The Internet of Things in Poland

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One definition of the Internet of Things refers to devices that can be directly connected to the internet or other devices using wireless networks or, less frequently, cables. This definition of the IoT includes contemporary telephones, cameras, movement sensors, weather stations, even dishwashers, vehicles, industrial machinery, and daily outfits. Almost any object can get connected to the internet even if it was not manufactured as intended for the IOT, because in the majority of cases its functionality can be extended. The IOT has been growing dynamically, offering smart technological solutions. IoT-based applications are client-server operable which requires a specific communication protocol that can be used to determine a client-server communication model, allowing all clients to perform specific tasks thanks to communications via the internet. Poland's rural areas that are diversified in terms of economic development are poorly equipped with basic infrastructure, which is a barrier to the functioning of people with limited mobility.

1. Introduction

The Internet of Things (IoT) refers to all devices with access to the internet that are capable of communication. Therefore, this includes the mass use of modern technologies and an extremely diversified range of IoT consumer, corporate, and industrial products. The latest forecasts related to the development of the IoT cover the next few years. IHS Markit that delivers analytics and intelligence for industries and markets, including in economy and finance, and supports decision processes of business and institutional clients [1] forecasts that the number of connected IoT devices is going to grow at 12% per year from 27 billion in 2017 to 125 billion in 2030. On the other hand, according to a survey conducted by Statista, one of the largest global platforms with statistical and market data [2], it has been estimated that the connected IoT devices could total USD 75 billion worth of investments in 2025 [3]. The global IoT market in 2018 was valued at USD 190 billion, and is predicted to amount to USD 1.1 billion in 2026 (an increase of approximately 24% per year). On the other hand, by 2022, IoT spending in all industries worldwide will have approximated USD 4 billion [4].

In Poland, it is also anticipated that in the near future the IoT technology and solutions will show high-growth pace, i.e., approximately 13% every year, resulting from the development of new communication technologies, including 5G [5]. The market of the Internet of Things in Poland in 2019 totaled over USD 2.2 billion (an increase by more than 6 percentage points vis-a-vis 2018). It is projected that by 2023 the growth rate of that market will have reached 23.9% [4].

The Digital Economy and Society Index (DESI), in 2020, showed that, as compared with other countries, Poland was ranked low, at the 23rd position. However, the data show that Poland is a leader in the EU with respect to the widespread access to mobile broadband services, which, undoubtedly, effects research results, according to which Polish consumers are "enthusiasts of digital services" and above all appreciate their convenience, speed, as well as the possibility of using them at any time and place. It should be noted that smart home technology is the fastest growing market segment in Poland as well as other countries. It is estimated that by 2022 its global value will have reached USD 123 billion. However, in Poland, consumers are not as interested in the application of IoT technology in their homes; as many as 42% of Polish people have stated that they are not interested in such solutions [4].

The latest document that discusses the IoT status in Poland and its prospects for development over the coming few years is the Report of the IoT Working Group of the Ministry of Digital Affairs entitled "The IoT and the Polish economy", dated 2019. The report's authors present the Internet of Things as a wave of innovations that takes advantage of networks of smart objects having significant importance to the "emergence of new areas of use, unexpected consumer behaviors, and new business models" [5] (p. 2).

The Report contains the characteristics of the current IoT market in Poland and presents the opportunities for the Polish economy in the context of those technologies. Furthermore, the report's authors have identified problems and barriers to

the development of the IoT and have proposed related solutions. Importantly, the report contains a review of global trends with recommendations for the future for Poland that pertain to the most important issues related to the functioning of the Internet of Things, namely, aspects such as education, legislative regulations, and ethical issues. It should be recognized that the analysis of experiences of global IoT development leaders and drawing conclusions based on the observed phenomena and then their skillful adaptation to the needs of the Polish economy is now particularly important. In the face of the dynamic growth of modern technologies, the report's authors postulate the need for regular IoT data updates in Poland and the preparation of comprehensive reports on a cyclical basis, which should "remain to be valuable guides and material supporting the formulation of technological strategies that will manage the development of the Internet of Things in Poland". The reports should be comprehensive, especially in the context of coordination with areas related to the Internet of Things, i.e., national plans pertaining to the growth of artificial intelligence and the program of the development of the 5G network. Such a holistic approach to the development directions is particularly important in the context of the plans of Poland's economic growth [5].

