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FACTORS OF POST-INDUSTRIAL TRANSFORMATIONS OF URBAN SOCIOGEOSYSTEMS (case Kharkiv)

О. С. Суптело, К. Ю. Сегіда. ФАКТОРЫ ПОСТИНДУСТРИАЛЬНЫХ ТРАНСФОРМАЦИЙ МІСЬКИХ СОЦІОГЕОСИСТЕМ (на прикладі міста Харкова). У статті розглядаються особливості постіндустріальних трансформацій міської соціогеосистеми, на прикладі міста Харкова. Збільшення рівня урбанізації, що проявляється в збільшенні чисельності міст, міського населення та впливу міст на загальний розвиток регіонів та країн, стимулює інтерес фахівців різних галузей до дослідження міст. При цьому, в контексті концепції постіндустріального розвитку, значний інтерес дослідники проявляють до факторів, що впливають на вектор та інтенсивність трансформацій міст в сучасних умовах. У даному дослідженні місто розглядається як складна міська соціогеосистема, на розвиток якої впливають велика кількість як зовнішніх, так і внутрішніх чинників. Обране як дослідницький кейс місто Харків має складну історію, в якій найдовший період пов'язаний з індустрією та промисловим розвитком, а з початку 1990-х років розпочало шлях трансформаційних перетворень до постіндустріального періоду. Мета дослідження полягає у визначенні факторів, що впливають на напрям та інтенсивність постіндустріальних трансформацій міста Харків за період 1991-2019 роки. Мультидисциплінарний дослідницький підхід до вивчення міст та особливостей їх розвитку, функціонування та трансформування, сприяє формуванню значного набору міждисциплінарних та конкретно наукових методів дослідження. Розглядаючи місто як складну соціогеосистему, що характеризується значним набором показників розвитку, найбільш ефективними методами для визначення факторів його трансформування є математико-статистичні методи, зокрема кластерний та факторний аналіз. Кластерний аналіз, як інструмент групування, дозволив упорядкувати показники соціально-економічного та просторового розвитку міста за досліджуваній період, встановити три основних етапи постіндустріального переходу. На основі факторного аналізу було встановлено сукупність чинників та визначено їх силу впливу за вказаний період. Аналіз показників розвитку міста в динаміці дозволяє стверджувати, що саме визначені фактори є такими, що впливають не лише на розвиток міської соціогеосистеми, а й на особливості її трансформації.

Ключові слова: трансформації міста, фактори розвитку, факторний аналіз, постіндустріальний розвиток, кластерний аналіз, міська соціогеосистема, Харків.

О. С. Суптело, К. Ю. Сегіда. ФАКТОРЫ ПОСТИНДУСТРИАЛЬНОЙ ТРАНСФОРМАЦИЙ ГОРОДСКИХ СОЦИОГЕОСИСТЕМ (на примере города Харькова). В статье рассматриваются особенности постиндустриальных трансформаций городской социогеосистемы, на примере города Харькова. Увеличение уровня урбанизации, проявляется в увеличении численности городов, городского населения и влияния городов на общее развитие регионов и стран, стимулирует интерес специалистов различных отраслей к исследованию городов. При этом, в контексте концепции постиндустриального развития, значительный интерес исследователи проявляют к факторам, которые влияют на вектор и интенсивность трансформаций городов в современных условиях. В данном исследовании город рассматривается как сложная городская социогеосистема, на развитие которой влияют большое количество как внешних, так и внутренних факторов. Выбранный как исследовательский кейс город Харьков имеет сложную историю, в которой самый длинный период связан с индустрией и промышленным развитием, а с начала 1990-х годов начал путь трансформационных преобразований к постиндустриальному периоду. Цель исследования заключается в определении факторов, влияющих на направление и интенсивность постиндустриальных трансформаций города Харьков период 1991-2019 годы. Мультидисциплинарный исследовательский подход к изучению городов и особенностей их развития, функционирования и трансформации, способствует формированию значительного набора междисциплинарных и конкретно научных методов исследования. Рассматривая город как сложную социогеосистему, характеризующуюся значительным набором показателей развития, наиболее эффективными методами для определения факторов его трансформации является математико-статистические методы, в частности кластерный и факторный анализ. Кластерный анализ, как инструмент группировки, позволил упорядочить показатели социально-экономического и пространственного развития города за исследуемый период, установить три основных этапа постиндустриального перехода. На основе факторного анализа было установлено совокупность факторов и определены их силу воздействия за указанный период. Анализ развития города в динамике позволяет утверждать, что именно определенные факторы являются влияющими не только на развитие городской социогеосистемы, но и особенности ее трансформации.

Ключевые слова: трансформации города, факторы развития, факторный анализ, постиндустриальный развитие, кластерный анализ, городская социогеосистема, Харьков.

Formulation of the problem. The rapid growth of urban population in the world, the growing role and influence of cities, informatization and the formation of new forms of economic development in combination with globalization and anthro-

pocentrism stimulate scientific interest in the study of cities, their populations and development. At the same time, complex interdisciplinary and systemic approaches are of great importance. The city, as a complex socio-geosystem [15, 16], which is influ-

enced by a number of external and internal factors, is a dynamic formation, which is characterized by the concepts of development and transformation. In the context of the concept of socio-geosystems, cities have the following fundamental properties: openness, dynamism, integrity, hierarchy, emergence, homeostasis, self-development and instability.

