THE LATEST TECHNOLOGIES USED IN THE CONCEPT OF SUSTAINABLE SMART CITY

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Abstract

The dynamic development of technology greatly affects not only the Smart City concept, but also its sustainability. The aim of the article is to identify the latest technologies that are used in the concept of sustainable Smart Cities and reflect the current state of 2022. The method of secondary analysis, summarization, synthesis, induction and deduction was used to achieve the set goal. The main finding of the article is that the latest technologies cover all processes of effective management of Smart City from data collection to their communication and presentation in the form of relevant information. The benefits of their implementation and use include, in particular, savings, harmonization, data protection, support for sustainability, resilience and building comprehensive urban systems for current and future generations.

***Keywords**: ICT, Smart City, technologies, sustainability*

1   INTRODUCTION

Developments in the field of digital transformation are creating new concepts, infrastructures and innovative technologies, which, however, are currently focused not only on the technological aspect, but also:

- resilience,
- sustainability,
- harmonization,
- protection,
- comprehensive solutions.

Today's sustainable Smart City technologies create frameworks that seek to harmonize the technological environment with the social aspect and the environment. Only in this way is it possible to mediate the satisfaction of citizens and continuously improve their quality of life in a rapidly changing world.

2   METHODOLOGY

The aim of the article is to identify the latest technologies that are used in the Smart City concept. The method of secondary analysis of relevant sources was used in the article to fulfill the goal. The search criteria were the phrase "technologies in Sustainable Smart City" in the Web of Science and Scopus databases, including:

– Article type,

– Open Access,

– year 2022,

– Environmental Sciences category.

24 selected articles met the conditions. After removing duplicate articles included in both databases, 13 publications were subsequently analyzed. In addition to secondary analysis, methods of summarization, synthesis, induction and deduction were also used.

3   RESULTS

Sustainability-based Smart Cities process huge amounts of field data on a daily basis, which are transmitted over long distances for analysis. Monitoring, planning and analysis in 2022 are carried out through LPWAN technology, which includes technologies such as LTE-M, NB-IoT, LoRaWAN and Sigfox. Benefits include high range, wireless, low power consumption in use, indoor and outdoor use Smart City [1].

In addition to the mentioned advantages, the given technologies have a shortcoming in the field of security protection, for which the latest technologies such as authentication and key management protocols for IoT technology or next-generation Cyber Physical Systems (NG-CPS) have been developed [2, 3].

To build and stabilize a sustainable environment, it is necessary to standardize the technological tools and equipment, networks and databases that make up the sustainable resources of the Smart Cities infrastructure [2].

The latest technology in the field of security for urban concepts are innovative CPS systems of the new generation, which cooperate with technologies such as IoT, machine learning, Big data, artificial intelligence, etc. The framework is designed to provide all the necessary details from design, communication to solution implementation [3, 4].

IoT (Internet of Things) and IoE (Internet of Everything) are technologies that in 2022 have developed and increased use in Smart Cities. According to Bellini, Nesi and Pantaleo, by 2025, up to 75 billion devices connected and communicating via IoT will be used in urban environments. According to the authors, the Internet of Things is the main driving force for the sustainability of cities. In their work, Bellini, Nesi and Pantaleo agree with Borsos, Berek, and among the latest technologies in 2022, they include the low-energy wide LoRaWAN network, its NB-IoT, LTE-M protocols and

the Sigfox communication system. In addition to the above, they also prefer the Z-Wave protocol and the 5G mobile network [5].

Anjum, Umar and Shahab link IoT with information and communication technologies (ICT) in sustainable waste management (SWM). Ultrasonic sensors use RFID technology and a GPS control system [6].

Data transmission is increasingly carried out through Cloud computing, on the basis of which IoT-Cloud was created. The technology provides organized data transfer, Smart City vision support, predictions, an early warning system and significant energy savings [7, 8].

