

Assessing the negative impact of the it sector on the environment: a call for sustainable solutions

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Abstract. The article explores the negative impact of the Information and Communication Technology (ICT) sector on the environment and offers recommendations to reduce this impact. The article highlights that while digital and environmental issues are major topics of public debate worldwide, they are rarely discussed together. The article uses a qualitative approach to assess the current impact of the ICT sector on the environment by reviewing relevant literature, analyzing data on the global impact of the sector, and considering measures to prevent the negative effects. The study reveals that while ICT can have positive effects on the environment, it also carries sources of threats, such as excessive consumption of resources for the production of devices, CO₂ emissions into the atmosphere, changes in flora and fauna, and growing electronic waste. The article concludes by calling for manufacturers to use environmentally friendly materials and manufacturing processes to create products with high recycled content to reduce the environmental impact of the ICT sector.

1 Introduction

Digital and environmental issues are major topics of public debate worldwide. While politicians try to address environmental degradation and digital technologies separately, these two issues are rarely discussed together in a common context. However, the negative impact of the IT sector on the environment is substantial. In 2019, it was found that the carbon footprint from our devices, the internet they use, and related infrastructure was about 3.7% of global greenhouse emissions [1]. The main purpose of this article is to analyze the negative impact of the IT sector on the environment and develop recommendations to reduce this impact. The goal is to not only analyze the various effects of digitalization but also study what measures are being taken to control the impact of IT industries by considering the statistics and practices of companies in the ICT industry in the context of compliance with the principles of sustainable development. The objectives are to contribute to a better understanding of the consequences of world digitalization and how people and companies can cut their digital impact.

The study of scientific papers and various studies has revealed that the field of ICT can have both positive and negative effects on the environment. Some academics have pointed out that the ICT sector contributes to reducing harm from other industrial sectors [2] (Perelet, 2018). In this case, the ICT sector itself is a tool for reducing effects. Increasing the beneficial

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effects of ICTs for the green economy is to improve the efficiency of production, distribution, and consumption of goods and services throughout the economy and society [3] (Sorrell et al., 2020).

Despite the fact that digital technologies can mitigate many environmental risks, having material (devices and infrastructure) and virtual (data exchange, etc.) dimensions, digitalisation carries sources of threats that are traditionally associated with excessive consumption of resources for the production of devices, CO₂ emissions into the atmosphere during the generation of electricity for the production of devices and ensuring their operation, changes in flora and fauna during the construction and operation of infrastructure, the growing volume of electronic waste [4-6] (Belkhir and Elmeligi, 2018; Usman et al., 2021).

Criticism of existing papers on this topic includes a lack of attention to the negative impact of the digital world on the environment, as demonstrated by the Paris Agreement's failure to mention it. However, some academics have pointed out that the ICT sector contributes to reducing harm from other industrial sectors, and the sector itself is a tool for reducing effects. Furthermore, although digital technologies can mitigate many environmental risks, digitalization also carries sources of threats that are traditionally associated with excessive consumption of resources for the production of devices, CO₂ emissions into the atmosphere during the generation of electricity for the production of devices and ensuring their operation, changes in flora and fauna during the construction and operation of infrastructure, and the growing volume of electronic waste.

2 Methods

This study employs a range of methods to comprehensively present the impact of the Information and Communication Technology (ICT) sector on the environment. A literature review was conducted to gather relevant information on the positive and negative effects of the ICT sector on the environment. This review involved analyzing various scientific papers and studies.

Statistical analysis was also utilized to present data on the impact of the IT sector on the environment. A table was compiled containing figures and statistics on different aspects, including electricity consumption, water consumption, number of devices connected to the internet, and e-waste produced.

The efforts of large global companies, such as Amazon, Google, Microsoft, and Apple, in reducing their environmental impact were discussed as examples of organizations that have implemented measures to reduce their environmental footprint. This discussion provides valuable insights for others to follow.

Furthermore, comprehensive solutions were presented to help reduce the environmental damage caused by the ICT sector. This included Kapoosta, ICTFOOTPRINT, a group of ICT consulting companies, and ESG, which offer access to energy-efficient ICT solutions, methodologies, and metrics, advice to interested organizations, and calculation of carbon footprint.

Finally, the negative consequences of the IT sector on the environment were analyzed, and the importance of Environmental, Social, and Governance (ESG) principles in addressing the challenges of our time was discussed. A discussion of the positive and negative effects of the ICT sector on the environment was also provided. By utilizing a range of methods, this study aims to provide a comprehensive understanding of the impact of the ICT sector on the environment and offer potential solutions to reduce this impact.