Modern society of highly developed countries, according to some scientists, is at the stage of post-industrial development, the rest are striving to reach this level and are in the process of transformation. For Ukraine, as a part of the European region, the processes of post-industrial transformations are also characteristic. First of all, they are manifested in large cities, including Kharkiv.

Over the more than 360-year history of formation and development, Kharkiv, under the influence of a significant number of factors, has repeatedly changed the vector of its development. The existing potential of the city and the current state of development suggest that Kharkiv has entered a phase of active post-industrial transformation, the manifestations of which are present in all spheres of life and functioning of the city, from economy and production to urban space and everyday practices.

Analyzing the experience of cities in the world, it should be noted that there is no single scenario for the development or transformation of urban socio-geosystems [19, 13]. As M. Weber noted [4], it is not possible to define the concept of a city, because each city is unique. Consequently, the conditions of development, the peculiarities of transformations, and most importantly the factors that influence these processes are completely unique for each city. Therefore, when planning and formulating a strategy for the development of the city, it is necessary to study the factors influencing these processes. In the period of post-industrial transformation, this is extremely important, given the dynamism and instability of post-industrial development in today's globalized world.

Analysis of recent research and publications.

The city and its development are the subject of research in many sciences, including economic and social geography, sociology, economics, urban planning, philosophy, futurism, ecology, political science and others. The formation of cities as centers of civilizational [8] growth and development of the territory in the period of total globalization has influenced the output of this object of study and the boundaries of the interests of one particular science or field of knowledge. At the same time, the most effective can be considered an interdisciplinary approach to the study of such a complex and dynamic socio-geosystem as the city.

Peculiarities of post-industrial transformations

of cities and the factors influencing them are a rather new field of research for domestic specialists. Instead, this topic has been widely studied by Western scholars since the early twentieth century, which is undoubtedly explained by the level of economic and scientific development of the respective countries.

Analyzing the results of previous research on the topic, it should be noted their main vectors: 1) theorizing of post-industrial urban development; 2) study of economic features and factors of development; 3) the study of spatial and social transformation.

The founder of the concept of post-industrial society D. Bell [2], notes that the manifestations of the post-industrial stage of development are mainly reflected in the economy and production, society and space, science and culture.

Andy Pike [1], in a comprehensive study of Glasgow's transformations, emphasizes that post-industrial development is a complex process and often leads to polarization and uneven development of the city, which in turn can affect the development of the region of influence of the city. The author notes that for Western highly developed countries, the period of post-industrial transformations begins after World War II and is gaining momentum in the early 1970s. The author assigns a significant role in the further development of Glasgow to the tertiary sectors, and notes that it is the processes of tertialization that can contribute to the establishment of sustainable development of the city.

On the example of the study of transformations of the city of Montreal, Sarah Moser, Gabriel Fauveaud, Adam Cutts [5], describe the impact of urban policy as one of the factors of city development. In times of economic and social upheaval, the main regulatory role is given to municipal authorities. The transition to the post-industrial stage of development of the city of Montreal was accompanied by the support of the city authorities of creative and science-intensive sectors of the economy, which overcame the decline of the manufacturing sector. Despite the success of the measures described by the authors, the transformation of the city, due to a number of factors, was uneven.

Lars Nilsson [7] explores the tendencies of post-industrial transformation of urban space as an important component of the city's functioning on the example of Western European cities in his work "Urban space in the post-industrial era". The author considers the processes of deindustrialization and development of creative branches of the city economy to be the main factors influencing the changes in urban space.

Post-industrial development and transformation of cities and urban spaces are quite new for domestic scientists. Undoubtedly, this is due to the fact that

the manifestations of post-industrial transformations in the Ukrainian socio-economic space, in particular at the city level, have appeared relatively recently. However, the study of foreign experience in the study of these processes, contributes to the formation of a comprehensive interdisciplinary study of cities and their development processes.

M. Bykova's research is devoted to the study of economic aspects of post-industrial transformations of Kyiv [10]. The author identifies the main aspects and their characteristics of economic transformations of the city in space-time aspects, including their qualitative and quantitative indicators (spatial organization of the economy, the level of post-industrial transformations, the sphere of dominance of post-industrial transformations). An important aspect of this study can be called a sufficient statistical base, unfortunately, its absence at the level of other cities in the country makes it impossible to conduct an equally effective study of economic transformation.

Another area of the urban socio-geosystem in his study describes O.V. Senyur [17]. The author refers to the transformation of the social space of the city to the main transformations of the post-industrial transition period. According to the concept and scientific views of A. Lefebvre [3] and other classics of sociological research of urban transformations, the author identifies two main areas of post-industrial changes in the social space of the city: first - the transformation of the essence and forms of social relations in urban areas; secondly - the transformation of the urban environment.

