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# THE EU COHESION POLICY AND HEALTHY NATIONAL DEVELOPMENT: MANAGEMENT AND PROMOTION IN UKRAINE

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## Editors

Nataliia Letunovska,  
Liudmyla Saher,  
Anna Rosokhata



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Reviewers:

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Rekunen Ihor – Doctor of Economics, Professor, Sumy State University  
(Sumy, Ukraine)

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The monograph focused on the specifics of the principles of the EU Cohesion Policy implementation. The authors conducted an analysis of the economic, ecological and social aspects of the integration of the EU experience into the state policy of Ukraine. The monograph summarizes approaches to the restoration of the country and healthy development. Particular attention is paid to the issues of health care system management, the trends and prospects of achieving the state of resilience of the medical and social provision system of the population in the context of the impact of COVID-19 on the national economy. The experience of using marketing and innovative technologies in the context of healthy national development is summarized.

The monograph is generally intended for government officials, entrepreneurs, researchers, graduate students, students of economic, medical, and other specialties.

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## 2.9. Green IoT for energy efficiency and environmental sustainability

Energy consumption has risen to alarming levels over the last decade due to massive digital adoption in 2020. In the near future, experts anticipate a phenomenal data rate and a massive content size at the cost of unprecedented carbon emissions into the environment.

As a result of these massive (CO<sub>2</sub>) emissions, and environmental and health issues, renewable and green technologies are becoming an increasingly attractive research topic in the evolution of technology. Additionally, current gadget battery technology is a severe challenge, contributing to green technology. The Internet of Things (IoT) technologies will enable future 5G networks to consume less energy and minimize (CO<sub>2</sub>) emissions.

The Internet of Things (IoT) has been hailed as one of the most endearing technologies of the last decade. It enables the connection of people and things anywhere, anytime, with anybody and everything, via any link or service. It provides a framework for sensors and gadgets to communicate fluidly inside an intelligent environment, enabling enhanced and competent services to humans.

IoT has resulted in building Smart Technology that promotes environmental sustainability by optimising the use of conventional power sources, making reuse of materials, and recycling products; thereby further reducing waste and carbon emissions. Sustainable solutions range from smart homes, smart healthcare, smart agriculture, and smart cities, to name a few. The positive impact of the IoT is improving the quality of life while raising environmental sustainability initiatives.

But billions of IoT devices produce and send a huge amount of data which require significant energy cumulatively as it passes through the network. These devices mostly are operated using batteries. The more frequently batteries need to be replaced, the more batteries end up in landfills. These have propelled issues related to environmental sustainability and challenges to use resources more responsibly and organise processes in ways that reduce waste.

The Internet of things (IoT) unites everyone in the smart world, so the energy consumption of IOT technology is a complex and attractive field of research. The development of technology in the field of IoT changed the way of life and enriched society with its benefits, but we should not ignore the fact that IoT consumes energy, promotes toxic pollution, and forms

electric waste. To increase the advantages and reduce the harm from IoT, there is more and more of a tendency to switch to green IoT (G-Iot). G-Iot is considered the future environmentally friendly IoT. Environmentalization of ICT technologies plays a key role in the G-Iot and promises the company many advantages, such as effective production and reduction of energy consumption used to develop and spread ICT devices and equipment.

The level of interest in Green IOT was also investigated using the category "IoT" and "Environmental Sustainability". The theoretical aspects of 5 categories of Green IOT were studied. The main aspects of the impact of IoT on sustainable development were formed and practical options of such technologies were presented. Also, the statistics of the use of IoT technologies in Smart Cities were studied. The statistics of the global IoT market and the reasons for the decrease in the growth rate of this market were also presented.

The development of Green IoT, its technologies, and the impact of the Internet of Things on sustainable development and ecology are explored in the works of such scientists as Huang H., Elsaadany M., Opasjumruskit K., Sheng, Q. Z., Wang Y. Etc. The purpose is to research Green IoT technologies and their impact on sustainable development.

The most radical innovation of the digital era, the Internet, made a revolution in communication, as well as in the possibilities of connecting. He opened the world for us with one click of the mouse. The era of intermissive interaction led to the appearance of connected devices that interact with each other, making our life convenient. The Internet is now in everyday things, such as food bags, furniture, watches, household appliances, and much more. IoT support devices offer significant potential for new business models and the possibility of receiving income by increasing the efficiency of energy consumption and other costs.

