BEYOND THE VEIL OF TECHNOLOGY- THE SOCIO-ECOLOGICAL COSTS OF AI IN BUSINESS

Ruchita Nandy[1], Dr. Aruna Dev Rroy[2]
[1] Student, The Assam Royal Global University Guwahati: 781035
[2] Associate Professor and HOD, The Assam Royal Global University Guwahati: 781035

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ABSTRACT

Artificial Intelligence (AI) is a newly emerging technology that has transformed society due to its vast range of use cases. It has especially had a large impact on the way businesses are operated, from digital marketing, customer service through chatbots, inventory management, etc. AI is being utilized in almost every business activity. In the current landscape of rapid adoption of Artificial Intelligence (AI), it is thus essential to critically evaluate whether this technology ultimately yields benefits to society as a whole. Although numerous studies have been conducted on the positive impact of AI, its overwhelming social and ecological costs have been overlooked. The current literature has the overarching themes of the impact of AI on Sustainable Development Goals (SDG), AI Ethics, as well as AI's positive impact on sustainability. This paper thus explores the direct ecological costs, i.e., the carbon footprint of AI, as well as the indirect social costs, including the marginalization of many minority communities. The paper utilizes methodological triangulation to highlight such socio-ecological costs, illustrating how AI, as a technology, still has areas where it can be optimized, especially in business practices that use society's vast resources for profit. Companies and businesses must therefore be made aware of such costs in order to ensure greater accountability and corporate governance. In conclusion, this paper aims to present the future scope of AI-related studies in India as well as practices that can be implemented on the corporate level to reduce such socio-ecological costs.

Keywords: AI, Business, Socio-Ecological Costs

INTRODUCTION

There was once a time when Artificial Intelligence (AI) was predicted to become the fifth generation of the computer. The dawn of AI came sooner than expected; however, with the onset of AI Agents such as DeepBlue and Apple's Siri. In the simplest of words, AI refers to a method or technique or 'algorithm' that allows machines to simulate human intelligence in order to create something new or solve problems. In the words of Marvin Minky, one of the founders of AI, AI is "enabling machines to do things that require human intelligence"[1] .

In the present day, Artificial intelligence (AI) is causing a revolution in business and society by changing the existing relationship and therefore interactions between stakeholders and individuals[2] . The prevailing outlook among companies regarding AI is extremely positive. After all, with machines and automation taking over business operations, companies can look forward to reduced costs, increased efficiency, and rising profit margins. Given the massive impact that AI has had, changing the way in which society as a whole thinks, functions, and interacts, it is necessary to know the socio-ecological costs of AI in business.

Berger, S. states that social and ecological costs are interrelated concepts in existing capital markets and thus refers to socio-ecological costs as "preventable resource depletion, environmental disruption, and social problems, such as unmet human needs"[3] . The use of AI in business implies the setting up of data centers for energy, water for cooling the hardware, and large storage demands. It is assumed that training AI alone consumes up to 1,287 megawatt hours of electricity (enough for 120 average U.S. homes for a year) and generates about 552 tons of carbon dioxide. This does not include the environmental costs of dirty mining procedures and the use of toxic chemicals in obtaining raw materials for fabricating GPUs. The cool water used in the process also has massive environmental impacts[4] .

The human input required by Large Language Models during the training phase is typically outsourced to independent contractors in low-income countries. These workers face downright toxic and exploitative working conditions. LLMs are also being used for spreading fake news, propaganda, data theft, and bias. If no action is taken soon, AI has the potential to cause harm to our biosphere and undermine social and democratic processes[5] . The attitude of critical optimism that businesses and other organizations alike have adopted is inadequate in tackling this complex technology.

The first step in preventing this is thus to equip both businesses and those affected by AI with the necessary knowledge to ensure the ethical and sustainable utilization and

development of Artificial Intelligence[6] . Thus, the study attempts to ascertain the socio-economic costs of AI and identify measures and areas for policy intervention.