Investigating the spatial transformations of urban areas of Ukraine of peripheral-industrial type, O. Hnatyuk [11] identifies the main factors of transformation transition from planned to market economy, increasing importance of services compared to industrial production, low efficiency and innovation of the existing technological structure and conservatism. local population (including local elites), who are not ready to abandon the vision of their city, primarily as an industrial center.

The study of A. Sochuvka and A. Mazurova [18] is devoted to the issue of socio-geographical features of the transformation of industrial regions. Using the examples of the Katowice Conurbation, the authors describe the main characteristics and problems of the development of typical industrial areas in the period of industrial decline. Comparing the features of development of different industrial cities (Katowice and Kharkiv), A. Mazurova [13] identifies a number of factors influencing the functioning of these urban socio-geosystems, including demographic-educational, infrastructural, innovative, economic-industrial.

Positioning the city as an urban geosystem, O.

Chuyev [22], on the example of Kharkiv, reveals the features of the infrastructural component of its functioning with the help of spatial GIS analysis. According to the author, the establishment of a network of existing infrastructure facilities and a survey of public opinion on the features and efficiency of their operation is the basis for urban planning in the context of infrastructure development.

According to the analysis of the main publications on the topic of the study, we see that the statement of M. Weber [4] about the uniqueness of each individual city is confirmed. However, global trends in world development contribute to the spread of certain characteristics and vectors of development to different territorial patterns, which in turn increases the relevance of research on the factors influencing the post-industrial transformations of cities.

Selection of previously unsolved parts of the overall problem. The study of factors of post-industrial development is an important and relevant step in developing a strategy and planning for urban development, given the uniqueness of each individual city, and taking into account the main theses of a comparative approach to urban research in the interpretation of J. Robinson [9] and others. Kharkiv is a typical post-socialist city in the Eastern European region, which seeks post-industrial transformations. The study of factors of development of this kind of city, gives the chance of implementation of the received results for implementation at planning of development of other cities.

The purpose of this study is to determine the main factors of post-industrial transformation of urban socio-geosystems on the example of Kharkiv. To achieve this purpose, the following research questions were asked:

- What periods of post-industrial transformation did the city of Kharkiv undergo?
- What factors and with what force influenced the transformation of the city?

Research methods. Researching cities as complex sociogeosystems should not limit the set of research methods. The complexity of the object of study contributes to the application of a comprehensive cross-sectoral approach. In this paper, the main research methods are cluster and factor analysis. Based on the data of the Main Department of Statistics in Kharkiv region [12], a database of 41 indicators was compiled, describing the basis of the characteristics of the functioning of the city for the period from 1991 to 2019.

Cluster analysis, as a method that allows to group the objects of research into homogeneous groups - clusters, in this study was used to organize a dynamic series of indicators of Kharkiv over the years and highlight the main stages of development and transformation of the city. In turn, the use of

factor analysis, the purpose of which is to identify hidden variables responsible for the presence of linear statistical correlations between the observed variables for a dynamic series of data for such a significant period, allows to identify factors influencing the transformation of the object. At the same time, methods of systematization, generalization, induction and deduction, morphological analysis were applied in symbiosis with retrospective and systemic approaches, which allowed to establish some preconditions for transformation of urban sociogeosystem and their manifestations, and to systematize and interpret cluster and factor analysis.

Presentation of the main research material.

The transition to the post-industrial stage of development for most cities, countries and territories is an evolutionary solution to the problems that have accumulated during industrial growth. Accordingly, there are two possible ways to move to the post-industrial stage of development:

- I. *Extensive*: the decline of industry due to non-compliance with market conditions, or due to sharp economic or political shocks.
- II. *Intensive*: rapid development of technologies, science and technology, leading to a decrease in employment in industry, reducing the share of GDP of industries and industries of the primary sector, increasing the efficiency of tertiary sectors.

Kharkiv, like most cities in Ukraine and the Eastern Europe subregion, is characterized by the first scenario of transition to post-industrial development. The rupture of industrial ties after Ukraine's withdrawal from the USSR, outdated equipment and production technologies, and the low competitiveness of most types of industrial products led to the bankruptcy of a significant number of industrial enterprises in the city. However, the post-industrial stage of the city's development is the logical conclusion of the industrial stage and all these unfavorable preconditions for industrial development have become the engine for post-industrial transformations of the city, finding ways of rapid transformation. The classic transition to post-industrial development is accompanied by a combination of two processes: the tertization of the urban environment (the predominance of the service sector in the structure of the economy) and the modernization of industry. This has the following manifestations in Kharkiv [6]:

- among the industrial enterprises of the city, the enterprises of machine-building branch which have no analogues in the country possess considerable capacities, these are former giants of an industrial stage of development (HTZ, Turboatom, Hartron);

- industrial enterprises of food and light industry are gaining significant development, providing high-quality products not only in Kharkiv, but also in the whole region, forming powerful economic opportunities;
- the sphere of services in the city is developing mainly due to trade, transport, tourism (one of the largest shopping malls in the country "Barabashovo"; opening of 9 new metro stations during the period of independence, etc.);
- one of the largest IT clusters in the country was formed in the city;
- the city is the leading scientific and educational center of the country.

