METHODOLOGICAL BASES FOR THE SUSTAINABLE DEVELOPMENT OF UNDERGROUND INFRASTRUCTURE FACILITIES IN UKRAINE: PROBLEMS AND PROSPECTS

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The objective of this paper is to create methodological bases for the sustainable development of underground infrastructure projects with account of certain factors to substantiate elasticity and stability, when conducting technological processes on the underground space development. The analysis of modern methods and tooling for the formation of the urban designing system with the implementation of mixed-use schemes in Ukraine, made it possible to determine that the project financing is a promising form of the capital investment into the most profitable sectors of the state economy or into private business. The analysis of modern methods of planning and designing of urban infrastructure systems has made it possible to substantiate the promising directions for development of the underground space use with application of the innovation model of sustainable development through the implementation of designated programs of high-tech modernization and renovation of the economic complex. Based on the analysis of modern planning methods for infrastructure facilities, an innovation system of the country is proposed, which is being formed by stages in order to create sustainable urban designing with the implementation of mixed-use schemes with a high density in Ukraine, and with subsequent steady functioning of this infrastructure. The practical relevance is in the definition of universal innovation policy, as a combination of basic principles and directions for creating the effective state mechanisms of market relations, as follows: formation of the regulatory and legal framework in the field of innovation activity; ensuring the interaction between science, education, production, financial and credit sphere in the development of innovation activities; technology transfer and financial support. The scheme for the regulatory innovation mode has been substantiated by means of which the economic growth in the country is stimulated within the framework of the appropriate established system of incentives and constraints.

The high requirements for reliability, durability and safety of underground infrastructure facilities (UIF) predetermine the necessity to develop a reliable geomechanical interaction support of an underground structure or an underground part of an infrastructure facility with an enclosing massif. This requirement is an essential element in the process of designing, construction and operation of the UIF, and the large-scale goals facing the underground complexes show its necessity and expediency.
METODYKA I STROENNYI RAZVITOK PODZEMNYKH INFRASTRUKTUR

1. Підземні інфраструктурні проекти та їх важливість у впровадженні екологічно чистих технологій.

2. Важливість впровадження інноваційних рішень у сфері підземних інфраструктур.

3. Стосування інноваційних методів в урядових органах.

4. Питання модернізації інфраструктури.

5. Синергія екологічних та економічних аспектів у розвитку інфраструктури.

6. Стимулювання впровадження інноваційних проектів.

7. Економічні аспекти інноваційних інвестицій.

8. Роль інституційних факторів в розвитку інфраструктури.

9. Питання стабільності інфраструктур.

10. Питання ефективності інфраструктурних проектів.

11. Вплив інноваційних стратегій на економічний розвиток.

12. Питання управління інфраструктурними проектами.

13. Стосування інноваційних технологій в сфері підземних інфраструктур.

14. Питання ефективності інвестицій в інфраструктуру.

15. Питання екологічної безпеки інфраструктур.

16. Питання експлуатації інфраструктур.

17. Питання управління інфраструктурними проектами.

18. Питання ефективності інвестицій в інфраструктуру.

19. Питання екологічної безпеки інфраструктур.

20. Питання експлуатації інфраструктур.

21. Питання управління інфраструктурними проектами.

22. Питання ефективності інвестицій в інфраструктуру.

23. Питання екологічної безпеки інфраструктур.

24. Питання експлуатації інфраструктур.

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26. Питання ефективності інвестицій в інфраструктуру.

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40. Питання експлуатації інфраструктур.

41. Питання управління інфраструктурними проектами.

42. Питання ефективності інвестицій в інфраструктуру.

43. Питання екологічної безпеки інфраструктур.

44. Питання експлуатації інфраструктур.

45. Питання управління інфраструктурними проектами.

46. Питання ефективності інвестицій в інфраструктуру.

47. Питання екологічної безпеки інфраструктур.