The study further adopts an Information Systems perspective through the Socio-Technical Systems Theory and IT Governance Theory. These frameworks help explain how AI in business is not merely a technical tool but rather an interconnected socio-organizational system that influences environmental sustainability, social welfare, and governance mechanisms.

Despite the increasing discourse on AI ethics and sustainability, existing studies focus either on energy consumption and carbon emissions or on ethical concerns such as privacy and bias. There is limited research that examines the socio-ecological costs of AI in business operations through an integrated perspective combining environmental degradation, labour exploitation, governance failures, and sustainability concerns. This creates a significant gap in understanding how the use of AI in businesses affects both ecological sustainability and social welfare simultaneously. The study aims to address this gap by critically evaluating AI as a driver of ecological and social costs through an integrated perspective. It also proposes policy frameworks to support sustainable AI in business.

OBJECTIVE

1. To examine the ecological costs associated with the use of Artificial Intelligence in business operations, including energy consumption, water usage, resource extraction, and e-waste generation.
2. To examine the social costs associated with the use of Artificial Intelligence in business operations.
3. To propose policy frameworks for the sustainable and equitable utilization of AI in business operations.

Research Questions

RQ1. What are the major ecological costs associated with the use of AI in business operations?
RQ2. What social risks and inequalities emerge from AI business systems?
RQ3. What policy frameworks can support sustainable AI in business?

LITERATURE REVIEW

The existing literature puts more emphasis on analyzing or computing AI-related energy use and greenhouse gas (GHG) emissions[7] [8] [9] . While these papers contribute to the discourse on the ecological costs of AI, they fail to consider the broader impact of using AI in business practices on environmental degradation,

including aspects of water consumption, resource degradation, waste generation, as well as the indirect and adverse social effects. Additionally, some papers focus only on specific subsets of AI, such as Large Language Models (LLMs) or Generative AI (GAI). While studies that focus on AI's socio-ecological costs holistically do not consider the context of business and organizational settings[10] [11] .

Some key social issues related to AI as entailed by existing papers include the lack of data privacy, algorithmic discrimination and bias, and job loss [12] [13] . However, these issues are often isolated from environmental concerns, leading to two separate streams of research. As a result, there is limited understanding of how the social and ecological consequences of AI interact and reinforce one another within present business environments. This largely curtails the development of a comprehensive assessment of AI's social impacts.

Further, much of the research portrays AI as a catalyst for socio-economic sustainability rather than as a driver of much of the harm. AI is given credence simply for its potential to improve efficiency, optimize resource use, strengthen environmental sustainability effort, and support the achievement of the Sustainable Development Goals (SDGs)[14] [15] [16] [17] . Nishant[14] for example, maintain that the true value of AI lies in how it facilitates environmental regulation and sustainability. Similarly, several studies assess the impact of AI in helping accomplish SDGs and suggest measures to ensure a positive shift of AI in supporting the attainment of these goals[15] [16] [17] . In contrast, research by Christensen E. and Jallat F. & Morillon G contend such optimistic outlook by emphasizing material and social costs associated with AI systems, including increased resource consumption, environmental degradation and labour displacement[10] [11] . The paradoxical perspectives remain unresolved because most studies evaluate either the benefits or the costs of AI but in isolation. Thus, the net impact of AI in business practices on sustainability continues to be unclear.

In terms of policy frameworks for countering the adverse effects of AI on the environment, there exists a similar contrast. Studies in this area emphasize the need for norms, regulations, and guidelines to uphold moral values and human rights in the process of deploying AI in business practices[18] . Ethical guidelines issued by private companies, research institutes, and government organizations aim to ensure 'ethical AI,' while regulations aim to mitigate risks such as data security[19] [20] . However, there is yet to be a consensus on the effectiveness of such governance frameworks. Munn[21] argues that principles so put forth are often difficult to apply as they are isolated and lack, as businesses tend to largely ignore ethics and focus on profits. Therefore, it is entirely up for debate whether AI ethics and governance regulations in the current discourses are capable in mitigating the social and environmental costs of AI in any meaningful sense.