2. Key industries associated with the possibilities of developing the IoT in Poland

Taking into account the trends and structure of the Polish economy, it is possible to select nine key industries related to development opportunities IoT in Poland, among which were:

Safety and certification

Due to the widespread use of the IoT and massive data processing, both for the country's economy and defense and for each citizen, cybersecurity should be particularly important. Security is a sine qua non condition for the growth of the IoT, whereas proper certification of IoT products guarantees a proper level of security. Therefore, Poland must have appropriate legal and certification regulations. Security in IoT systems takes several forms: product safety (accounting for standards related to hygiene, toxicity, ergonomics, etc.); product cybersecurity (resistant to ICT risks); data security (e.g., as processed by the product); physical safety (the impact of the IoT technologies on a physical world, direct influence on the daily lives of citizens); legal and regulatory safety; and national and military security.

Finance and insurance

In the finance and insurance industry, the IoT is mostly related to payments for services. Transformations that are bound to occur in that area in the near future will be very dynamic and will require far-reaching changes in the attitudes of customers and partners towards information sharing (e.g., biometrics and tokenization). In Poland, the changes in the financial and insurance sector must, above all, include changes in legislation and supervisory regulations. Thus, the authors of the report recommend, among other things, the establishment of a cohesive legislative framework, development of clear legislation allowing unambiguous classification of the IoT data, protection of data processing and transfer, as well as adapting the provisions of the Insurance Activity Act and GDPR to enable IoT data processing.

Smart metering

The IoT is used to support the implementation of smart metering and monitoring corporate infrastructure. It is also related to the growing awareness of end customers about the possibilities of using data to streamline their household spending, for example, data collected from IoT meters in industry sectors are to be made available online on end-customers' smartphones.

Industry

The IoT has created new opportunities for industry, as the manufacturing process of the Industrial IoT devices (IIoT) is frequently based on innovative solutions. The scope of possible IoT applications includes: the Offline IIoT type, i.e., solutions which support data collection and allow their further processing in order to optimize the processes, and the Online IIoT, i.e., tools and systems that work operationally and influence the operations of an industrial plant on an ongoing basis. Recommendations provided by the report's authors mainly refer to the necessity of developing a National IoT Growth Strategy for the Industry to include all important assumptions underlying the growth of the industry.

Agriculture and environment protection

The Internet of Things is a key technology that shows huge potential for supporting the management and optimization of agricultural processes. When it comes to environment protection, the IoT offers opportunities for improving control of the

environment, for example, by increasing the number of measurement stations. The above is related to growing civilizational challenges and environment protection, for example, climate changes, smog, draughts, polluted waters, adverse changes in the habitat of animals and plants, etc. The Internet of Things is a key technology for monitoring these phenomena and supporting rapid action.

Telecommunications

The telecommunications sector plays a key role in the implementation and development of the Internet of Things. Based on the services provided by the telecommunications industry, it is possible to quickly implement IoT concepts on a large scale. The above refers to, for example, wireless telecommunications for the IoT that make it easier to integrate IoT devices into networks, and therefore, make them available virtually anywhere.

Transport, logistics, and autonomous vehicles

The IoT can be used in different kinds of transport, but given the prevalence of their use, land and air transport are currently key areas for its implementation, for example, in traffic management systems, prioritizing public transit, accident or collision identification, and automatically informing emergency services (eCall), traffic prediction, driving times, traffic density, etc. From the logistic perspective, the IoT is essential, for example, to the development of integrated supply chains—it can facilitate the optimization of how people, systems, and resources work together, and can also co-ordinate actions.

