Demographic Factor as a Criterion for Forming Networks of Public Buildings in Ukraine

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Abstract. The study of the developmental delays of temporal and spatial transformations of architecture and the architectural space is often based on a comprehensive fact analysis. Demographic factors, among others, determine trends of architecture development of public buildings and complexes and changes in the structure of their networks for the short-term. The authors consider fact analysis and trends at three levels to deal with current architecture issues of demographic indicators: the macro-level (global and European), the state level (meso-level), and the micro-level (the region, city, and district level). The demographic situation in Ukraine is objectively different from both the average global trends and the situation in European countries. Currently, there are depopulation signs of changes in Ukraine. The pace of urbanization is projected to be rapid for low-income countries. It was also revealed that public buildings and complexes and their networks are the most sensitive to demographic changes and, at the same time, are more open to the upcoming changes. These changes will include: increasing role and demand for public buildings and complexes under conditions of rapid urbanization; designing in conditions of dense existing development; development, expansion and new types of public buildings appearance following the needs of the population progressive link; the need to create and redistribute networks of public building and complex types depending on the quantitative meanings of demographic forecasts; the predominance of modernization, renovation, expansion and reconstruction of existing buildings in comparison with new construction; providing public buildings with more multifunctionality; public buildings architectural and typological improvement with maximum use in the engineering, construction and operation of modern architectural and engineering innovative practices and techniques.

1. Introduction

The study of the developmental delays of temporal and spatial transformations of architecture and the architectural space is often based on a comprehensive fact analysis. Demographic factors, among others, determine trends of architecture development of public buildings and complexes and changes in the structure of their networks for the short-term. Consideration of rapid demographic change scenarios in qualitative and quantitative terms gives ground to forecast the trends in the architecture of public buildings and complexes and changes in the formation of their networks for the short-term. The realities and consequences of the demographic transition were analysed based on official United Nations population estimates and projections that have been prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. These sources embody an authoritative perspective on levels, trends and characteristics of the population, as well as perspectives on demographic development [1]. The actual data on the population of Ukraine, the dynamics of changes, and the age and
gender structure were studied based on available data [2], [3]. In one way or another, research on architecture and urban planning appeals to various aspects of demographic data.

2. Research Methodology
To address current issues of architecture, the authors propose to consider demographic indicators against the background of factual analysis and trends at three levels: the macro-level, the state level (meso-level), and the micro-level.

3. Study of the demography influence on urban planning and architectural processes at the macro- and meso-levels
*Earth population growth (macro-level).* The population rapid growth, which is commonly referred to as the "population explosion" began after World War II and peaked in the 1960s. According to UN forecasts, the world's population, which currently stands at 7.7 billion (2019), will increase to 8.6 billion by 2030 and 9.7 billion in 2050 [4]. The current demographic growth, called the "demographic transition", is due to both an increase in the birth rate and an increase in life expectancy, changing the age structure of the population [4, p. 2]. Figure 1 shows the distribution of the permanent population by gender and age as of the beginning of 2018. High rates of demographic growth due to fertility are concentrated in the poorest countries, wherein 2010-2015 the total birth rate was 4.7 per woman, while in Europe it was 1.6 [4]. Some European countries have made their choice to overcome depopulative tendencies in favour of interstate migration, although this has provoked some situational problems. The net inflow of migrants to high-income countries in 2010-2015 amounted to 3.2 million persons per year as a whole. The architecture responds to the need to solve the inevitable problems of demographics: migration-immigration-emigration, as well as integration, disintegration and multiculturalism.

![Figure 1. Changes in the world's urban and rural population, 1950-2050 (billion people). The point of "demographic upheaval"](image)

During the 20th century, the average life expectancy in the world has doubled. It continues to grow in the 21st century. As noted at the World Economic Forum, those who are 50 years old today can expect to live up to 83 years. And about 50% of children born in 2007 in the US, UK, Japan, Italy, Germany, France or Canada have a chance to live up to 100 or more years [5].

In the context of the completed demographic transition, there is another problem – the urbanization growth rate. In just 200 years, the world's urban population has grown from 2% [6] to more than 50% of all people. The "demographic upheaval" took place in 2007, when the number of urban residents
equalled the number of rural residents (3,303,992,253). Based on data and forecasts from the Department of Economic and Social Affairs [1], a graph of changes in the number of urban and rural populations in the world between 1950 and 2050 is made, showing a tendency for further rapid gap widening between these parts (Figure 1). The current pace of urbanization has already exceeded the forecasts of previous years [6], [7] and the urban population has reached 4.2 billion people. In the 2018 "Revision of the World Urbanization Prospects", the United Nations population Department (UN DESA) claims that about 55% of the world's population now live in cities. The disproportion between urban and rural population is increasing, and by 2050 the urban population will increase to about 68%.