In the context of the concept of sustainable development, the transition to the post-industrial stage is logical and most effective. At the same time, given the experience of a number of cities around the world (Detroit, Manchester, Katowice and others), the rapid transition from industrial to post-industrial development is not always the most optimal. In general, regardless of the pace, such a transition may be accompanied by crises in industry and other industries and spheres of activity, which generally slows down the pace of city development. The lack of significant resources, a clear strategy for the development of the city and a number of alternative industries in the period of post-industrial transformations become a threat to the development of the city and can contribute to the rapid transformation of the city into a solid brownfield.

During the period of Ukraine's independence in Kharkiv, as in most powerful industrial cities of the country, transformations of all spheres of their functioning took place. Grouping the years of the study period according to the main indicators of urban development (cluster analysis), you can clearly see the phases of transformation processes in the city (Fig. 1).

Figure 1 shows that during the period from 1991 to 2019, Kharkiv went through three main phases of its development in the context of post-industrial transformations:

1. **1991-1997** – a period of development at the expense of residual resources. During this period, most industrial enterprises of the city continue to operate, but entering a state of crisis;
2. **1998-2010** – a period of crisis that was characteristic of the whole country. During this period, a significant proportion of the city's industrial enterprises go bankrupt and cease to operate. This period can be called the beginning of post-industrial transformations, the most striking manifestation of which is the process of *deindustrialization*.

3. **2011-2019** – a period of gradual recovery from the economic crisis. Currently, the economic situation in the city is stabilizing, some industries are being modernized (HTZ, Turboatom, Malyshev Plant). Among the post-industrial processes, the most manifestations are: gentrification, revitalization, neo-industrialization, tertialization.

Compared to cities in higher development countries, such as Detroit or Manchester, for Kharkiv, as for most post-socialist cities, the period of transformation will be protracted and somewhat wavy. This is due to a significant number of influencing factors, and in turn makes it difficult to predict the further development of the city.

The factor analysis of Kharkiv development for

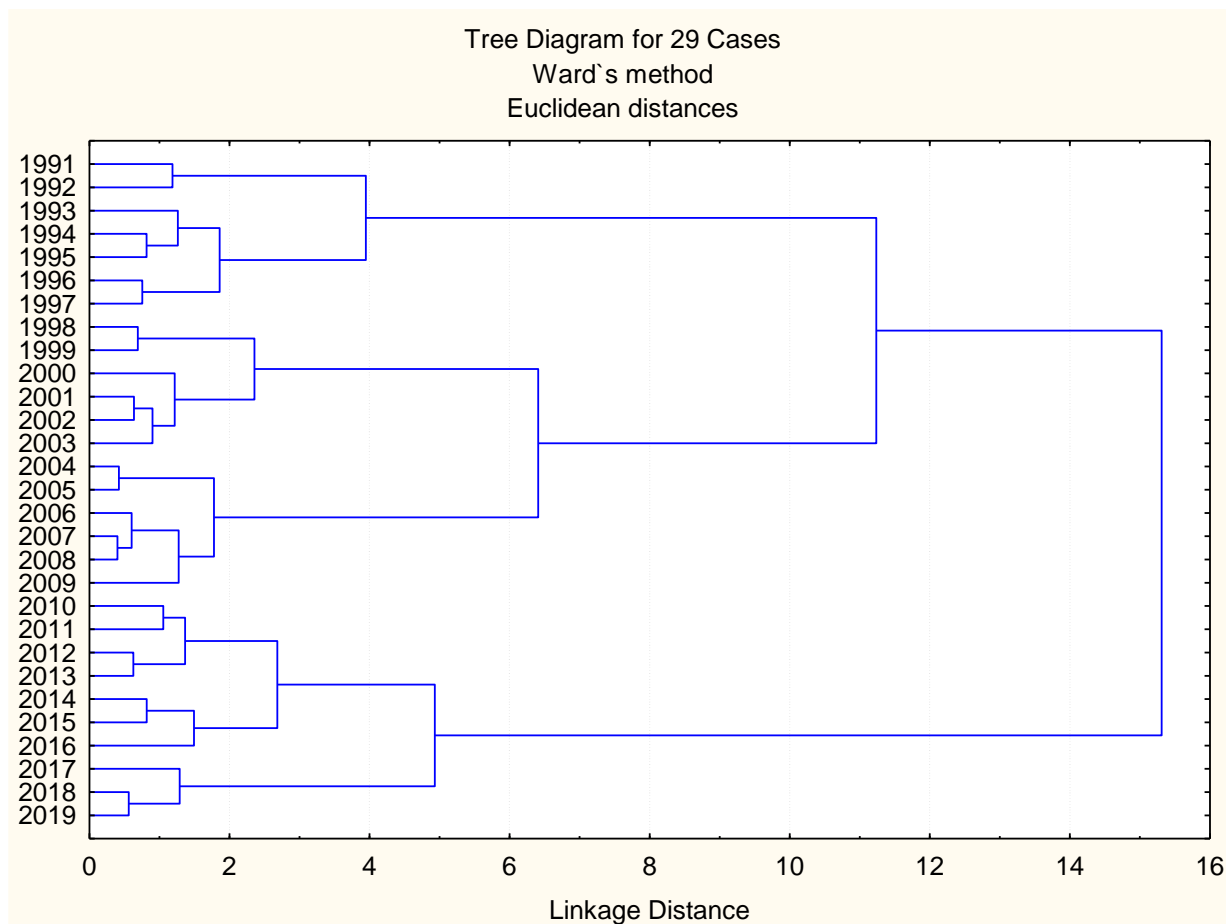


Fig. 1. Grouping of years of development of Kharkiv according to the main indicators of functioning of the city sociogeosystem (built by the authors according to [12])

