Stochastic Modelling and Computational Sciences

GREEN COMPUTING: SIGNIFICANCE AT RURAL AND SUB-URBAN AREAS FOR SUSTAINABLE FUTURE

Abhishek Chakraborty[1], Sunil Kumar[2*] and E.V. Revaty[3]
[1,2]Bhilai Institute of Technology, Durg, Bhilai House, GE Road, Durg, C.G., India, 491001
[3]Government Nehru PG College, Dongargarh, C.G., India, 491445
[1]abhishek.chakraborty@bitdurg.ac.in, [2]s.kushwaha@bitdurg.ac.in and [3]evrevaty.clg.dgg@gmail.com
[1][0000-0002-8028-9742] and [2][0000-0002-8395-3899]

ABSTRACT
"Going Green" is a growing movement promoting environmental protection in various aspects of life, including recycling, energy-efficient equipment, renewable energy sources, environmentally friendly cars, and green structures. Green computing, also known as green technology or green IT, refers to the responsible and eco-friendly use of computers and their resources. It involves designing, developing, producing, using, and disposing of computer systems to minimize environmental impact. Green computing has become the most effective way to use technology, contributing to environmental conservation. The advancement of technology has led to environmental contamination, causing a shift towards efficient computing. This shift aims to reduce hazardous materials use, maximize energy efficiency, and promote recyclability of defunct products and factory waste. This has led to a revolution in computing technology, known as green computing. Green computing focuses on efficient and eco-friendly computing, helping organizations reduce their energy footprint while maintaining performance. This paper aims to raise awareness about green computing.

Key words: Green computing, E-waste, sustainability, awareness.

INTRODUCTION
Green computing is receiving more and more attention (Kothari, 2019) with increasing energy costs (Kadry, 2012) and growing environmental concerns (Patra, 2014). Green computing is the latest movement (Raut, 2022) in the IT industry towards scheming, building (Tripathi, 2022), and operating computer systems to be energy-efficient (Ruth, 2011). ICT contributes 2.8% of global greenhouse gas emissions (Yau, 2020), equivalent to aviation industry pollution (Albreem, 2021). Its carbon footprint grows from raw material extraction (Mandal, 2021), manufacturing, transportation, energy use, and end-of-life emissions from all life cycle stages (Bakır, 2022). India, the world's second-most populous country, faces environmental challenges due to energy consumption and carbon emissions from developing information communication and technology (ICT). Green-ICT, or green IT, aims to reduce these issues by transforming physical resources into information resources that are equally efficient in productivity (Vermesan, 2022). Chhattisgarh (Roberts, 2017), a power surplus state with lower tariffs, abundant mineral resources, and lower capital costs, is a fast-growing state with well-connected infrastructure, bordering seven states and is emphasizing sustainability in its growth (Chakraborty, 2020).

PROBLEM STATEMENT
Computers, like other electronics, pose environmental challenges due to toxic chemicals like lead, mercury, and arsenic, consuming more electricity, contributing to the energy crisis, CO2 emissions, and global warming. Institutions often struggle to dispose of outdated computers, laptops, and electronic devices, with only 25% of equipment recycled annually. This leads to the generation of harmful non-degradable substances and contributes to the severe environmental impact.

CHALLENGE FOR INDIA
India's population in 2023 is 1.42 billion, with 36.1% in urban areas (Gupta, 2023) and 64.9% in rural areas. In January 2023, GSMA Intelligence's data shows that mobile connections in India accounted for 76.0% of the total population (Lyons, 2022). India has achieved 50% internet penetration, with 720 million internet users as of 2022, accounting for 50.5% of the country's total population, according to a Nielsen report. In early 2023, India had

692.0 million internet users, with a 48.7 percent internet penetration rate. The country had 467.0 million social media users, comprising 32.8% of the total population. Additionally, 1.10 billion cellular mobile connections were active, representing 77.0% of the total population.