48. Питання експлуатації інфраструктур.

49. Питання управління інфраструктурними проектами.

50. Питання ефективності інвестицій в інфраструктуру.
essential element in the process of designing, construction and operation of the UIF, and the large-scale goals facing the underground complexes show its necessity and expediency.

The geomechanical supporting of the UIF on the territory under consideration solves the following tasks: creation of a long-term (for a calculated period) stability of underground facilities, geomechanical control over the stress-strain state of the host rocks; determination of the underground facility influence on the environment and engineering structures, both during construction and operation, as well as in the period of reconstruction and especially liquidation. The main purpose of the geomechanical support of the UIF is to prevent emergencies during the underground space development, to increase safety and efficiency of mining operations, to ensure the integrity and standard operation of buildings, structures and engineering networks that fall within the zone of their geomechanical influence, as well as environmental protection.

The UIF are defined as the space under the urban areas that provide direct services to the city (for example, sewage disposal, groundwater flow, metro operation, or geothermal energy). The UIF include the rocks and soils formed geologically, as well as man-made structures of different origin and determine the four main resources, namely, space, materials, water and energy. These resources have different degree of recovery, depending on their use and the rate of extraction.

But, as a result of the rapid change in the conditions of economic management, Ukraine has standards and organizational-economic mechanisms for a project and program-oriented and goal-oriented approach to solving the tasks of the industrial and construction state complex development through the construction of new, reconstruction and technical upgrading the existing enterprises and other facilities, which require further improvement.

Analysis of the experience of economically developed world countries in the direction of UIF use, taking into account their legislative base, as well as maintaining the stability of surface soils showed that the need to create a way to the future sustainable use of underground space, given the high density of the surface construction, and the pursuit of economic growth are identified now. As a result, a large-scale study and substantiation of the planning and designing processes for underground infrastructure projects in addition to the underground space in less developed (rural) regions has begun.

An analysis of various statements about stability has shown that planning of infrastructure projects, in addition, the UIF is an important medium for the implementation of both economic growth and social progress. First of all, we define that both economic growth and social progress should not occur at the expense of the environment (e.g., depletion of groundwater level, the quality of rivers, air quality and excessive carbon emissions), and thus it emphasizes the complexity associated with the desire to realize sustainable construction.

It is clear that any project cannot be implemented without appropriate funding. In order to recover the domestic economy as a whole and its main strategic sectors — the fuel and energy complex, the metallurgical industry and agriculture — the significant investments will be required (based on foreign experts' studies results, $2.5—3.5 trillion is needed per year) [11]. Therefore, as the experience of highly developed countries shows, for the gradual and effective recovery of the domestic economy, a considerable attention should be paid to a new method of financing the large-scale high-risk investment projects, as well as to project financing.

However, the constant changes in the domestic legislation, financial and political instability in the country are responsible for searching the new directions of the project finance development and the creation of conditions for preferential treatment for both domestic and foreign investors in order to implement sustainable urban designing of UIF with implementation of mixed-use schemes with a high density in Ukraine.

And also use two main approaches of designing: sustainable approach, with the implementation of mixed-use schemes with a high density in Ukraine and comprehensive approach to consideration of the investment projects, given its viability, efficiency, availability of adequate resources, the presence of risks, and the like. One of the important factors that, in our opinion, put the brakes on the development of project financing in Ukraine, first of all, are the restrictions of the National Bank on the volumes of investment, the lack of provisions on project financing in the Law on Budget for 2018.

The general indicators characterizing the innovation activity in Ukraine have a tendency to an increase in the number of innovation enterprises and the volume of expenditures on innovation activity, but, at the same time, there is no real structural change and modernization of the economy (Figs. 1, 2).

Among the reasons for the lack of innovation development is complex business environment in Ukraine. According to the World Bank rating, Ukraine ranks 183th in the world in terms of indicators characterizing the ease of doing business [12]. The most problematic components of this rating are the tax system, the introduction of international trade, the property registration, the setting up and closing of businesses on the territory of Ukraine [13].

