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RESTORATION OF UKRAINIAN CITIES BASED ON THE CONCEPT OF SMART CITY IN THE CONDITIONS OF CIRCULAR ECONOMY AND INDUSTRY 4.0

Summary. *The rate of growth of the urban population and the problems of urban planning were studied. Implementation of the smart city concept is proposed for the post-war reconstruction of Ukrainian cities. The possibilities of using Industry 4.0 technologies for the balanced development of cities based on the principles of the circular economy are revealed.*

Key words: *smart city, circular economy, Industries 4.0, urban reconstruction, balanced approach.*

The analysis of statistical data of the World Bank indicates a long-term trend towards an increase in the share of the urban population in most countries of the world. This trend is both global in nature and specific to individual countries. Figure 1 shows that in high-income countries, the largest part of the population lives in cities. In Ukraine, the share of the urban population also prevails. If we analyze the rate of growth of the urban population, after the 1990s the rate of growth decreased somewhat, but it continues to grow.

The presence of a large share of the urban population is caused to a greater extent by the processes of industrialization, which have an ambiguous impact on the environment. In particular, this leads to a negative impact due to an increase in the volume of emissions into the environment, an increase in the need for energy consumption, the need to build the necessary infrastructure, etc. The existing urban planning model does not allow to fully solve these tasks.

Unfortunately, due to Russian aggression, many cities and other populated areas of Ukraine have been significantly destroyed. There is a need to develop a strategy for the restoration of settlements. Here, several approaches are possible: either the complete reproduction of destroyed cities as they existed before, or the use of progressive approaches to urban planning. At the same time, there is a problem of disposal of the remains of destroyed building structures. We believe that in this context it would be appropriate to apply the smart city model, which allows taking into account modern approaches to urban planning based on the principles of the green economy and Industry 4.0. In

recent years, the governing bodies of Ukrainian cities have shown significant interest in smart-infrastructure creation projects, actively implementing digital technologies and increasing the level of «intellectualization» of the urban environment. For example, facial recognition technology allows financial transactions in networks, payment for travel in transport, etc. A «smart» lighting system that responds to the movement of people and vehicles is also being actively implemented. This system also allows you to accumulate information about environmental indicators (temperature, air quality, noise level). In many settlements, smart meters have been installed to record the amount of water and gas consumed. In order to optimize the collection and sorting of garbage, «smart» garbage containers are used [3]. In recent years, smart projects have been developed for Kyiv, Kharkiv, Lviv, Dnipro, Vinnytsia, Poltava and other Ukrainian cities. Among the main areas and directions of digital transformation in these cities, the following should be highlighted: e-democracy and city management, education, medicine, ecology, urban mobility and public safety [2].

The ability to receive data from a wide range of sensors in public spaces, in transport systems, in energy networks provides a real-time understanding of traffic and energy flows, pollution levels and human behavior. The use of information and communication technologies in smart-city allows to quickly receive information and exchange it. The use of the following elements makes these processes possible:

- sensors, i. e. smart devices that measure and monitor various parameters related to the city;
- network interaction, namely the transfer of data and information from sensors to storage and data aggregators for further analysis;
- analysis of data collected by various smart-infrastructure systems to help predict future events;
- process automation of a large number of devices in various fields.