Taken together, the literature reveals three key limitations that constrain the comprehensive view of socio-ecological costs of AI in business. First, the research on environmental aspects of AI focus on energy consumption and carbon emissions while neglecting broader ecological impacts such as water use, resource depletion, and waste generation. Second, social and environmental costs are typically examined separately, thereby limiting the understanding of their connection and subsequent effects. Third, studies on governance and ethics concentrate on theoretical guidelines and not on policy mechanisms capable of addressing the socio-ecological impacts.

This study addresses these gaps in the existing literature in three ways. First, it develops an integrated socio-ecological perspective on AI in business, combining ecological and social dimensions. Second, the paper critically evaluates AI as a driver of ecological degradation and social inequality rather than as a sustainability enabler. Third, the study proposes a policy-oriented framework for India, where AI adoption is rapidly increasing despite limited regulatory preparedness.

METHODOLOGY

This study adopts a qualitative conceptual research design based on the analysis of the literature and policy suggestions. Methodological triangulation has been used to collect the requisite data. Primary and secondary data in the form of company BRSR, Sustainability Reports, research papers, and telephonic interviews with five environmentalists have been utilized. The selection of five environmentalists was guided by the principles of methodological triangulation and qualitative depth rather than statistical representation. These participants were chosen for their expertise and engagement with environmental issues with the aim to eliminate bias and provide in-depth understanding of the complex theme. Interviewees were selected based on a snowball sample, and their insights were divergent from some of the information collected through company reports.

The collected data were analyzed using thematic analysis. Themes relating to ecological costs, social costs, governance gaps, and sustainability interventions were identified using an interpretation of the literature and interview responses.

The Google Scholar and SSRN databases have been used to cover most articles. Keywords such as “AI and sustainability”, “socio-ecological cost of AI”, “environmental cost of AI data centers”, “AI ethics”, and “AI and SDG” have been employed to search for articles in the databases.

ANALYSIS/ DISCUSSIONS

Ecological Costs

The adoption of Artificial Intelligence in business operations have enhanced their efficiency, automated routine processes, and improved decision-making capabilities. However, these benefits are accompanied by ecological costs, often overlooked in discussions surrounding the technology. Most of these drawbacks arise due to something called an AI data center and GPUs (Graphics Processing Units).

An AI data center is an energy-consuming and power-hungry computing, processing and storage infrastructure for the training and deployment of AI services[22] . On the other hand, GPUs enable the training and deployment of AI models by processing large amounts of data[23] . Together, these components allow businesses to use AI in their operations and lead to serious ecological harm.

Energy Consumption and Emissions

Strubell [24] calculated that training AI for a single session produces around 313 tons of CO_2. For comparative purposes, this number is equivalent to 5 times the emissions of an average car (throughout its lifecycle). The Solar Impulse Foundation mentions that it is training an AI model that costs the most in terms of the environment and energy. According to Sheng Y[25] , at the global level, data centres and AI consumed around 460 TWh of electricity (around 460 million MWh) in 2022. The International Energy Agency[26] also pointed out that data centres consumed nearly 1.5% of global electricity in 2023 and could reach 2% by 2026[25] . In order to run an AI model as well, thousands of GPUs must run in parallel for months, resulting in a gigantic energy usage. This energy consumption is expected to further increase with the increasing demand for AI chips and models by companies around the world. In its Sustainability Report, for example, Google attributes a 27% increase in its energy consumption as well as around 3 million metric tons of carbon dioxide emissions to its growing data centers for AI[27] . Similarly, it is estimated that approximately 19% of Microsoft's total FY2024 emissions (3.26 million MT CO_2e) can be directly attributed to AI-related activities[28] . However, environmentalists interviewed for the study contend that companies tend to seriously underestimate or under-report the emissions related to their AI use. These claims suggest that AI models in business could be responsible for as high as 50% of greenhouse gas emissions emitted by AI companies. They also highlight that the renewable energy claims that companies make tend to be based on paper certificates rather than on ground realities. For context, NVIDIA claims that 100% of its global electricity consumption is powered by or matched with renewable energy.