The fastest pace of urbanization is observed in low-income countries [1]. A striking example of rapid urbanization is the growth of megacities. The number of megacities with 10 or more million inhabitants grew from 2 in 1950 to 4 in 1975; in 2000, there were 16 megacities. As of 2018, the number was 33. By 2030, the UN predicts that there will be 43 megacities in the world, most of them in developing regions. It is typical for countries with an above-average income to extend the advantages of urban life (in terms of comfort) to rural settlements — rurbanization, and one of its forms — suburbanization with a focus on suburban development [7], [8], [9].

Demographic situation in Ukraine and the development prospects (meso-level). Assumptions for the demographic situation development prospects in the country are based on probabilistic forecasts of the total birth rate and life expectancy at birth. Among the three demographic forecast hypotheses developed for Ukraine from 2014 to 2060, the "high" version of the forecast was optimistic [10]. Under favourable conditions, life expectancy would reach 80.2 and 84.7 years for men and women, respectively, the average number of children would be 2.0–2.1 per woman, and the migratory influx would be mainly due to the population from the post-Soviet states.

But, today against the background of the world population growth, Ukraine is experiencing a rapid decline in the number and relative demographic ageing of the population. Analysis of the current situation, as well as its dynamics over the past years, indicates a deepening demographic crisis.

- Ukraine is not included in the list of developed countries with a high level of income characterized by an increase in life expectancy and the development of rurbanization (suburbanization).
- Changes in social and economic life and a high level of education altogether have negatively affected the reproductive behaviour of the population, so Ukraine is not a country with a high birth rate.
- Despite the global migration increase tendency, the population of Ukraine is characterized, rather, by its attenuation, both for external and internal movements.

According to the latest available information in the results of 2017 World Population Prospects [2], Ukraine, together with Moldova and the Russian Federation, have the lowest life expectancy in Europe — 70–71 years. According to UN forecasts, Ukraine is among the top ten countries in the world with the highest rates of depopulation, which by 2050 will be more than 15%. Domestic data from administrative registers are scattered and not readily available for statistical purposes since the 2010 census was skipped. According to the State Statistics Service of Ukraine, the number of the permanent population of Ukraine in 2019 was over 42 (42 million 153 thousand) million people [4, p.16], and by results of electronic census — a total of 37 million 289 thousand people [11]. Ukraine was in the conditions of the "low" version forecast development. Which means:

- decrease of the birth rate to 1.3-1.5 children per woman;
- migration growth is close to zero;
- maintaining a low level of life expectancy — 67.2 and 76.8 years for men and women, respectively.

The distribution of the permanent population by gender and age in Ukraine is illustrated (Figure 2b) compared to the global average pyramid (Figure 2a).
To determine the need for public buildings for various purposes, as well as to review the relevance of the formation of their networks at the current stage (as of January 1, 2019), various variants of the numerical composition of the main age categories in the percentage ratio were calculated:

- children and youth up to 14 years old – 6,530,490 people — 16%;
- children and youth up to 18 years old – 7,609,297 people — 18%;
- people between 15 and 64 years old – 28,719,006 people — 68.5%,
- relatively working-age from 20 to 60 years old – 24,165,888 people (57.5%)
- elderly people from 60-years-old and more – 9,679,745 people — nearly 23%;
- elderly people from 65-years-old and more — 6,270,967 people — nearly 17%.

To predict future demand for public buildings, existing trends should be considered. So, for further assumptions, we derive the dynamics of changes in the structure of the population of Ukraine by age groups: from birth up to 14 years old; between 15 and 64 years old; over 65 years old, covering the period from 1990 to 2019 (Figure 3).

The pace of urbanization, to a certain extent, will determine the future of our country and shape the development trends of the architecture. The dynamics of changes was demonstrated by comparing demographic cross-sections of urban and rural population ratios between Ukraine (~42 million people, 603,628 km²) [12] and comparable in the territory and population France (58 million people, 543,965 km²) [13]. In the '80s, the total population of the countries equalled. Today, demographic realities and trends are different. Different trends in Ukraine comparing to global ones (Figure 4).