the period from 1991 to 2019 revealed three complex factors of influence among the 41 development indicators studied. As the city is a complex multi-vector object of study, the determination of impact factors was carried out according to three criteria: Kaiser's criterion, cumulative percentage criterion, Kettle's "stone talus" criterion (Table 1).

According to Kaiser's criterion, we choose as probable factors of influence, only power values greater than 1,000. After all, if the factor does not allocate a variance equivalent to at least the value of one indicator, this factor has no effect. According to this criterion, we have five factors of influence, which respectively have their own values: 19,19815; 7.53513; 5.88793; 2.80172; 1,52066 (table 1).

Another way to determine the number of factors is the criterion of cumulative percentage, as de-

termining factors are chosen those that together cover about three quarters of the original information (75% – cumulative percentage). A value of more than 75% is achieved between the first and second positions (46.8247% and 65.2031%, respectively). According to the criterion of cumulative percentage, there are one or two optimal factors of influence.

The last way to determine the number of factors – Ketell's test – the criterion of "stone rash" (Fig. 2).

This graph shows that there are three optimal factors for the development of Kharkiv for the period from 1991 to 2019, and the rest is a "factorial rash" – insignificant or short-term factors. Factors №4 and №5 are not defined, so you should refer to the results of the study according to the previous criteria. At this stage of the study, we identify five

optimal factors for the development of Kharkiv.

Calculate the factor loads for each of the five factors and determine their structure (Table 2).

As can be seen from Table 2, there are only *three influencing factors*. In the previously selected factor №5, none of the numerical values of the variables exceeds 0.700, and therefore is not a component of the impact factor. And the factor «№4 contains only one change, the force of influence of which is only 0, 052974, which is not significant.

Based on the data in Table 2, we have the following composition of factors influencing the development of Kharkiv for the period from 1991 to 2019:

- **Factor №1** (strength of influence – 33.3%) – variables № 1, 11, 13, 14, 16, 17, 21, 25, 29, 35, 40, 41 – population; population aged 15 to 60 (men); population aged 0 to 15 (women); population aged 15 to 60 (women); number of first registered cases of diseases, thousand;

Table 1

Dispersion of influencing factors for the study period 1991-2019
(compiled by the authors according to [12])

Value	Eigenvalues	% Total variance	Cumulative Eigenvalues	Cumulative %
1	19,19815	46,82475	19,19815	46,8247
2	7,53513	18,37835	26,73327	65,2031
3	5,88793	14,36080	32,62120	79,5639
4	2,80172	6,83347	35,42293	86,3974
5	1,52066	3,70892	36,94358	90,1063
6	0,78095	1,90477	37,72454	92,0111
7	0,76862	1,87469	38,49316	93,8858
8	0,63975	1,56037	39,13291	95,4461
9	0,41423	1,01033	39,54715	96,4565
10	0,35280	0,86049	39,89995	97,3169
11	0,29827	0,72749	40,19822	98,0444
12	0,20527	0,50065	40,40349	98,5451
13	0,15180	0,37025	40,55529	98,9153
14	0,10859	0,26485	40,66388	99,1802
15	0,08342	0,20347	40,74730	99,3837
16	0,08036	0,19599	40,82766	99,5797
17	0,06034	0,14716	40,88800	99,7268
18	0,03118	0,07604	40,91917	99,8029
19	0,02165	0,05280	40,94082	99,8557
20	0,01850	0,04513	40,95932	99,9008
21	0,01376	0,03356	40,97308	99,9343
22	0,00818	0,01996	40,98126	99,9543
23	0,00508	0,01239	40,98635	99,9667
24	0,00477	0,01164	40,99112	99,9783
25	0,00455	0,01111	40,99567	99,9894
26	0,00214	0,00522	40,99781	99,9947
27	0,00139	0,00339	40,99921	99,9981
28	0,00079	0,00194	41,00000	100,0000

number of school institutions; number of hospitals; number of junior medical staff, thousand people; total area of housing stock, million m²; number of tourists; serviced by tour operators and travel agents; number of scientists; persons, the volume of performed scientific and scientific-technical works in actual prices, thousand UAH – *the structure of labor resources, their social protection and the most important sectors of the tertiary, quaternary and fifth sectors of the economy.*

