

# Impact of ICT on Environment: Relationship between ICT and Ecology

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## ABSTRACT

The impact of information and communication technology (ICT) on the environment is a complex and much debated topic. ICT can have both positive and negative effects on the environment. Although ICT tools and equipment can be used to improve energy efficiency, which reduces carbon dioxide emissions and environmental pollution, the production and use of ICT equipment can become a significant source of emissions. Many ICT devices also contain non-renewable and recyclable components that can cause significant environmental damage. Therefore, one can ask, does ICT improve the quality of the environment in countries with different income levels? To answer this question, this study investigated the environmental effects of ICT in three groups of high, medium and low countries from 2005 to 2019 using the generalized method of moments (GMM). The ICT Development Index (IDI) was used as a measure of ICT development. Empirical results showed that the use of ICT reduced total carbon dioxide emissions, CO<sub>2</sub> emissions due to solid fuel consumption, CO<sub>2</sub> emission damages, particle emission damage and energy consumption in the studied countries. Therefore, it was established that information and communication technology generally has a negative (beneficial) effect on the deterioration of the environment in these countries. Considering this environmental degradation and pollution from ICT, it is recommended that governments achieve their energy consumption and emission targets by promoting the use of ICT in the environmental sector and the implementation of green ICT projects.

**Keywords:** ICT, environment, ICT tools, pollution, development, degradation, energy

## I. INTRODUCTION

Due to the remarkably rapid development of information and communication technology (ICT) in recent years, the digitization of the economy is expected to accelerate in the coming decades. This development and the intensification of environmental problems such as climate change highlight the need to further investigate the possible environmental effects of ICT. While the amount of greenhouse gas (GHG) emission of ICT-related products or activities during their life cycle is an important issue (Freitag et al., 2021), the ability of ICT to reduce and resist energy consumption is also important. increasing energy costs (Wong and Schuchard, 2011).

Indeed, some ICT-based solutions introduced in recent decades have been able to reduce greenhouse gas emissions in some sectors, which has had a positive impact on the environment. For example, using email instead of physical mail reduced paper and fuel consumption. In addition, ICT allows all transactions to be completed online without a physical trip. ICT has also provided a platform for automated and intelligent solutions in the fields of power generation, agriculture, etc., which tend to reduce greenhouse gas emissions (Bekaroo et al., 2016). Today, the world is facing several major environmental crises, some of which appear to be irreversible. Identifying the factors that increase or decrease these environmental damages is necessary to save the planet and humanity from the consequences of these crises. Considering the many environmental and energy problems that the world is facing today, and the possible positive and negative effects of ICT on the environment, we tried in this study to examine in detail the general environmental impact of ICT. The innovation of this study was the analysis of 30 countries from three different income groups and time periods (2005-2019), including high, middle and low countries. In addition, the effects of a combination of variables including population variables, industrial value added and GDP, and ICT development index on several groups of environmental components (ie, carbon dioxide [CO<sub>2</sub>] emissions, solid CO<sub>2</sub> emissions) are recruited. fuel consumption, CO<sub>2</sub> losses, energy consumption and particulate emissions) were investigated separately in five different equations using the generalized method of moments (GMM). There are different views and theories about the role of ICT in changes in environmental energy consumption and emissions, some of which are discussed in the next section together with available empirical evidence. The third section introduces the research model and analysis method, followed by empirical conclusions. Literature Review ICT has had a revolutionary effect in countless economic, social and environmental dimensions, transforming the world into an information society. The relationship of information and communication technology with the environment is a complex and multidimensional issue. ICT can have both positive and negative effects on environmental sustainability. ICT provides communities with an effective tool to protect the environment. It also gives people the opportunity to reduce the need for natural resources and the amount of waste released into the environment. However, the development, production and distribution of ICT devices and equipment require significant energy and resources, and since these devices tend to have a short lifespan, ICT development has also increased the amount of electronic waste. to the environment

## II. REVIEW OF LITERATURE

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### III. AIM

The aim of the thesis is to provide new information about the environmental effects of ICT, to explore the possibilities of ICT in promoting environmental sustainability, and to consider the possibilities for assessing the environmental effects of ICT and their challenges. In doing so, my aim is to promote discussion in the ICT community and among politicians and decision-makers about the environmental impacts of ICT now and in the future, and the ways in which ICT can contribute and participate in sustainability. in developing the assessment methodology.