All the above data and statistics shows that our country is adopting ICT at a very fast speed. Thus it is spreading at the sub-urban and rural areas as well. The speedy adoption is a threat towards sustainability as the average life of computer and allied technologies is 3 to 5 years thus it generates huge waste and that waste is not bio degradable (Kumar, Chakraborty, & Sharma, Green Investments: Implications on Sustainability, 2023).

GREEN COMPUTING: SOURCE OF POTENTIAL

Green computing, or green IT, is the responsible and eco-friendly use of computers and their resources, focusing on efficient and effective learning, manufacturing, engineering, and disposal of computing devices to reduce their environmental impact. India is aiming to achieve a 56% clean energy mix by 2026-27, increasing its global energy demand to 9% by 2035. Green computing aims to reduce hazardous materials use, maximize energy efficiency, and promote recyclability of obsolete products. Research continues on energy-efficient computer use and efficiency-related algorithms. Carbon footprint refers to the amount of carbon dioxide released from a lifestyle due to fossil fuel use or tree cutting (Kumar, Gomes, & Chakraborty, 2022).

PROBLEMS ASSOCIATED WITH ICT.

- Electricity consumption involves the use of natural resources (Sambo, 2008) to generate electricity, which has various environmental impacts (Midden, 2007).
- Modern computer users are producing hazardous toxic waste (Pinto, 2008) by updating outdated hardware, resulting in the disposal of outdated resources and peripherals
- Computers, like other electronics, pose significant environmental challenges (Needhidasan, 2014) due to their toxic chemicals (Oteng-Ababio, 2010) like lead, mercury and arsenic, increased electricity consumption, and contribution to the energy crisis, CO2 emissions, and global warming, often ending up in landfills (Mundada, 2004).
- The rise in data centres necessitates constant server addition (Uddin, 2012), increasing energy demand and causing the release of toxic chemicals like mercury, lead, and cadmium, prompting a search for green computing solutions.

A survey in the rural and urban areas was made to identify the number of users of ICT and other mobile devices in Chhattisgarh along with their response related to green computing. The figure 1 shows that there is strong association of awareness and use of ICT considering green computing (Kumar, Gomes, & Chakraborty, Green Hydrogen: Future Fuel?, 2022).