Within mobile wireless networks, a 5G network was created, which transforms Smart City into an organic, open and complex environment. Security analyzes point to a threat to data protection in this network through DoS attacks, which, according to Chen, Mou and Zhang, can be addressed with ProVerif tools and BAN logic. The tools provide efficiency, security, harmonization between resilience and anonymity of data, thus meeting the requirements for a smart urban environment [9].

Among the emerging technologies of the new Smart City Li-Minn Ang et al. consider geoinformation approaches, data analysis, machine learning, deep learning and artificial intelligence [10].

Geoinformation technologies are used for three-dimensional planning, risk management and sustainability support. Big data analyzes data from GPS or RFID technology. Machine learning provides optimized solutions to complex problems and in-depth learning based on past experience. At the same time, in-depth learning builds on tree models. Artificial intelligence automates processes and effectively replaces the human factor [10]. Which, on the one hand, poses a threat and an opportunity.

Khan et al. They consider IoT technologies to be one of the most frequent problems with the small number of analytical platforms and the lack of BDA technologies, which serve to make optimal use of limited resources, and thus support the principles of sustainability of Smart Cities. Big data analysis (BDA) can be performed by Hadoop via Big Data Lake [11].

At the same time, the digital transformation of 21st century cities is facing trends in Blockchain technology and artificial intelligence. In connection with IoT and Cloud computing, efficient digital analysis, decentralized storage, resilience and support for the creation and use of modern applications are emerging [12].

Shehab et al. call for modern technologies in 2022 in the composition of enhanced mobile services (EMBB) with broadband usage, reliable communication based on uRLLC or machine communication mMTC based on 5G network [13].

4   BENEFITS OF USING THE LATEST TECHNOLOGIES IN SUSTAINABLE SMART CITIES

A summary of new technologies, including their benefits in the environment of sustainable Smart Cities, can be found in the following Table 1.

Table 1 Summary of new technologies in the concept of Sustainable Smart Cities and their benefits

New technology	Utilization	Benefits
LPWAN, LTE-M, NB-IoT, LoRaWAN, Sigfox	monitoring, planning, analysis, data collection and processing	high range, wireless, low power consumption, interior and exterior use
NG-CPS	next-generation data protection and security, authentication protocols, key management	protection, security, details from design to implementation, cooperation with other technologies
IoT, IoE	data collection	sustainability support, real-time data
SWM	use with RFID or GPS for field data collection	speed, simplicity, connection
IoT-Cloud	sending data	organized data transfer, early warning, savings
5G based on ProVerif and BAN	data transmission	protection against DoS attacks, resilience, anonymity
Geoinformation technologies	three-dimensional planning, risk management	promoting sustainability
BDA	analysis	efficiency, processing of large amounts of data
Machine learning	comprehensive problem solving	optimization
Deep learning	learning based on past knowledge	building a knowledge base
Artificial intelligence	process automation	efficiency, fewer errors, lower costs
Blockchain	digital analysis, decentralized repositories	support for the creation and use of new applications
EMBB, uRLLC, mMTC	communication, mobile services	efficiency, economy, improved design and use

Source: own processing according to section Results [1-13]

The latest technologies cover areas from collection, storage, analysis, monitoring to communication and presentation in the form of relevant information. The goal of the new approaches is to build comprehensive solutions focused on sustainability, system resilience, protection of sensitive data, savings, and thus the overall efficiency of current and future Smart Cities.

5   CONCLUSIONS

From the analysis of relevant resources in the field of technological development in the Smart City concept, 13 latest technologies have been identified that have a positive impact on the resilience and sustainability of cities. Their use is extensive, as it covers the processes of data collection, storage, processing, presentation, communication to the implementation of complex solutions in a holistic system. In addition to promoting sustainability, optimal allocation of limited resources and resilience, the biggest benefits include cost savings, energy, harmonization, anonymity, security, predictions and early warning systems that reflect the basic criterion of every Smart City, i. e. citizens' satisfaction and their associated quality of life.

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