![Figure 2. Graphic illustration of the population age-sex structure:](image)

- a - global demographic distribution [2];
- b - demographic distribution in Ukraine [4, 29]
Figure 3. Dynamics of changes in the structure of the population of Ukraine by age groups (from birth up to 14 years old; between 15 and 64 years old; over 65 years old) in the period from 1990 to 2018.

Figure 4. Comparison of the dynamics of urban and rural population ratios from the '50s of the last century and according to forecasts by 2050 [14]:
   a - in the world (billion people);
   b - in Ukraine (million people).

4. Results and discussions
Changes in population size, growth rates, and groups will have consequences for society, the economy, and individual health and well-being. Demographic growth or depopulation processes, as well as redistribution in the population structure, cause the emergence of new specific types of public buildings: changes in the network and redistribution of demand for some "traditional" types of public buildings. These are the processes that need to be investigated and modelled at the micro-level.

Today, there are many complex demographic problems in Ukraine: a decrease in childbirth, a decrease in the working-age population, a rapid rate of population ageing and a gradual increase in life expectancy, as well as the urbanization of the population, which exacerbate all traditional challenges. To ensure that benefits are fully shared and comprehensive, access to infrastructure and social services must be provided for all segments of the population, focusing on the critical needs of the most vulnerable groups: education, health, work, and a safe and comfortable environment [1].

Networks of public buildings are being formed in spite of indicators that reflect "quantitative pressure" and today require a radical revision taking into account trends in demographic changes. The increase in the birth rate would form the need to expand the network of children’s and educational
(Table.1) as well as other institutions to meet the needs of this age group. But the decline in the birth rate reduces the demand across the country for pre-school, general education and higher education institutions. And these dynamics has already been noted by Ukrainian researchers [15] and is derived from the analysis of available statistical data [4]:

- at the beginning of the 2017/2018 academic year, there were 661 units of various level higher education institutions in Ukraine, compared to the 2013/2014 academic year the number decreased by 142 units (from 803 to 661) – 17.68%;
- in 2017/2018, 16,180 school institutions were functioning, compared to 2016/2017 the number decreased by 678 units (4.3%);
- in 2017, there were 14,907 pre-school institutions and the number decreased by 28 units compared to 2010.

The processes that are best modelled at the micro-level are identified. Current statistics in regions and cities confirm a "low" forecast version too. For example, according to the results of 2018, the number of the existing population of Lviv city (including the settlements in the outskirts assigned to it such as Vynnyky town, Briukhovskyi town, Rudne town), decreased by 2061 inhabitants per year and amounted to 755,822 thousand people [16]. During the year, 6719 children were born in Lviv, which is 411 (or 5.8%) less than in 2017. This number of children will reduce the number of children entering kindergartens, which is the average of 2-4 kindergartens, which will not be needed in a year. These processes should be modelled carefully at the micro-level (Figure 5). This progression over the next few years will have a significant impact on secondary and higher education institutions and the demand for medical and other types of public buildings. The formation of a quality level of human potential [17] is influenced by the level of higher education, and to maintain a decent existence of society and overcome the energy crisis, a high level of technological development and scientific development is necessary. Ukraine is among the leaders in the proportion of adults (aged 25 years old and more) with higher education per 100 thousand people. This level must be maintained.

On the other hand, the relative growth in the number of older groups is predicted. Along with the ageing of the population and the increase in life expectancy, the accompanying problems of architecture appear [18]. There is a demand for the formation of a network and the development of many types of gerontological, geriatric and palliative institutions [19]. Today, there are only a few examples of leisure, education and service institutions, gerontological centres for people of the so-called “third age” in domestic architecture. The development of a network of such institutions, their typology, features of design requirements, etc. requires scientific support [20].

In comparison with other and mostly “ageing” European countries, Ukraine has additional problems. In particular, this applies to medical care for elderly citizens [19], [20], especially for...
providing medical care to groups of people aged 60 years old and older, which should also be different [21], [22]. It is impossible to overlook the fact that with increasing (though insignificant) life expectancy, the working-age increases too. In architecture, there will be a growing demand for institution buildings to create guarantees of social and economic security for the elderly, as well as providing them with the opportunity to work and actively participate in society [23], [24].