Rostirolla[29] highlight the challenges of integration of renewable energy sources into AI data centres. AI data centres require enormous amounts of power and have limited tolerance for disruptions. In contrast, renewable energy sources are by nature intermittent and often undergo loss of energy in transmission. This implies that the use of AI in business contributes not just directly but indirectly to the GHG emissions of the world. However, while a large proportion of Indian organizations have started utilizing AI in their operations, they have yet to disclose any AI-related emissions or costs. Indian firms look to AI in their business practices as a lever to drive better resource utilisation and reduce environmental impact rather than considering it as a potential cause of emissions. Environmentalists point out that the lack of transparency on their part can be due to the lack of direct laws that regulate AI directly in India, and point out the need to bring in better AI regulations.

Water Consumption

The rapid growth of data centres has led to a surge in water consumption, often used as a cooling source. Privette AP, et al. point out that around 38 million litres of ultra-pure water is used per day in the production of data centre hardware, primarily for cooling machinery and ensuring wafer sheet purity. Further, data centres lead to the evaporation around 1–9 litres of water per kWh of server energy for cooling, depending on technology and climate. In an era where many regions are facing freshwater scarcity challenges, AI models are consuming more water than ever before; Google reported the consumption of 6.1 billion gallons of water by its AI data center in FY 2023[30] .

Despite their growing impact on water stress and freshwater redirection, data centres remain among the least transparent industrial users of water. Most companies disclose partial or aggregate water use figures, sometimes omitting water consumption data entirely from sustainability reports[30] .

Resource Consumption and E-Waste Generation

The hardware for AI (GPUs) requires rare earth elements, such as 3 neodymium, indium, and tantalum, all of which are mined in regions with poor environmental governance, leading to ecosystem degradation[31] [11] . According to UNEP[32] , making a 2 kg computer for AI data centers requires 800 kg of raw materials. Data centres also produce electronic waste containing hazardous substances, like mercury and lead. Such waste generated is difficult to dispose of, as reselling data center hardware components requires the secure wiping of data and maintaining component functionality. Reducing such components is also a hassle, as it means securely crushing and deforming to protect the data security of the companies[27] . The

import of GPUs and AI hardware by companies in India relying on AI is a serious issue due to the lack of proper waste disposal systems and rising e-waste generation.

Social Costs

Aside from these environmental costs, the social costs of AI are very much overlooked, as there are no suitable measures to quantify them. Colón Vargas[33] mentions that big tech players in the AI industry, such as Amazon and Facebook, heavily rely on laborers in developing countries like India. Due to such outsourcing, these workers endure minimal pay, constant surveillance, and safety hazards. For example, companies often acquire the hardware for AI (GPUs) through mining in regions with child labor and unsafe working environments[31] [11] .

Further, AI is expected to replace a substantial number of routine and manual jobs (around 40%), leading to large-scale unemployment, particularly in manufacturing, retail, and transportation sectors. This serves a great challenge towards India as a significant portion of the workforce is engaged in unskilled labor[34] [35] . As more and more companies engage in AI, there is a need for investment in upskilling and reskilling. However, most labourers from India do not possess the necessary resources to do so. Additionally, AI models improve the performance of lacking individuals, thereby undermining the rationale for the meritocratic systems of colleges and jobs and increasing income inequality among individuals[36] .

Another social cost of AI is the uneven distribution of its access and benefits. Large corporations and high-income countries reap most of the benefits, while small businesses and developing nations fall behind. This digital gap means an increase in income inequalities between companies and challenging prospects of long-term development for India[37] .

Aside from this, data privacy is a social issue that is imperative to be tackled in modern businesses. Gupta[13] mention that as AI takes over the tasks of process automation and customer interactions, organizations are becoming more sensitive to issues related to data privacy and security. As AI technologies rely on customers' personal data to enable predictions and ensure personalization, there is a significant risk for data privacy[38] .