### IV. METHODS

A thorough on-line and offline search procedure was applied for the acquisition of evidence in this systematic qualitative study. An analysis of the paper was systematically done through online databases: PubMed, Google Scholar, and Google Advance Search.

### V. RELATIONSHIP BETWEEN ICT AND ENERGY COST AND CONSUMPTION

The use of ICT can benefit or harm the energy sector in a number of ways. The development of ICT affects energy consumption in two ways: 1) ICT reduces energy consumption by providing a platform for wireless data exchange. For example, in the field of education, it allows students to use distance learning services. In the business world, ICT enables most purchases and transactions to be completed online or electronically, greatly reducing the need for physical transportation. 2) ICT increases energy consumption by increasing the use of electronic devices. Indeed, electronic devices will constitute a large proportion of total energy consumption in the future (Wang and Han, 2016). ICT can also make technologies more energy efficient to combat climate change. For example, it has the ability to minimize energy losses and improve the efficiency of energy production, storage and distribution systems. Information and communication technology can also be used to reduce energy consumption in the construction and transportation sectors, with the ultimate goal of mitigating the effects of climate change (Asia Disaster Preparedness Center, 2013). ICT can have a significant environmental impact in relation to climate change. This technology can help improve energy efficiency in buildings and the transportation sector through dematerialization and remote work. ICT also enables the creation of smart grids with better monitoring and control capabilities that reduce energy loss, improve work efficiency, improve the quality of energy supply, improve energy consumption management, improve energy source management and reduce greenhouse gas emissions. In relation to buildings, ICT can be used to create intelligent systems for automatic control of lighting, heating and cooling equipment and to measure the energy efficiency of buildings (Houghton, 2010). Bastida et al (2019) report from the literature on the impact of ICT on the environmental impact of energy consumption that ICT has a positive impact on reducing electricity consumption, improving energy efficiency and reducing greenhouse gas emissions in the European Union. . The results of this study showed a positive impact of ICT on household energy consumption patterns and ultimately on greenhouse gas emissions in the electricity generation sector. Schulte et al. (201 ) on the relationship between ICT and total energy demand concluded that there is a negative relationship between these factors. After examining the relative demand for electricity and non-electricity, these researchers

reported that while there is no significant relationship between ICT use and electricity demand, non-electricity demand decreases significantly as ICT use increases. . Based on these results, decisions can be made about replacing and supplementing electricity and fuels. Since fuel consumption causes air pollution, while electricity consumption causes much less or no pollution, the negative relationship between ICT and non-electrical demand is beneficial for the environment. Han et al. (2016) on the role of ICT in China confirmed a significant negative impact of ICT on short-term energy consumption in that country. According to these researchers, ICT-based wireless data exchange capabilities have changed newspaper reading and business travel habits, leading to better energy conservation. ICT provides a platform for online shopping, remote communication, video conferencing and virtual meetings and conferences, which reduces the need for travel and thus energy consumption in the transport sector.