The level of interest in the Green IoT for Energy Efficiency and Environmental Sustainability was investigated. Thus, according to the search query "IoT" and "Smart City" (2018-2022), the appropriate level of interest is determined, which is characterized by a growing trend. The vertical axis shows the level of interest in the corresponding topic in relation to the highest indicator for a certain region and time.

The use of the Google Trends toolkit allows you to monitor relevant trends for certain categories (Figure 2.12).

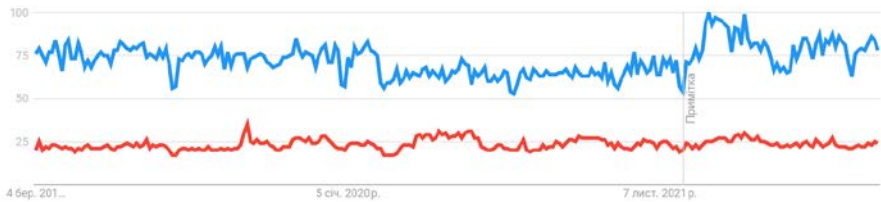


Figure 2.12 – Dynamics of the popularity of search queries of the category "IoT" and " Smart City" (blue line – category "IoT", red line – category "Smart City") (created by the authors on the base of Google Trends)

The level of 100 points characterizes the highest level of popularity of the query. In this case, 0 points mean a location for which there is insufficient data for this query.

As a result, the interest in the category "IoT" is much higher than in the category "Smart City". However, over the past 5 years (2018-2022), a stable interest in the concepts has been observed, but there are moments of greatest interest, so this interest tends to grow.

In addition, the Google Trends (Google Trends, 2023) toolkit allows you to explore the geographical location of relevant search queries. The study results show that the category of "IoT" is the most widely used in the scientific field in China, Ethiopia, Republic of Korea, Singapore, India.

In this case, the maximum number of points (100) means that the location with the highest share of popularity of the query, and the lack of information about the selected category is characterized by zero level and no markings on the map.

In addition, the Google Trends toolkit allows you to explore the geographical location of relevant search queries. The study results show that the category of "Smart City" is the most widely used in the scientific field in the Malta, Pakistan, Mauricio, Vietnam, India (Figure 2.14).

Technology Advances in IoT changed the way of life, enriching society with their advantages. It is important to emphasize and not ignore the fact that the IoT consumes energy, contributing to toxic pollution and electrical waste. Green technologies refer to the development of energy-efficient technologies, including computer and communication technologies. These technologies mean lower energy consumption through more efficient use of existing green infrastructure. After numerous discussions by several authors about what includes green IoT based on green communication technologies and green smart networks, it is

concluded that the technologies that make up green ICT are listed and presented in Figure 2.13.

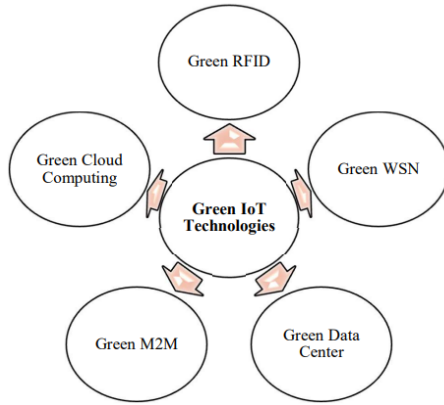


Figure 2.13 – Green IoT Technologies (Memić et al., 2022)

The exchange of IoT in the real world is possible only through the cooperation of several technologies that enable it, which are implemented through green tags, sensors, and the Internet. Only the synergy of these green IoT providers can create future technologies that will contribute to a smart world and its greening.

To achieve the goal of sustainable development plans developed at the national and international levels, taking into account environmental, social and economic aspects. The Coming Era of Revolution - Green Internet of things. The Green Internet of Things is set to bring significant improving the state of the environment and human well-being making the world smarter using sustainable technological development. The use of technological advances in technologies enabling IoT, Green IoT has great opportunities to strengthen environmental and economic sustainability. There is a great need for and importance of green technologies and green processes in the sustainable development and construction of a smart world. Towards Green IoT for Sustainability development focuses on technologies that adequately contribute to a sustainable environment through the creation of efficient energy-saving systems (MDPI, 2023).

The focus of the G-IoT for sustainable development (Dalal, 2021):

1. Focus on generating efficient energy conservation systems through design technology.
2. Increased energy savings and reduced carbon emissions through leverage technologies.