Healthcare

The IoT solutions in the area of health protection may help to reduce treatment costs, to improve the quality of medical services, and also, as part of an integrated emergency medical system, to help improve survival rates. Moreover, the data collected through IoT solutions are used by manufacturers of medicines and medical devices to supervise the use of products after they are marketed. It should be noted that IoT solutions also improve the well-being of the ageing population, as well as the length and quality of life for patients. Recommendations of the report's authors mostly focused on legal regulations related to patients' data processing, preventative, and educational activities and, of particular importance, from the perspective of the presented report, those that pertained to senior care, for example, financed by self-governments.

Smart cities and buildings

The key element of the Smart Cities concept is the digitization of urban space, and its purpose is to build cities that are more citizen-friendly, eco-friendly, and more economical The Internet of Things technologies that cover, among other things, urbanistic areas such as transport and mobility, waste management, street and city infrastructure lighting, provision of utilities or health, are required to that end [5][6].

The IoT also covers technologies that are friendly to seniors and the disabled. It is a particularly important challenge in the era of an ageing society. Proper adjustment of technical solutions aimed to support the functioning of senior citizens in the society requires comprehensive knowledge of many fields such as cognitive psychology, AI, neurobiology, and engineering in a broad understanding of the term (e.g., IT, electrical engineering, and communications), as well as antropotechnology, i.e., the knowledge of the relations between a human and a computer [7]. Activities as part of gerontechnology cover many levels. Therefore, it has been observed that gerontechnology helps solve many problems of the elderly individuals with the following main exemplary areas being:

✓ Cognitive-inspired computing and supporting technologies and devices;

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✓ Cognitive-inspired computing and detection of household accidents;

✓ Emotions (controlling them), mood recognition, and regulation;

✓ Environment personalized adaptation;

✓ Social/care cognitive robots and agents;

✓ Cognitive-inspired computing and technologies providing entertainment to adults;

✓ Cognitive-inspired computing and fitness and sports for seniors;

✓ Smart telehealth, telemedicine, and communications services;

✓ Social networks for seniors;

✓ Lifelong learning for mental health [8] (pp. 358–359).

Telecare is remote care of the elderly, physically less able people, and the disabled, is an example of gerontechnology applied in practice. To that end, ICTs are used to provide remote care, in an automated manner with the possibility of remote control. They allow seniors and other persons in need to safely function in their own homes. Another example is a telemedicine wristband which is being used more and more often for remote health monitoring. It is mostly intended for people who live independently or require constant monitoring and care. The wristbands have multiple functions, which include calling for help by pressing an SOS button; providing reminders about the necessity to take medications; and enabling cyclical pulse, temperature, and blood pressure measurements. There are also bands for detecting falls or those equipped with a GPS to locate their user, etc. Other innovations dedicated to the elderly and disabled individuals are smart home solutions, which can be remotely supervised by a consultant who informs a caregiver once they have noticed something alarming. Smart home solutions can help to control household appliances with, for example, a gesture or voice. In addition, they can remind individuals about turning off water or lights or taking medicines. They can also be used to monitor falls [7][9]; the more advanced designs of smart homes make the lives of seniors and the sick much easier. Numerous activities that previously had to be done manually have been gradually automated for convenience [10].

Other technological examples include, for example, Beacon, that is, micro-location technology (up to 100 m) that uses Bluetooth Low Energy (BLE) to connect with smartphones to exchange information. The application of Beacon technology has been considered in medicine, for example, in hospitals for the purpose of developing "centralized patient information" and also in the manufacturing of devices dedicated to seniors. For example, an electronic "life chart" is one such solution which is a device transmitting data about health condition and diseases that can be easily accessed by a doctor or a paramedic. Such solutions are particularly important as the process of improving devices that can monitor health 24/7 can save lives [10].

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