The main purpose of the state innovation policy is to create social and economic, organizational and legal conditions for effective reproduction, development and utilization of the scientific and technical potential of Ukraine, ensuring the introduction of modern environmentally friendly, safe, energy- and resource-saving technologies, production and sales of new types of competitive products.

The basic principles of state innovation policy are: orientation on the innovation way of development of the Ukrainian economy; determination of state priorities for innovation development; formation of the legal and regulatory framework in the field of innovation activity; creation of conditions for preservation, development and use of domestic scientific and technological, as well as innovation potential; ensuring the interaction between
science, education, manufacturing, financial and credit sphere in the development of innovation activities; effective use of market mechanisms to promote innovation activity, support for entrepreneurship in the research and production sphere; implementation of measures to support of international scientific and technological cooperation, technology transfer, protection of domestic products in the domestic market and its promotion to the external market; financial support, the implementation of favourable credit, tax and customs policy in the field of innovation activity; assistance in development of innovation infrastructure; information assistance of subjects of innovation activity; training of personnel in the field of innovation activity [14].

Based on the above stated purpose of the innovation policy, there is an orientation of innovation policy, which arises depending on the existing conditions and set tasks. Thereof, four directions are distinguished: the innovation policy of ‘technological push’, the innovation policy of ‘market pull’ (based on the fact that the state plays a secondary role in this policy, the main participants are directly business entities that carry out innovation activity on their own initiative); the innovation policy of ‘social orientation’ aimed at the involvement of the public, as the driving force of innovation development; innovation policy aimed at changing the structure of the economic mechanism.

The combination of these policies with the priority distribution of industries of application is the universal innovation policy. However, in the present conditions of economic reforms, it is necessary to intensify the public activity, to create conditions for the formation of non-governmental organizations and unions, which will have a direct interest in the modernization of the economy and initiate innovation development, and make proposals on changes in the institutional framework of innovation policy. It should be noted that, compared with European ones, Ukrainian innovation networks of business support infrastructure have quite a low level of interaction both within networks and between them. The Ukrainian constituents of infrastructure to support the business and innovation do not unite in the network, since they mostly do not even know about them.

The financing of science based on a residual principle, the lack of incentives for innovation activity and state support of high-tech enterprises, imperfect legislation, total corruption of government officials and organizations has led to extremely negative structural changes in the economy, namely, the increase in the share of raw production, low-technology industries and the decline in the share of high-technology industries.

One of the forms of innovations development in the first stages is the creation of Science Parks at universities of the country. Threweth, the Article 65 ‘On Higher Education’ of the Law of Ukraine states that ‘the main purpose of scientific, scientific and technical, as well as innovation activity is to obtain new scientific knowledge through research and development and their direction to the creation and implementation of new competitive technologies, types of equipment, materials, etc., in order to provide the innovation development of society, the training of innovation type of specialists’. The Article 66 of the Law of Ukraine defines the conditions for the creation of business incubators, technological Science Parks, etc. [13].

However, the administration of research institutions and universities do not have weighty incentives to intensify their research activity in the framework of the Science Parks and is counting on the old contractual form of work for clients, the number of which decreases with time. An alternative form of contractual form of work performance is the formation of Science Parks at universities, where ‘start-ups’ were carried out.

It should be noted that the innovation policy management system in Ukraine covers a large number of different ministries, agencies and committees, is uncoordinated, therewith, there is no governing board that as a sole representative could be responsible for innovation policy. The Ministry of Science and Education is responsible for the development and implementation of national policy in the scientific, technological and innovation sphere, as well as the implementation of innovation policy, which is also included into the tasks of the Ministry of Economic Development and Trade.