3. With enabling technologies, G-IoT offers unlimited opportunities to improve environmental and financial performance.

Table 2.20 – Green strategies and mechanisms for G-IoT (Memic et al., 2022)

| Green technologies             | Energy-saving mechanisms   | Energy-saving strategies   |
|--------------------------------|--|--|
| Green RFID                     | <ul style="list-style-type: none"> <li>– Existence of active tags and passive sensors</li> </ul>   | <ul style="list-style-type: none"> <li>– Energy-efficient algorithms and protocols</li> <li>– Reducing the size of rfid tags due to recycling</li> <li>– Production of labels on recycled paper substrate</li> </ul> |
| Green WSN                      | <ul style="list-style-type: none"> <li>– Reducing communication between nodes</li> <li>– Sleep mode</li> </ul>   | <ul style="list-style-type: none"> <li>– Smart modes of operation through dynamic energy management strategies</li> <li>– New energy-efficient routing algorithms</li> </ul>   |
| Green Cloud Computing          | <ul style="list-style-type: none"> <li>– Creating hardware solutions aimed at producing devices that consume less energy</li> <li>– Design of software solutions that consume less energy with minimal use of resources</li> </ul> | <ul style="list-style-type: none"> <li>– Usage of resources that are eco-friendly and maintain computing performance without degradation</li> </ul>  |
| Green Machine to Machine (M2M) | <ul style="list-style-type: none"> <li>– Common energy-saving mechanisms</li> <li>– Use of efficient communication protocols</li> </ul>  | <ul style="list-style-type: none"> <li>– Group-based strategies</li> <li>– Low-mobility-based optimizations</li> </ul>   |
| Green Data Center              | <ul style="list-style-type: none"> <li>– Energy efficiency</li> <li>– Use of renewable energy sources</li> </ul>   | <ul style="list-style-type: none"> <li>– E-waste recycling</li> <li>– Low-emission building materials</li> <li>– Exclude unnecessary content</li> <li>– Minimizing data</li> </ul>                                   |

Various industry verticals are using IoT technology to create greener solutions, optimizing their operations for greater sustainability and lower energy costs (Jain A., 2023):

1. Energy-efficient homes by monitoring home appliance usage with affordable circuit-level energy monitoring, real-time reporting, smart alerts,

and remote energy management. IoT devices are needed to reduce costs and power consumption. Demand for long-range, low-power IoT-enabled products with indoor and outdoor tracking has increased as it helps homeowners track energy consumption in real-time.

2. Intelligent lighting, heating and cooling according to needs to improve comfort in homes and offices while reducing energy consumption; in addition, Energy Star-certified thermostats learn what temperature users prefer and plot based on that setting.

3. Smart health services and alerts for the elderly to help them lead a safer and more independent life.

4. Smart utility meters and real-time energy monitoring collect, save and send data to smartphones to manage energy and water consumption.

5. Intelligent watering of plants for irrigation using sensor data analysis.

The main goal of sustainable development is to create and maintain a balance between the social, financial, and environmental requirements of society, allowing prosperity for present and future generations. Green IoT aims to bring significant improvements to the environment and human well-being to make the world smarter using sustainable technological development.

Cities are increasingly relying on IoT technology to become “smart”. IoT technology helps cities curb inefficiencies, fight rising pollution levels, and lift the quality of life of their citizens. IoT Analytics (IoT Analytics, 2023). surveyed key decision-makers from 50 cities around the globe on the details of their Smart City initiatives. IoT Analytics (IoT Analytics, 2023). surveyed key decision-makers from 50 cities around the globe on the details of their Smart City initiatives (Figure 2.14).

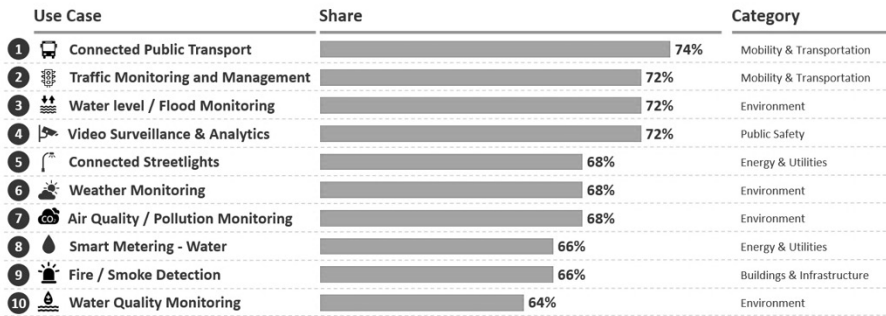


Figure 2.14 – The top 10 Smart City use causes (created by the authors on the base of IOT Analytics)



In conclusion, connected public transport tops the list at a 74% implementation rate. But we can also see that technologies that are used to improve the environment have a significant place at this top. For example, Water level / Flood Monitoring, Weather Monitoring, Air Quality/Pollution Monitoring, and Water Quality Monitoring.