## VI. RELATIONSHIP BETWEEN ICT AND ECOLOGY AND AGRICULTURE

Regarding the effects of ICT on ecology and agriculture, a study by Yilmaz et al (2019) showed that ICT has a positive (reducing) effect on deforestation. Information and communication technology can benefit forestry in many ways, for example by facilitating the mapping and monitoring of forest threats and hazards, and by preventing illegal logging and fires. Bonvois et al. (201 ), these researchers provided an integrated framework for the design and evaluation of an ICT-based optimization service environment at the three levels of hardware, infrastructure, and information, and presented such an optimization service for urban waste collection at the city level. The negative environmental impacts of ICT include the use of non-renewable and environmentally harmful resources such as lead and mercury, and pollution caused by the disposal of electronic and non-electronic waste. Another negative environmental impact of ICT is the increase in the use of paper in small printers (Rodhain and Fallery, 2013). Also, incineration of ICT equipment together with other waste can cause the release of hazardous compounds such as bromine dioxins and furans. Another environmental problem with ICT devices and equipment is that many cannot be easily recycled (European Union, 2021). In fact, improper recycling of these devices can be a major source of environmental pollution in developing countries (Williams, 2011). ICT has had a significant positive impact on improving agricultural processes. For example, ICT provides farmers with the knowledge and information they need to produce higher-value crops, reduce production costs, increase sales prices and use less herbicides and pesticides. Farmers can also use ICT to get better climate, natural resources and other information related to agriculture (Das and Kabir, 2016). ICT can also benefit agricultural marketing in two ways: 1) provide real-time information on market demand, 2) provide long-term marketing information to facilitate planning. For example, mobile phones have become a convenient tool for gaining market knowledge and insights. Previous studies in the field have shown that ICT-based market information services improve the efficiency of agricultural markets (Kamande and Nafula, 2016). Although most of the above studies have focused on the role of ICT in environmental development and mitigating environmental damage in this area, several articles have shown how ICT has harmed the environment by accelerating the emission of greenhouse gases and energy consumption. However, this article assumes that the implementation of ICT-based innovations and policies can have a positive impact on the environment.

## VII. RESULTS AND DISCUSSION

Based on a review of existing research and a case study of online journals, it was concluded that the stage of production and use of ICT solutions plays a decisive role in their environmental protection. The use phase becomes increasingly critical, as production becomes more efficient and environmentally friendly. Similarly, improving energy efficiency can increase the importance of production in terms of overall environmental impact, especially for small equipment. A longer lifetime of the device would reduce the environmental impact of production during its life cycle. User behavior and location have been found to have a significant impact on the environmental impact of certain ICT solutions and thus determine their potential impact on environmental sustainability. The total operating time of the device, the location (and thus the electrical combination), the lifetime of the device and the end of life treatment affect the importance of the use or production phase and the overall environmental impact of the ICT product. User behavior is also important when comparing ICT solutions with their traditional counterparts.

## VIII. RESEARCH ON FUTURE

Research on Futures is research in which possible, probable and recommended futures are identified, proposed and analyzed through systematic and explicit thinking about alternative futures (Bell and Olick 1989; Bell 2003). Futures research seeks to discover future possibilities, prepare for the unpredictable, and increase people's control over the future by understanding how certain futures can be achieved or avoided (Bell and Olick 1989; Bell 2003). One of the key concepts for future research is the scenario (Börjeson et al. 2006). A scenario can be defined as a description of a possible future situation, which may not be a complete picture of the future, but which would nevertheless highlight the main elements and highlight the key factors and 8 important factors of future development. A scenario can include a description of the development path leading to this situation (Kosow and Gaßner 2008).

## IX. CONCLUSION

In recent years, the spread of information and communication technology has improved significantly in most countries of the world, regardless of income level. The increase in the spread of information and communication technologies creates interesting challenges and opportunities in economic, social and energy dimensions, but it is also important to study the role of ICT in reducing or increasing emissions. To investigate this role, this study examined the impact of the ICT Development Index (IDI) on five environmental variables in three groups of high, medium and low countries from 2005 to 2019. The results of the panel estimation of the GMM -model showed that the positive effect of IDI on the reduction of environmental damage in the studied countries. In other words, this index has a negative impact on their countries' total CO<sub>2</sub> emissions, CO<sub>2</sub> emissions from solid fuel consumption, CO<sub>2</sub> emission damage, particle emission damage and energy consumption. These findings are consistent with Zhou et al. (2019), Bastida et al., (2019) and Haini (2021), but they contradict Arushanyan et al., (201 ), Amri et al. (2019) and Avom et al. (2020). This difference may be due to differences in the countries studied or the time periods studied. Another reason for this difference can be the destructive environmental impact of the spread of information and communication technology in countries

where this process is combined with inefficient energy use, high dependence on fossil fuels and excessive electricity consumption. Information and communication technology can indirectly affect the emissions of carbon dioxide and other pollutants by influencing the level of energy consumption.

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