- **Factor №2** (strength of influence – 17.1%) – variables №2, 4-7 – number of births, persons; natural increase (reduction); birth rate,

mortality rate; natural growth rate – *demographic development of the city.*

- **Factor №3** (strength of influence – 24.4%) – variables № 10, 15, 18, 20, 22, 30, 32-34 – population aged 0 to 15 (men); population over 60 (women); number of secondary education institutions; the number of universities of III-IV level; average salary; volumes of sold industrial products; retail turnover, thousand UAH; retail turnover of retail trade enterprises, thousand UAH; capital investments, thousand UAH – *age structure of the population and main indicators of economic development.*

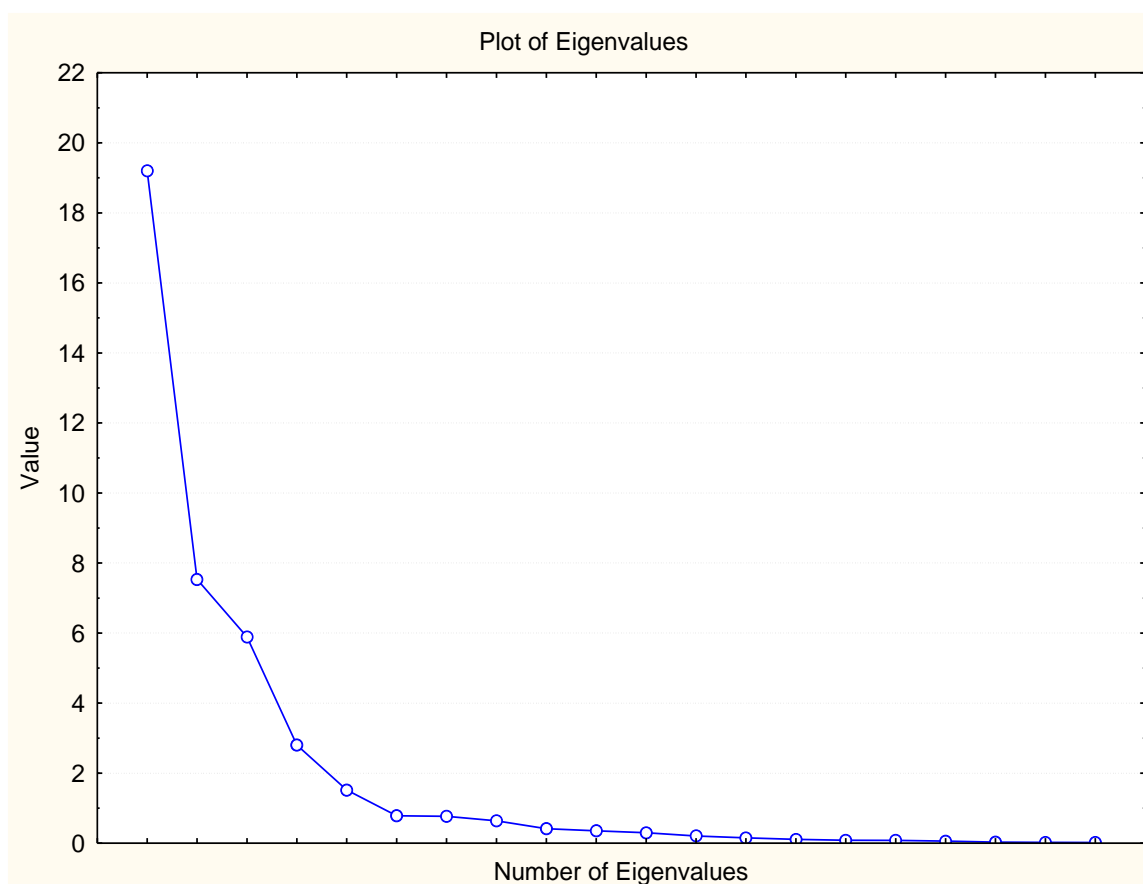


Fig. 2. Graph of variance ("stone or factorial talus") (created by the authors according to [12])

Of course, each of these factors changed the strength of its influence during the study period. To study this process, factor weights were calculated for each of the identified factors of influence during the study period (Table 3). Factor weights are indicators that assess the contributions of the studied years to each of the factors. The matrix of factor weights is calculated by multiplying the matrix of the original data by the matrix of factor loads. They are interpreted as relative estimates of the manifestation of a certain factor in each of the studied years and serve as a basis for their grouping.

If the value of the factor weights is about 0, then the influence of this factor corresponds to the

influence as a whole for the whole period, if more (and especially more than 1) – the influence of this factor is significantly greater, and if with a minus (more than 1) – significantly less. period as a whole (Table 3).