The company IOT Analytics (IoT Analytics, 2023) researched the global growth of the IOT market (Figure 2.15).

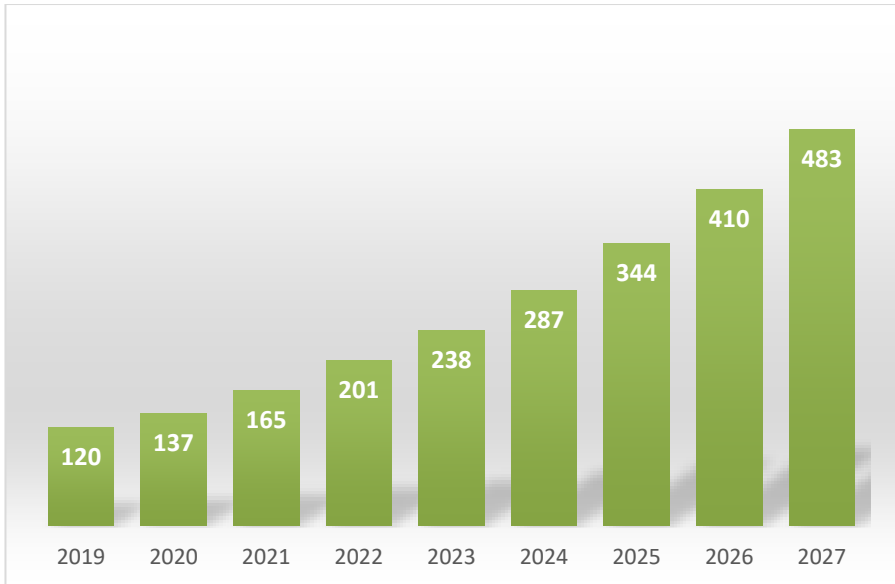


Figure 2.15 – Enterprise IOT Market, 2019-2027, USD Billion (created by the authors on the base of IOT Analytics)

The enterprise IoT market grew by 21.5% to \$201 billion in 2022. IoT Analytics forecasts the IoT market size to grow at a CAGR of 19.4% to \$483 billion from 2022 until 2027.

There are several reasons for the lower-than-expected growth of IoT enterprise spending. The three primary reasons are (IoT Analytics, 2023, Tadvise.com., 2023):

- lower GDP growth. According to the IMF, the growth of real GDP is going to be lower in 2023 than in 2022 for nearly all major world economies;

– sustained inflation. In January 2023, inflation has finally shown a downward trend. However, in most developed economies, inflation is still higher than in the last decade(s);

– high-interest rates. In the last year, central banks increased interest rates to fight inflation. The US Federal Reserve increased the federal funds target rate from 0.125% at the beginning of 2022 to 4.375% by the end of 2022. To fight inflation, other central banks followed suit (e.g., the European Central Bank [0%–2%] and the Bank of England [0.1%–3.5%]).

Based on the assessment of various technologies, techniques, strategies, and methods for the implementation of green IoT, relevant principles can make IoT greener. Below are some of the principles regarding green IoT (Zhu, et al. 2015, Alsamhi, 2019):

– the use of bioproducts in the production of G-IoT components and their ecological design;

– use of renewable green energy sources, such as solar energy, wind energy, water, oxygen, and geothermal sources;

– enable security mechanisms and data privacy in each component of the G-IoT system and the overall G-IoT system;

– develop more effective reduction recommendations for energy consumption in smart buildings. Politicians can have a direct impact on energy consumption and, as a result, a significant amount of energy can be saved;

– reduce the size of the network by efficiently installing nodes and using appropriate routing mechanisms, which will result in high energy savings.

The article discusses examples of Green IoT technologies and their impact on sustainable development. Analysis of recent trends has shown that people are increasingly interested in smart energy use and demand greater sustainability, reliability, convenience, personalization, and control in their cities through IoT technologies. For example, Water level / Flood Monitoring, Weather Monitoring, Air Quality/Pollution Monitoring, and Water Quality Monitoring. Digital technologies such as the Internet of Things and directly Green IoT are gaining popularity. The IoT market is growing every year and will become crucial by 2030. Green IoT will transform our lives into a greener and healthier environment in the future that is socially and environmentally sustainable, smarter, and safer.