption

H0: No significant relationship exists

Pearson correlation method was used to analyze the relationship between variables.

Hypothesis Testing

Correlation analysis was conducted to examine the relationship.

Table 1: Correlation between Awareness and Adoption

Variables	Awareness	Adoption
Awareness	1.00	0.68
Adoption	0.68	1.00

The correlation value (r = 0.68) indicates a moderate positive relationship.

Findings

- Positive relationship exists between awareness and adoption
- Higher awareness leads to better practices
- H1 is accepted and H0 is rejected

Limitations

- Small sample size
- Limited age group (18-25)

- Self-reported data may include bias
- Focus on perception rather than actual energy measurement

Conclusion

The study reveals that while users engage in eco-friendly practices, their awareness of Green Computing is moderate. Lack of awareness is the primary barrier rather than cost or technology. Increasing awareness through education and policies can significantly improve adoption of sustainable computing practices and contribute to environmental sustainability.

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