Thus, the *factor №1* – the structure of labor resources, their social protection and the most important sectors of the tertiary, quaternary and fifth sectors of the economy, the greatest impact and development of the city had in the period from 1991 to 1995, and the least in the period from 2007 to 2010 years. *Factor №2* – demographic development of the city had the maximum impact on the functioning of the city of the arch in 1991, 1992, 2012 and 2013,

Factor loads of the studied factors of Kharkiv development for the period 1991-2019
(compiled by the authors according to [12])

Value	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1	0,95009	0,055552	0,25038	0,051131	0,128252
2	0,13048	0,920341	0,04421	0,144338	0,053572
3	0,45185	-0,689888	-0,01212	0,102945	0,214693
4	-0,09213	0,985250	0,03847	0,065471	-0,050130
5	-0,12288	0,922086	-0,00804	0,142800	0,003553
6	-0,21707	-0,783209	-0,22151	0,064570	0,158282
7	-0,00707	0,985785	0,07970	0,080795	-0,058574
8	-0,58238	0,554968	-0,33780	-0,278640	0,278665
9	-0,58238	0,554968	-0,33780	-0,278640	0,278665
10	-0,55724	0,010426	-0,71771	-0,216319	-0,025047
11	0,98064	-0,100800	0,14120	-0,032243	0,028462
12	0,07919	0,522117	0,53343	0,452309	0,210842
13	0,96978	0,070394	0,13972	0,058994	0,097740
14	0,98138	-0,089393	0,14287	-0,036270	0,040671
15	0,23676	0,268372	0,82464	0,313603	0,224828
16	-0,89319	0,024200	-0,04162	0,278556	0,176121
17	0,95364	0,173224	0,09470	0,121929	0,017369
18	0,60336	0,087691	0,76574	-0,055835	0,091104
19	0,69577	-0,221752	0,56016	-0,179003	0,174573
20	-0,22398	0,142071	0,89952	-0,008594	0,235920
21	0,80133	-0,342239	0,35671	-0,119717	0,041648
22	-0,37069	0,051926	-0,89019	0,085847	-0,108745
23	0,06812	-0,108358	-0,54968	0,273318	-0,662375
24	-0,12927	0,198831	0,01861	0,876865	-0,137099
25	0,78825	-0,128475	0,56462	-0,035553	0,145937
26	-0,28329	-0,459586	0,15227	-0,418069	0,031339
27	0,42541	-0,286782	0,02417	-0,389046	0,106601
28	0,08780	0,113408	0,56546	0,383440	0,658651
29	-0,84135	0,006418	-0,44777	0,038139	-0,255245
30	-0,27209	-0,057205	-0,91228	-0,095362	-0,149072
31	-0,42704	-0,058100	-0,01581	-0,096204	0,215278
32	-0,17912	0,343919	-0,80392	0,054891	-0,109425
33	-0,63726	-0,172549	-0,68768	0,059684	-0,192493
34	-0,53805	-0,098736	-0,78280	0,143001	0,071695
35	-0,87293	0,073165	0,21445	-0,024208	0,292414
36	-0,28344	0,408550	-0,54079	0,095882	-0,576581
37	-0,05894	0,327028	-0,40526	0,236148	-0,657582
38	0,60407	0,463575	0,56654	-0,027259	0,216007
39	0,30380	-0,106148	0,53234	-0,043375	0,639939
40	0,79249	-0,079650	0,57285	0,068100	0,107369
41	0,79249	-0,079650	0,57285	0,068100	0,107369
Explanatory variable	13,65879	7,000164	10,02231	2,171954	2,941180
Prp. Totl (The strength of the influence of the factor)	0,33314	0,170736	0,24445	0,052974	0,071736

Factor weights of certain factors influencing the development of the city of Kharkiv for the period from 1991 to 2019 (compiled by the authors according to [12])

Years	Factor 1	Factor 2	Factor 3
1991	2,15861	2,41962	0,04477
1992	2,16358	1,77068	-0,32109
1993	1,75180	0,27175	0,15289
1994	1,54375	-0,75767	0,43184
1995	1,41674	-1,33972	0,47547
1996	0,99082	-1,03224	0,63962
1997	0,75338	-0,88660	0,58537
1998	0,63038	-0,55014	0,68114
1999	0,38110	-1,08435	0,51850
2000	-0,02105	-1,37216	0,59324
2001	-0,17525	-1,04788	0,40685
2002	-0,40801	-0,77703	0,50606
2003	-0,57003	-0,49978	0,31748
2004	-0,79676	-0,32724	0,46756
2005	-0,84369	-0,30063	0,59408
2006	-0,87189	0,03062	0,64188
2007	-1,02139	0,06777	0,76918
2008	-1,02466	0,52662	0,64150
2009	-1,03823	0,85654	0,89652
2010	-1,00181	0,75479	0,86734
2011	-0,62875	0,94606	0,08115
2012	-0,80947	1,53841	-0,13612
2013	-0,66056	1,37954	0,04467
2014	-0,65200	0,97158	-0,22587
2015	-0,43940	0,15374	-0,63355
2016	-0,07900	-0,23813	-1,58241
2017	-0,23700	0,19136	-2,35969
2018	-0,20085	-0,88991	-2,61557
2019	-0,31038	-0,77561	-2,48282

and the least – in 1995, 1996, 1999-2001. Regarding the *factor №3* – the age structure of the population and the main indicators of economic development, it acted with almost the same force throughout the study period, and only from 2016 to 2019 its strength was slightly less than the previous two factors.