The analysis of demographic changes does not only formalize the demand or rejection of certain institutions (Figure 6). It will also answer the question of whether to build new ones or to reconstruct, renovate and modernize the existing building stock. Considering the age redistribution of the population structure and in the absence of demographic growth, the last options should be favoured. The pace of new construction, especially in the social orientation in the public sector, will be reduced. Taking into account the main demographic indicators in Ukraine, we can assume a demand reduction for new construction of educational institutions. The existing fund should be reviewed in terms of its quantity and quality. The required and modernized (energy modernized) number of schools has been identified. A small percentage of the total number of public buildings can be withdrawn from the material fund. Unlike residential buildings, public buildings and complexes designed to serve and meet the needs of the 65+ age group will need to be increased. Part of the required number of complexes, buildings or premises can be compensated by repurposing and revalorizing existing buildings. Simultaneously with these changes and viewing functions, a number of their characteristics will change, including the level of energy consumption [25]. It is also necessary to determine trends by comparing the development of the fund and the architecture of public buildings in developed countries, taking into account demographic realities and prospects that differ from Ukrainian ones.

![Figure 6. Demand for buildings and complexes and their energy consumption under conditions of demographic transition.](image)

5. Conclusions
The consequences of the "demographic transition" will lead to changes in the architecture. Consideration of demographic change scenarios in qualitative and quantitative meanings gives grounds to forecast the trends in the architecture of public buildings and complexes and changes in the formation of their networks for the short-term.

The authors propose to analyse the current state and prospects of the demographic situation at three levels:
- **macro-level** (global and European-wide processes),
- **meso-level** (processes in the state);
- **micro-level** (situation in the region, city, village).

At these levels, the study identifies the following indicators: *the available population size; demographic cross-sectional data of age and gender population and social groups; and the ratio of the rural and urban population.*

Using only today's factual material does not allow us to objectively assess the situation and make
forecasts for the near future, so these indicators in development are studied and trends are determined.

The demographic situation in Ukraine is objectively different from the average global trends in developed countries. As of today, there are depopulation signs of changes in Ukraine (birth-rate falling, lack of external migration, a slight increase in life expectancy). The pace of urbanization is projected to be rapid for low-income countries. It was also revealed that public buildings and complexes are the most sensitive to demographic changes and, at the same time, more open to upcoming changes. These changes will include:
- increasing role and demand for public buildings and complexes under conditions of rapid urbanization;
- design in the conditions of existing restrained urban conditions;
- development, expansion and new types of public buildings appearance following the needs of the progressive link in the population structure (for example gerontological, geriatric and palliative);
- need to create and redistribute networks of public building and complex types depending on the quantitative meanings of demographic forecasts (for example kindergartens, general academic schools);
- the predominance of modernization, renovation, expansion and reconstruction of existing buildings in comparison with new construction;
- providing public buildings with more multifunctionality;
- architectural and typological improvement of public buildings with maximum use in the engineering, construction, operation of modern innovative practices and techniques.

The analysis presented in the article allows us to look at the prospects for the development of public buildings, their architecture, and networks development. It formed the basis of the justification for improving the energy efficiency of public buildings and complexes. These materials can also be used in studies related to housing architecture, city-planning, and other studies.

References

[1] 2018 Revision of World Urbanization Prospects, United Nations, 2018. [Online]. Available at: https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html. Accessed on: Apr. 15, 2019.

[2] World Population Prospects: The 2017 Revision, United Nations, 2017. [Online]. Available at: https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html. Accessed on: Apr. 15, 2019.

[3] М. B. Timonina, Population of Ukraine for 2017: demographic yearbook. Kyiv, Ukraine: State Stat. Serv. of Ukraine, 2018. [Online]. Available at: http://database.ukrcensus.gov.ua/PXWEB2007/ukr/publ_new1/2018/zb_dy_2017.pdf. Accessed on: Mar. 12, 2021.

[4] State Statistics Service of Ukraine, 2019. [Online]. Available at: http://www.ukrstat.gov.ua/. Accessed on: Apr. 15, 2019.

[5] J. Hewitt, “How to grow old like an athlete”, World Economic Forum, 2017. [Online]. Available at: https://www.weforum.org/agenda/2017/02/healthspan-vs-lifespan?utm_content=buffer37f73&utm_medium=social&utm_source=facebook.com&utm_campaign=buffer&fbclid=IwAR0X_agIjg7EV6_AdBoXK25spWdgGbxFS5HVEdnsJ-Iped8E8vXHu0ZtGCw. Accessed on: Jan. 15, 2019.

[6] B. Torrey, “Urbanization: An Environmental Force to Be Reckoned With”, Population Reference Bureau, 2004. [Online]. Available at: https://www.prb.org/urbanization-an-environmental-force-to-be-reckoned-with. Accessed on: Apr. 15, 2019.