3 Results

3.1 Negative impact of IT on the environment

The role of energy consumption affects other factors, for example, it causes 8% of Europe's greenhouse gas levels. First of all, the development of ICT and the use of various gadgets significantly increases energy use. The rapid development of technology exacerbates these negative effects. Secondly, the rapid development of the sector increases CO2 emissions into the atmosphere [7] (Park, Meng and Baloch, 2018). Although ICT uses many natural resources, it has many sustainable uses as well. The materials needed for ICT are often extracted from the earth through mining. ICT is dependent on oil as a primary power source; it uses about three barrels of oil per year globally. Manufacturers use petroleum to create plastic and circuit boards, which are then used in various devices. Furthermore, manufacturers use a lot of water to create circuits and produce material waste. Therefore, using less water would reduce the need for petroleum while producing less waste [8] (OECD, 2019). As already mentioned by scientists, ICT also releases carbon dioxide into the atmosphere. If everyone used electronic devices instead of gasoline-powered ones, it would save billions of dollars annually in CO emissions costs. Additionally, when devices are turned off, energy is saved as well, which saves more energy resources. Thus, it's necessary for manufacturers to create more devices to save energy.

Unfortunately, not every aspect of ICT is useful to the environment. Manufacturers can reduce the environmental impact of their products by using environmentally friendly materials and manufacturing processes. Additionally, creating products with high recycled content reduces the need for new resources and creates more environmentally friendly products.

3.2 Statistics on the ecological consequences of IT

The collected data on the global negative impact of the IT sector on the environment is presented in Table 1.

Table 1. Statistical Review of Environmental Impact Assessments of Information Technology.

Information Technology Impact	Figures and Data
Annual electricity consumption by global IT industry	2 trillion kilowatt-hours [9] (Jeff Kettle, 2021)
Data centers and data transmission networks electricity consumption	Up to 1.5% of global electricity consumption [10] (Guillaume, 2022)
Water consumption by data centers worldwide	About 980 million m3 of water per year, or up to 2.7 million m3 per day [10] (Guillaume, 2022)
Total length of underwater infrastructure cables	1.2 million km [11] (Gómez, Santos, 2019)
Number of satellites in Earth orbit in 2022	6,800 units, up to 5,000 of which provide communication [10] (Guillaume, 2022)
IT industry contribution to global emissions	4% [12] (Duncan, Berners-Lee, 2010)

Continuation of Table 1.

Information Technology Impact	Figures and Data
Estimated number of devices connected to the internet in 2023	29.3 billion pieces, or 3.6 devices per capita [13] (Cisco, 2020)
Annual e-waste produced (2018)	Approximately 50 million tons, of which only 20% is professionally recycled [14] (Dzhusupova; Saylaubekova, 2018)
CO2 emissions from online video streaming in 2018	Over 300 million tons, equivalent to Spain's annual greenhouse gas emissions [15] (Secretova, 2021)
Environmental impact of turning off camera during zoom conference	Reduction of human environmental footprint by 96% [16] (Obringer, 2021)

From the table, it can be concluded that the information technology industry has significant ecological consequences, including high electricity consumption, water consumption, and greenhouse gas emissions. The industry is also responsible for producing large amounts of electronic waste, much of which is not properly recycled. However, there are ways to reduce the environmental impact of technology, such as turning off cameras during virtual meetings, which can significantly reduce human environmental footprint. It is important for the industry to continue to innovate and adopt sustainable practices to minimize its impact on the environment.

3.3 Large global companies' initiatives to reduce their impact on the environment

After analyzing the main negative consequences of the IT sector, the study examined the main large global companies in terms of reducing their impact on the environment:

1. Amazon announced in 2019 its climate pledge, in which it committed to meeting the goals of the Paris Agreement 10 years ahead of schedule. The company also plans to fully use renewable energy sources by 2030 [17] (Dolsak, Prakash, 2019);
2. Google (The world's largest buyer of renewable energy) has been carbon-neutral since 2007 and has taken steps to recycle equipment, including recycling old servers into new ones [18] (Google, 2021);
3. Microsoft (As a zero-carbon enterprise) for its part, announced its plan to reduce carbon emissions. To step up his efforts, he launched the Climate Innovation Fund, dedicated to developing technologies that fight greenhouse gas emissions, and his AI for Earth program provides participants working on environmental issues with access to artificial intelligence technologies and their cloud [19] (Stiffler. 2020) ;
4. Apple has also made strides in the field of environmental protection. Since 2014, its data centers have been operating using 100% renewable energy sources, which, in turn, has reduced greenhouse gas emissions at the company's enterprises by 54% worldwide [20] (Apple, 2021).

3.4 Comprehensive Solutions to Reduce Environmental Damage from the ICT Sector

As far as can be seen, there are also various comprehensive solutions that help to reduce the environmental damage from the ICT sector, not only for IT giants, but also for medium and

small-sized businesses. The following were considered: Kapoosta, ICTFOOTPRINT, a group of ICT consulting companies and ESG. In many ways, their functionality is the same:

1. conditions for access and effectively accelerate the implementation of energy-efficient ICT solutions;
2. a wide range of methodologies, standards, procedures and metrics;
3. assistance and advice to organizations interested in using the methodologies;
4. calculation of carbon footprint and providing an overview of how many tons of CO2 a business produces and how many trees will be needed to offset their carbon footprint,
5. publication of ICT carbon footprint reduction success stories, which acts as a motivating factor for companies.

The tasks of further growth of the world economy have come into conflict with the climatic and social challenges of our time. Today, ESG principles are becoming an essential element of the global financial system, able to smooth out this contradiction.