Thus, the most influential are the three main factors of development: the city population, social sphere and economic activity. In the period of post-industrial transformations, the combination and interconnection of the triad of these factors is constantly changing, changing the internal structure of the urban socio-geosystem and its appearance. At the same time, the composition and structure of the city's population, the structure of the economy and methods of production are transformed, the sphere of social security of the population and the non-productive sphere comes to the fore, the interaction of the population with the city is transformed.

Conclusions. The complexity of the urban socio-geosystem and its dynamics affect the formation of complex factors of post-industrial transformation.

Kharkiv, as the second most developed city in terms of development and population, is characterized by a long and difficult post-industrial transition. During the period of independence, the city's economy managed to transform from industrial to post-industrial. Forced, due to a number of economic, political and social factors, post-industrial transition can be considered successful for Kharkiv. This is evidenced by the recognition of the city's development by international experts [14, 20, 21].

Analyzing the main indicators of socio-economic development of the city, we can distinguish three different periods of city development. The dynamics of the studied indicators indicates the formation and passage of transformation processes in the city. The results of factor analysis suggest that the greatest impact on the development of the city have economic, social and demographic aspects. But, based on a systematic approach to the study of the functioning of the urban socio-geosystem, these factors should be considered as a cumulative interaction. Thus, three main factors that significantly

influenced the transformation of Kharkiv in the period from 1991 to 2019 from industrial to post-industrial stages of development were identified: the structure of labor resources, their social protection and the most important sectors of the tertiary, quaternary and fifth sectors of the economy; demographic development of the city; age structure of the population and the main indicators of economic development. Undoubtedly, in different years these factors had different levels of influence. Determining the factor weights for the established factors for the study period and comparing them with the re-

sults of cluster analysis suggests that Kharkiv is undergoing a number of transformations for the period 1991-2019. At each stage there is a set of factors that act with a certain force.

Determining the periods of Kharkiv development and the main factors of influence is an important step for creating and substantiating a comprehensive description of the city in the period of post-industrial transformations, identifying problems and prospects for further development of the city.

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FACTORS OF POST-INDUSTRIAL TRANSFORMATIONS OF URBAN SOCIOGEOSYSTEMS (case Kharkiv)

Research problem introduction. Modern society of highly developed countries, according to some scientists, is at the stage of post-industrial development, the rest are striving to reach this level and are in the process of transformation. The city, as a complex socio-geosystem, which is influenced by a number of external and internal factors, is a dynamic formation, which is characterized by the concepts of development and transformation. For Ukraine, as a part of the European region, the processes of post-industrial transformations are also characteristic. Kharkiv is a typical post-socialist city in the Eastern European region, which seeks post-industrial transformations. The study of post-industrial development factors is an important and relevant step in developing a strategy and planning for urban development, given the uniqueness of each individual city. The study of factors of development of this kind of city, gives the chance of implementation of the received results for implementation at planning of development of other cities.

The purpose of this study is to determine the main factors of post-industrial transformation of urban socio-geosystems on the example of Kharkiv. To achieve this purpose, the following research questions were asked: What periods of post-industrial transformation did the city of Kharkiv undergo? What factors and with what force influenced the transformation of the city?

Research methods. Multidisciplinary research approach to the study of cities and the peculiarities of their development, functioning and transformation, contributes to the formation of a significant set of interdisciplinary and specifically scientific research methods. Considering the city as a complex socio-geosystem, characterized by a significant set of development indicators, the most effective methods for determining specific factors of its transformation are mathematical and statistical methods, including cluster and factor analysis.

Results, Scientific novelty, Practical significance. Cluster analysis, as a grouping tool, allowed to streamline the indicators of socio-economic and spatial development of the city for the study period, and to establish three main stages of post-industrial transition: a period of development at the expense of residual resources (1991-1997); a period of crisis, the beginning of post-industrial transformations, the most striking manifestation of which is the process of *deindustrialization* (1998-2010); a period of gradual recovery from the economic crisis, the economic situation in the city is stabilizing, some industries are being modernized, activation post-industrial processes like gentrification, revitalization, neo-industrialization, tertialization (2011-2019). Factor analysis allowed to identify three main factors groups transformation of Kharkiv from industrial to post-industrial stages (1991-2019): 1) the structure of labor resources, their social protection and the most important sectors of the tertiary, quaternary and fifth sectors of the economy; 2) demographic development of the city; 3) age structure of the population and the main indicators of economic development. During the period of Ukraine's independence in Kharkiv, as in most powerful industrial cities of the country, transformations of all spheres of their functioning took place. In the period of post-industrial transformations, the combination and interconnection of the triad of these factors is constantly changing, changing the internal structure of the urban socio-geosystem and its appearance. At the same time, the composition and structure of the city's population, the structure of the economy and methods of production are transformed, the sphere of social security of the population and the non-productive sphere comes to the fore, the interaction of the population with the city is transformed. Determining the periods of Kharkiv development and the main factors of influence is an important step for creating and substantiating a comprehensive description of the city

in the period of post-industrial transformations, identifying problems and prospects for further development of the city.

Keywords: city transformations, development factors, factor analysis, post-industrial development, cluster analysis, urban sociogeosystem, Kharkiv.

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