[7] E. S. Demidenko, “Urbanization: the concept and policy of urban development”, doc. thesis, Lomonosov State University, Moscow, Russia, 1992.

[8] Ye. Shcherbakova, “World Urban and Rural Population Forecast 2018”, Demoscope Weekly, no 776-776, 2018. [Online]. Available at: http://www.demoscope.ru/weekly/2018/0775/barom02.php. Accessed on: Nov. 13, 2018.
[9] Annual Urban Population at Mid-Year by region, subregion and country, 1950-2050 (thousands), United Nations, 2018. [Online]. Available at: https://population.un.org/wup/Download/Files/WUP2018-F19-Urban_Population_Annual.xls. Accessed on: Nov. 13, 2018.

[10] O. V. Poznyak, and P. Y. Shevchuk, “Population prospects of Ukraine up to 2060”, Demohrafiya ta sotsial'na ekonomika, 1 (21), pp.72-84, 2014.

[11] Results of the electronic census: 37.3 million persons live in Ukraine - detailed infographics, 5 kanal, 2020. [Online]. Available at: https://www.5.ua/suspillstvo/rezultaty-elektronnoho-perepyusu-v-ukraini-prozhyvaie-373-mln-osib-infohrafika-206926.html. Accessed on: Jan. 25, 2020.

[12] Ukraine, Wikipedia, 2018. [Online]. Available at: https://uk.wikipedia.org/w/index.php?title=Ukraine&redirect=no. Accessed on: Nov. 13, 2018.

[13] France, Wikipedia, 2018. [Online]. Available at: https://fr.wikipedia.org/wiki/%D0%A4%D1%80%D0%BD%D1%86%D1%96%D1%8F. Accessed on: Nov. 13, 2018.

[14] Country Profiles, United Nations, 2018. [Online] Available at: https://population.un.org/wup/Country-Profiles. Accessed on: Apr. 15, 2019.

[15] O. I. Zaklektka, and O. A. Slyvka, Estimation of the educational component in providing human development in Ukraine, Efektyvna ekonomika, no. 9, 2018. [Online]. Available at: http://www.economy.nayka.com.ua/pdf/9_2018/40.pdf. Accessed on: Apr. 15, 2019.

[16] Demographic situation in Lviv in 2018, State Statistics Service of Ukraine, 2018. [Online]. Available at: http://www.lv.ukrstat.gov.ua/ukr/si/express/2019/v1103_27.pdf. Accessed on: Apr. 15, 2019.

[17] Human Development Reports 2016, United Nations Development Programme, 2016. [Online]. Available at: http://hdr.undp.org/en/content/human-development-report-2016. Accessed on: Apr. 15, 2019.

[18] Z. Bauman, Individualized society. Moscow: Logos, 2002.

[19] A. Horbovyv, The concept of activity of centers of education of the third age in Ukraine. Kyiv: UIRFR, 2017.

[20] Y. O. Musiyenko, and O. A. Troshkina, “Features of designing centers of leisure and education for people of «third age»”, XIII mizhnarodna naukovo-tekhnichna konferentsiya AVIA-2017, pp. 24.14-24.18, 2017.

[21] O. Krentovs'ka, “Demographic factor of aging of the population in reforming the health care system of Ukraine”, Zbirnyk naukovykh prats' Natsional'noyi akademiyi derzhavnoho upravlinnya pry Prezydentovi Ukrainy, no. 2, pp.203-213, 2010.

[22] O. V. Khudoba, “The Impact of Aging of the Population on the Health Care System: An Analysis to Review Public Policy”, Efektyvnist' derzhavnoho upravlinnya, 3 (56), pp.87-98, 2018.

[23] Guidelines for Gerontology and Geriatrics: in 4 vols. Fundamentals of Gerontology. General Geriatrics. General gerontology, vol. 1, V. N. Yarygin and A. S. Melent'yev, Eds. Moscow: GEOTAR-Media, 2010.

[24] K. Fedyachko, “Justification for the need to create objects and spaces for the elderly in cities”. Visnyk Lviv's'koho natsional'noho ahrarnoho universytetu. Seriya: Arkhitektura i Sil's'kohospodars'ke bud'vnyctvo, no. 17, pp.159-165, 2016.

[25] L. O. Shuldan, and M. O. Brod'kyy, “Architecture of public buildings and problems of energy saving”. Visnyk Natsional'noho universytetu “Lviv's'ka politekhnika”: Seriya: Arkhitektura, vol. 674, pp. 335-340, 2010.