One of the most significant implications of AI may be its ability to threaten democracies and undermine laws through the spread of fake news, propaganda, and biases within a company. Colón Vargas[33] notes that AI models help in the spread of racial and gender stereotypes on a massive scale. AI tools can have pervasive and far-reaching effects in amplifying stereotypes due to their widespread use. These algorithmic issues can shape the opinions and behaviours of users through distorted media representations, biased hiring processes and discriminatory consumer interactions[39].

This could undermine the company's morals and negatively affect the democracy and integrity of India, and its national safety.

The divided nature of the existing literature further highlights the need for a theoretical perspective integrating environmental, social, and governance dimensions of AI adoption. Accordingly, this study draws upon Socio-Technical Systems Theory and IT Governance Theory to examine how ecological and social costs of AI are managed and governed within business environments.

Theoretical Analysis

Socio-Technical Systems Theory

The findings discussed above indicate that the socio-ecological costs of AI cannot be understood solely through technical or economic perspectives. The Socio-Technical Systems (STS) Theory has been employed to stress on the interrelation between technological systems such as AI and social systems and the necessity to balance social and technical conditions in business environments to ensure both efficiency and humanity[40] . It implies that Artificial Intelligence must be evaluated in relation to their impact on people, culture, organizational processes, social conventions and power.

Organizations that integrate Artificial Intelligence into their operations are interconnected with labour markets, governance systems, and environmental resources. While AI improves operational efficiency and automation, it also generates ecological costs through energy-intensive data centres and social consequences such as unemployment, data privacy violations, and algorithmic bias.

Therefore, the theory positions AI not as an isolated model that creates only technical efficiency through integrations in organizational processes but as a part of a sociotechnical system. It encourages policymakers to consider that such technical innovations do not occur in a vacuum but require human labour, configurations and reconfigurations to repair any disruptions. By considering the wider impacts of AI, policymakers can ensure enhanced policies, like enhancing workers' voices in conundrum with data governance and algorithmic fairness[41] [42] [43] .

IT Governance Theory

IT Governance Theory refers to a framework for the efficient management of information technologies to achieve organizational goals by improving operational efficiency and reducing risks associated with technology and enhancing transparency[44] .

In the case of AI, it is crucial to ensure transparency, impartiality and safety in the integration of AI to prevent errors and risk arising from biases and faults in the algorithm.

The theory, therefore, emphasises data security and integrity through frequent audits, mandatory disclosure requirements, ethical AI policies, and sustainability reporting in AI-business environments.

The theoretical analysis demonstrates that the ecological and social impacts of AI are not inevitable consequences of technological innovation but are caused by the convergence of organizational decisions and regulatory frameworks. Therefore, addressing these challenges requires both policies and managerial interventions to ensure that sustainability in the deployment of AI.

Policies and Managerial Implications

There is a need for holistic and integrative policies and measures to deal with the socio-economic costs of AI in business. Through the constant efforts of the government, environmentalists, and society keeping businesses accountable, we can harness the power of AI as a technology without many of its harmful effects.

Policy Implications

1) AI- Specific Regulations Mandating Disclosures

The most important step is to ensure a comprehensive law that directly regulates AI and mandates the disclosure of key information, such as AI-related job loss, greenhouse gas emissions, and waste generation. Providing an ethical code of conduct and codified laws similar to the EU AI Act regarding compliance can help keep companies in check and prevent any exploitation. These laws can further prevent the spread of misinformation and propaganda through AI tools.

2) Mentorship and Allyship Programs

The Government can mandate the setting up of mentorship and allyship programs in listed companies with AI operations to help lower-level employees upskill and reskill in AI skills and prevent massive job displacements. It is also necessary to ensure the inclusion of employees engaged in MSMEs, especially in the unorganized sector, given the fact that these enterprises are the backbone of the Indian economy. This can be done through the help of not-for-profit organizations, as well as free government courses and vocational training.