It is predicted that ICT will have the potential to reduce greenhouse gas emissions by 20% by 2030 [21] (ITU, 2020), which, however, is less than the 45% required to meet the goals set out in the Paris Agreement. The rest of the reduction will have to be made up by implementing the principles of sustainable development in all companies.

Large companies are already actively implementing ESG principles and becoming greener mostly because that banks and government agencies refuse to lend to non-green companies.

However, business owners often do not attach importance to the harm caused by their ICT activities. It seems necessary to explore how to identify potential harms and find ways to reduce such harms. It was decided to conduct a general analysis of the awareness of the harm caused by ICTs and how to minimize the damage. Nevertheless, a significant part of respondents was entrepreneurs, 44% of the total number of 32 respondents. The set of questions was directly related to the topic of the study. The questions used for the survey are shown in Table 2.

Table 2. Questionnaire for a survey on awareness of the harm caused by ICTs.

Questions	Answers proposed
Do you know about the Sustainable Development Goals?	1. Yes 2. No
Do you think ICT affects the environment?	1. Yes 2. No
How do you evaluate the environmental impact of ICT?	1. Positive 2. Negative 3. Both positive and negative
Do you think that ICT affects CO2 emissions?	1. Yes 2. No
Do you think ICT affects the increased consumption of resources?	1. Yes 2. No

Continuation of Table 2.

Questions	Answers proposed
Are you aware of practices that reduce the negative impact of ICT on the environment?	1. Yes 2. No
If you answered "yes" to the previous question, please suggest an option.	Open-ended question

The results showed that the majority of respondents, which is 55.6% are not aware of practices that reduce the negative effects of ICTs on the environment. At the same time, the respondents who were aware of such practices gave the following answers:

- reduce the number of devices used to a reasonably necessary minimum (3 similar answers);
- use energy efficient appliances (9 similar answers);
- actively participate in the recycling of failed devices (7 similar answers).

Based on the results of the survey, it can be concluded that the majority of respondents are aware of the impact of ICT on the environment, while many note the duality of such an impact: it can be both positive and negative. Respondents found it difficult to determine the impact of ICT on CO2 emissions and therefore divided in their opinions, but the majority indicated that ICT affects the amount of resources consumed.

Relying on the main weaknesses of competitors and industry analysis, there was a list of questions to ICT, SD and ESG experts, on which further analysis was conducted and possible proposals were then formulated. Among the interviewed experts were representatives of companies and start-ups in the ICT sector, which are engaged in various activities. There were also collected opinions of experts, engaged in implementation of sustainable development, ESG consulting, business environmental assessment services.

4 Discussions

According to experts from the ecological community, reducing the negative impact on the environment is beneficial to the companies themselves. However, often only large businesses are included in this number, while small enterprises do not pay due attention to the environmental aspect. According to experts from the ict sector, energy-efficient, environmentally friendly products provided to consumers help IT corporations spend less on the maintenance of such devices. However, eco-experts have noted that in Russia, the introduction of green technologies and environmental responsibility of companies at the small and medium-sized enterprise level is not yet in high demand. Today, companies are facing other problems and challenges provoked by an acute political situation and a declining economy, and the need for this project may be less relevant in the near term.

Environmental experts noted that in Russia, the introduction of green technologies at the small and medium business level is not yet in high demand. Companies are facing other problems today, provoked by the political situation and the declining economy, and the need to address environmental issues may be far less relevant and urgent in the near term. For example, in the example of a Russian company from the oil and gas sector, 90% of projects related to the environment have been phased out due to a lack of funding, while commercial startups in other areas are financed at the same level. Moreover, the similar opinion was expressed by the experts of the Russian environmental organization.

5 Conclusions

In this study, the main factors of the negative impact of the IT sector on the environment were shown, which presented that this impact is generally no different from the impact of any other industry and requires the same attention to reduce this impact. The examples of large corporations show that the IT sector at this level is itself actively engaged in harm reduction.

Thus, for the B2B level, the following proposals were formulated:

1. Since the leverage of green loans is not so strong in the field of small and medium-sized businesses, there is a suggestion that large companies that have already implemented the principles of sustainable development should choose suppliers on the same principles. Thus, green standards will descend from above.
2. The solution to the problem of implementing the principles of sustainable development in small businesses can be a service for individual assessment and recommendations. Also, due to the fact that large businesses are increasingly willing to add their suppliers only with a high green rating, this may be an incentive to implement these principles, especially in the field of ICT.

Overall, our data provided a more comprehensive view on the negative impact of IT-sector, including digitalization. The end result of the study are recommendations for reducing this impact, based on the collected and analyzed experience of large global IT companies. Also, the results of the study can serve for the future development of recommendations for reducing the ecological impact of not only companies, but also the impact of personal humans using gadgets and services.

The ICT sector has a responsibility to ensure that it is doing its part in protecting the environment. By taking steps such as reducing carbon emissions, conserving resources and recycling products, the sector can make sure that it is contributing positively towards global sustainability and the planet's long-term survival. To do this, it is vital that companies operating in the ICT sector develop an environmentally friendly culture and implement sustainable business practices.

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