The National Academy of Sciences, sectoral ministries form their own innovation policy, create tools for implementing the scientific and practical results of their research, have a system of research institutes, sources of funding (their budgets), material base and manpower. It is necessary to coordinate the activities of the bodies that implement innovation policy into a single strategy, where each ministry, committees, and institutions are responsible for the stages of economic modernization, the implementation of innovation policy and the consolidation of their functions by legislative regulation. For this purpose, it is advisable to assign the Ministry of Economic Development and Trade as the coordinating authority and consolidate this with the legislative regulation. It is necessary to define as a separate chapter in the Law of Ukraine ‘On Innovation Activity’ the role and functions of the Ministry for coordinating the activities of government bodies in the implementation of innovation policy.

To form an innovation policy, it is necessary to use a regulatory regime scheme. This scheme is as follows: interest — regime — interest [15] (Fig. 3).
regulatory regime will contribute to the fluctuation of the 'satisfied interest' value.

In Ukraine, there is a problem of a gap between the national innovation programs and regional ones, which is explained by the diversity of innovation potentials of each region and country as a whole. In order to remove these obstacles, it is necessary to define priorities both at the national and regional levels, and to design programs with the implementation of mixed-use schemes in the country. At the same time, to make certain changes in the legislative base.

In the Law of Ukraine 'On Innovation Activity', there is a priority for the realization of sustainable urban designing with the implementation of mixed-use schemes with a high density in Ukraine, and their subsequent use and stable urban designing with the implementation of mixed-use schemes. It is confirmed that the transition from the regional to a centralized policy of innovation development is a complex process and it is difficult for regions to restructure their innovation policies into the policy of national programs.

After twenty years of reforms, the EU regional programs are behind the national ones; this fact should be taken into account when forming the innovation policy in Ukraine in the process of modernization of the Ukrainian economy. In the EU countries, there are no decisions on the possibility of balancing the interests of regions in a single program, although there are compromise solutions between the relative advantages of multi-regional programs (well-funded, no duplication) and regional programs that are adapted to solving regional issues of innovation development and consider the specifics of regional development [10]. That is, in the EU a single approach has not been developed to the coordination of regional programs into a single government program.

In Ukraine, the regional innovation policy is dependent on the state and activities of its industry. During the period of the economy modernization, the state of development of regional innovation policy can be characterized as an initial. It should be noted that the Government of Ukraine has made a lot of efforts to define specific programs and start certain projects, and they have been taken for the development of innovation infrastructure. However, the infrastructure does not meet the requirements of investors, there are no necessary communications, the location of industrial parks is inconvenient for investors (a long distance from the commodity market, transport routes, borders, lack of availability of skilled labour), the lack of information on the availability of infrastructure, and the complexity of finding the requirements of investors for industrial parks for innovation development.

The innovation system of the country can be formed in stages in order to create a sustainable urban designing with the implementation of mixed-use schemes with a high density in Ukraine, and their subsequent use and stable urban designing with the implementation of mixed-use schemes. It is confirmed that the transition from the regional to a centralized policy of innovation development is a complex process and it is difficult for regions to restructure their innovation policies into the policy of national programs.

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CONCLUSIONS

The analysis demonstrates the existence of significant experience in the field of geotechnical substantiation of the possibility to construct underground infrastructure facilities (UIF). The construction technologies and engineering solutions of the underground urban space have already reached a high level. In the near future, a developed urban underground infrastructure will be an essential component of large industrial cities.

The stable UIF development in Ukraine is possible provided the underground facility compatibility with the enclosing rock massif and technological features of construction and operation. The compatibility is based on the development of specific technical and technological safety solutions for the main stages of the technological cycle and at each stage of the 'masif-technological UIF' system operation. The technical and technological features are based on the dynamics of the technical system state during the process of UIF operation.

It is necessary to develop a regulatory framework of the innovation system of the country in order to create stable urban designing with the implementation of mixed-use schemes with a high density in Ukraine, as well as their subsequent introduction and sustainable operation.

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