3) Mandating Green Transition

An important policy intervention for developing economies like India is to mandate the phasing out of thermal/ fossil fuel-based energy to greener sources within a few years of setting up, as well as investing in alternative ways of operating data centers, including orbital data centers that cut down the water-stress on local areas[45] .

Managerial Implications

1) Sustainable Data Centers

Managers can follow the examples of NVIDIA and Google to set up systems and technologies that make them more resource-efficient and their data centers sustainable. NVIDIA[46] mentions the use of 100% renewable energy sources, closed-loop cooling systems, and responsible sourcing of minerals to counter the damage done by AI data centers. Large corporations can also look into developing and adopting more energy-efficient algorithms and models.

2) Data Shuffling

Given the rapid spread of AI in business operations, it is necessary to address data privacy issues efficiently in order to prevent the loss of customer trust. Data shuffling refers to shuffling values of confidential attributes. It is a data masking technique that ensures data security and protects the privacy of users[47] [48] . Managers can employ other masking techniques, such as encryption, as well, in order to ensure ethical use of customer data and retain customer loyalty.

3) Leveraging AI for Sustainability

Businesses can leverage AI solutions themselves to counter their socio-ecological costs. Supply chain optimization, intelligent energy grids for energy efficiency, AI-powered robots and applications for employee safety and electronic vehicles (EVs) for logistics and transportation are some examples of the use of AI for sustainability[49] . AI can thus be leveraged to find realistic and innovative solutions to such social and environmental harms.

Dimension	AI Impact	Evidence
Energy and Emissions	High electricity consumption and CO2 emissions.	460 TWh used in 2020. 313 tons of CO2 emissions in single session.
Water	Freshwater depletion	38 million litres per day for data center hardware production.
Resource Consumption	High, unsustainable consumption	A 2 kg computer for AI data centers requires 800 kg of raw materials
Labour	Job displacement	40% routine jobs are vulnerable
Governance	Weak regulation	Lack of AI-specific laws in India

Table 1 : Summary of Ecological and Social Costs[25] [30] [32] [34] [35]

LIMITATIONS AND FUTURE SCOPE

As observed, the use of Artificial Intelligence in business has high socio-ecological costs. The study attempts to identify these costs and suggest policies to alleviate these

harms. However, the study has key limitations which may provide guidance for future researchers-

- Quantification and Common Measure of Costs- As of the present, it is difficult to group and quantify the costs of AI use in business, such as the GHG emissions, water withdrawal, and waste generation, due to the lack of a common measure. Further, it is even more difficult to quantify social costs given their qualitative and subjective nature. Future studies can look to develop a common measure for a concrete overview of the situation, making it easier to govern and monitor the harm caused by AI.
- Overlooked Costs- Artificial Intelligence in itself is multifaceted. Hence, some of the other areas, such as the economic impact of AI in business, as well as the other social and ecological costs, may be overlooked. It is up to future studies to research such areas, assess the net effect, and suggest measures to counter the same.
- Implementation of Policies- Policies suggested in the paper are based on theoretical knowledge and examples of companies based in economies with greater resources. There is a need to verify the effectiveness and practicality of policies such as the setting up of mentorship programs, given India's unique economic position. This means it is necessary to ensure MSME inclusion, address funding issues, and provide governmental support.

Future studies conducted on these areas can expand the understanding of the actual effects of AI on the environment and society and cover the gaps in the existing literature.

CONCLUSION

The paper looks at environmental costs such as GHG emissions, energy use, water withdrawal, and unsustainable methods of sourcing resources. It also notes social costs such as data privacy issues, job loss, exploitation of workers, and imbalanced access to the benefits of AI. Lastly, it attempts to present certain policy frameworks to counter these socio-ecological costs. Any new technology or idea brings with it an inherent fear and uncertainty regarding its use and the changes it may trigger, and the same can be observed for Artificial Intelligence (AI). However, bringing in the required legislation and measures to control AI and alleviate its negative impact can ensure that this technology brings about positive changes in society and the world at large.

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