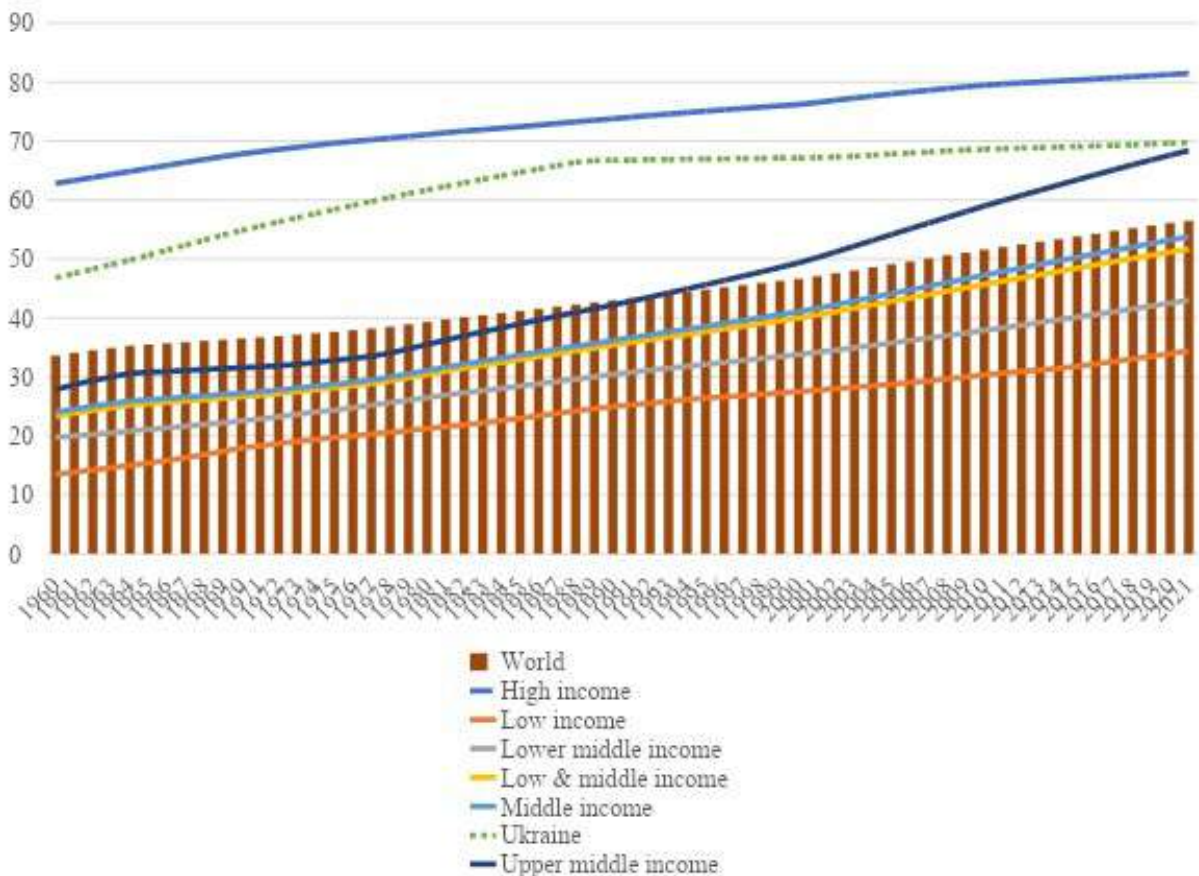


Figure 1. Urban population (% of total population), created from the data [4]

In addition, the combination of Industry 4.0 tools with the mechanisms of a circular economy based on a closed cycle will allow to partially solve the problem of accumulation and recycling of garbage, and will also contribute to improving the state of the environment in cities while providing comfort to its residents. A reasonable approach to the reconstruction of Ukrainian cities will contribute to the formation of a model of their balanced development based on modern standards of energy efficiency, accessibility, innovation, etc. The first step in this direction should be the formation of a modern urban planning strategy based on the analysis of the destruction caused and taking into account the characteristics of one or another settlement, in order to use the existing urban environment with the greatest benefit for people. The urban planning strategy should be based on the following principles:

- people-centricity — taking into account the requirements of the urban population to ensure their comfortable existence, with their active involvement in solving the problems of the respective settlement;

- sustainability and viability — the formation of urban infrastructure taking into account the requirements for ensuring the safety of people's lives and the functioning of businesses, uninterrupted transport connections, medical care, etc., based on the analysis of the experience of countering Russian aggression;

- circular energy independence — implementation of a circular economy model to form a model of energy independence of cities, which is particularly relevant for our country not only for solving energy problems, but also for rebuilding economic and political independence [1].

Thus, we believe that the formation of a model for the reconstruction of Ukrainian cities through the implementation of the proposed measures will ensure their balanced development based on the concept of a smart city in the conditions of the circular economy and Industry 4.0.

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