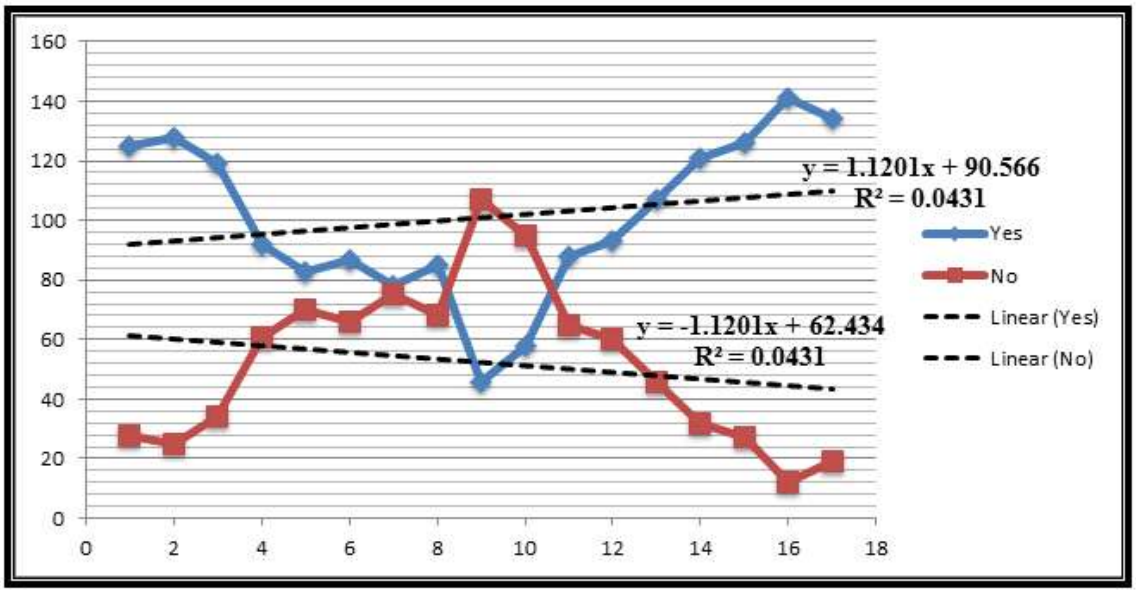

Figure 1: *Green Computing awareness in Rural and Urban Areas*

As it is very much evident that maximum respondents are from the ICT user category thus it becomes important for us to understand the importance of Green Computing

MOVING AHEAD

The Graph shows that Green Computing is a new concept for the area of Chhattisgarh and the respondents are unaware about the importance of Green Computing fundamentals. Green computing focuses on efficient computing, chip design, energy-aware software, power management, reducing energy consumption, improving mobile computing, increasing large data use, encouraging sustainable behavior, and lowering costs in institutions and environments.

Green Computing focuses on energy efficiency, reducing electricity usage in homes and institutions. It reduces e-waste by reducing the amount of lead and other chemicals found in computers. Additionally, Green Computing uses IT to address environmental issues, as technology can be a valuable tool for understanding and addressing these issues. Overall, Green Computing aims to reduce electricity consumption and promote environmental sustainability.

To resolve this problem let's ask ourselves a question can we solve the problem at individual and institutional level. To reduce environmental impact, consider reusing electronic devices, donating old ones to charity, enabling power management software, extending laptop battery life, transitioning to thin client computing, turning off computers and electronics, consolidating servers, and introducing cloud computing systems. These measures can help reduce pollution and expenses associated with laptops, while also promoting longer battery life and reducing the need for expensive laptop batteries. By adopting these sustainable practices, you can help reduce your environmental impact.

STRATEGIES EFFORT TO USE GREEN COMPUTING FOLLOWING CAN BE DONE.

E-Waste is crucial for green computing. It's essential to choose certified recyclers, such as e-Stewards or R2 Solutions, to ensure environmental and data privacy protection. A formal disposal plan is also essential. E-Waste can save time and money by reducing the time needed for project completion and managing technology, which can be a costly endeavor for organizations.

- Together with business leaders, create a sustainable green computing strategy that takes into account organizational rules, recycling policies, used equipment disposal, legal requirements, and green computer

equipment acquisitions. The strategy should include communication and implementation, and it should address power utilization, decreased paper consumption, new technology, and recycling.

- Electronic equipment should be disposed of safely and responsibly because it contains hazardous contaminants and poisonous metals. Use manufacturer recycling programs, local recycling facilities, or donate working computers to nonprofit organizations as an alternative to land filling.
- The Green Electronics Council uses the Purchase Electronic Product Environmental Assessment Tool (EPEAT) to assist institutional buyers in assessing and choosing environmentally friendly products, to give precise performance standards, and to acknowledge manufacturer efforts.
- Reduce paper usage by using electronic mail, archiving, track changes, using both sides of paper, recycling, using smaller fonts and margins, and printing only the necessary pages.
- Turn off your computer when not in use and activate power management measures when inactive for shorter periods.

CONCLUSION

Green computing strategies offer numerous business benefits, including cost savings, resilience, disaster recovery, and public relations. They contribute to reducing e-waste and maximizing energy use. The computing sector is well-prepared for rapid change, and it is expected that most computers will use significantly less power in the future. As more than 60% population in India are the residents of rural areas and the government is trying to minimize the Digital Divide it becomes important to understand and strategies green computing fundamentals for sustainable development as the total contribution of ICT towards pollution accounts for about 3% which is equal to pollution caused by aviation industry and is a significant value thus small contributions at larger scale can contribute a lot.

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