The urban planning information platform: progressive methods of planning and managing the sustainable development of territories

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Abstract. The urban planning information platform, including the “digital twin” model, has become the basis for the integration of various urban planning and sector-wide approaches and a tool for progressive spatial planning, design, and management of the sustainable development of territories. The study resulted in the identification of several “smart urban planning” aspects as a promising direction in the development of the theory and practice of urban planning. The article gives a brief description of the modern global experience in digital forecasting, programming, and design of the spatial system. It discloses the provisions of strategic urban planning, modeling the graphic identity of a territory, and master planning taking into account digital information systems and information and communication technologies. The authors propose to separate the concepts of “territorial” and “spatial”, taking into account their differences and tasks. They determine perspective tasks in the field of the development of urban planning information systems and “digital twins” aimed at spatial planning and modeling. They consider the theoretical provisions of predictive probabilistic modeling; initiative, institutional and participatory planning, taking into account the interests of residents, business, scientific and public institutions, as well as the tasks of creating a comfortable, safe and landscaped living environment.

1. Introduction
Modern world studies in the field of the theory and practice of urban planning are focused on solving the problems of forecasting the probabilistic development of an urbanized system, strategic urban planning, initiative, institutional and participatory planning, taking into account the interests of residents, business, scientific and public institutions, as well as the tasks of creating a comfortable, safe and landscaped urban and rural environment. At the same time, innovative digital models and methods of goal-setting, planning and managing the sustainable development of territories are progressive tools for improving these areas.

Digital modeling of an urbanized system of any hierarchical level is connected with the perception of its spatial form, taking into account both 2-, 3- or more dimensions. A “digital twin” of a territory can act in these issues as a successful mechanism of “smart” forecasting - programming - design (the trinity suggested by I. Smolyar) of such system development. The model of the “digital twin” of a
territory should form the basis of the urban planning information platform aimed at short-term, medium-term and long-term planning and management.

In parallel with the issues of digitalization in the field of spatial planning, the techniques and methods of system, civilizational, strategic (the civilizational approach and their integration were put forward by V. Kolyasnikov), proactive, “smart” approaches, as well as master planning, have been actively discussed. Therefore, the synchronization and aggregation of these approaches within the framework of the “smart urban planning” direction have become a relevant area in the theory and practice of urban planning.

The authors previously proposed the definitions of the terms “smart urban planning”, urban planning information platform, “digital twin” of a territory, “cyber-physical urban planning system”, as well as a theoretical model of an urban information platform. This theoretical model includes automation methods, peculiar features of its implementation, and characteristics of the working layers.

The presented study is aimed at solving several promising problems, taking into account modern approaches to planning, design and managing the development of the urban planning system.

2. The main part
The world is facing the updating of urban planning approaches connected with the appearance and rapid development of digital technologies in this sphere and related fields of knowledge. Despite the significance of such a movement, these changes are not systemic. This is expressed in the absence of a generally accepted scientific-research base of spatial “smart” planning, design and management of the development of territories, taking into account the generally accepted definitions, current concepts, theoretical models, principles, techniques, and methods of “smart urban planning”. At the same time, the accumulated successful “smart” practices in the field of the formation and development of urban planning systems allow us to test them to formulate methodological and basic procedures. The most relevant task in this area is the implementation of the “digital twin” of a territory based on the urban planning information platform.

The theoretical model of the urban planning information platform presented earlier by the authors includes the structure of the working layers, including the property fund, urban planning cadaster and investment map, social, transport and engineering infrastructure, landscaping and planting infrastructure, historical, cultural and natural heritage, tourism and recreation, non-capital construction facilities, construction and reconstruction facilities, accessible living environment, graphic identity model, strategic urban planning development model, master plan of the development of the territory, urban planning models of the detection and forecasting of emergency situations, BIM-technologies in construction. Most of these areas are related to the issues of the optimization of the urban planning system and its subsystems. Within the framework of research and project activities, many works have been devoted to them, including those taking into account the introduction of modern digital technologies. Works dealing with strategic urban planning, modeling the graphic identity of the territory and master planning are of the greatest interest.

The study of the generally accepted strategic urban planning experience shows that it relies on the formation of complexes and clusters, the development of partnership-based territories, areas of joint interests, and the uniqueness of the urban planning system [1-2]. The methods for the development of an urban planning project based on the formation of partnerships, areas of joint interests, complexes and clusters (V. Spiridonov and V. Kolyasnikov) are aimed at ensuring a coordinated joint development of socio-economic and administrative-territorial entities included in the urban planning system. At the same time, we distinguish different hierarchical levels of partnerships, from local to international, and different types of areas of joint interests, their complexes, and clusters. These include - environmental, economic, functional (urbanized), historical, cultural and aesthetic. Within the framework of this methodology, we perform environmental and urban planning, economic and urban planning, functional planning, historical-cultural and aesthetic zoning of the territory as a necessary condition for the sustainable development of the spatial system. The development methodology based on the uniqueness (V. Spiridonov and V. Kolyasnikov) rests on the use of unique
resources and the local identity of each of the territories of the urban planning system as a strategic resource for its development. Thus, the unique competitive advantages are directly linked with the establishment and development of a special role of historical, cultural, natural-landscape, functional, communication and compositional significance of territories. Digital monitoring, analytics, and modeling methods play a special role within the framework of using these methods.

As a result of the study, we have established that the world experience in modeling the graphic identity of a territory is connected with the formation of a unique image of populated places and inter-settlement territories, their recognizable appearance, and artistic and aesthetic expressiveness, tourism and recreation infrastructure. The methodology for the development of a territory based on its graphic identity should include such historically established concepts as urban planning traditions, cultural heritage and cultural diversity, the morphology of the urban planning facility, architectural and urban ensemble, silhouette of a building, panoramas and prospects of perceiving the urban and inter-settlement environment, its originality and uniqueness, systems of open spaces and public places, zones and territories with increased architectural and artistic requirements, central and peripheral districts; as well as new ones - facilities of the image component, the innovative potential of the territory, informal zones, active and quiet territories, preservation of the unique ecosystem of the territory, the transformation of the sociocultural framework, etc. [3-5].

When modeling the graphic identity of the territory, 3D visualization and virtualization become important, where the “digital twin” of the territory can take a key role. New concepts and methods of digital urban planning are elaborated with the development of information technologies. Their main task is the virtual inclusion of new facilities in the stereo-panoramic models of the existing architectural and urban planning environment or the modernization of elements of this environment [6-7].

3D visualization and virtual reconstructions of the urban and inter-settlement environment have become increasingly popular in the matters of its restoration, reconstruction, renovation and revitalization, new construction in culturally valuable housing development, landscaping, and other urban and related matters [8-9]. Studies in this field of modeling the urbanized environment cover a wide range of tasks and include issues of historical and urban planning analysis, reconstruction or formation of a new unique and recognizable image of the territory, taking into account its historical and material heritage.

An analysis of the world experience of master planning shows that this direction is linked with the architectural and spatial development of the territory, solving the problems of creating a comfortable, safe and landscaped living environment; initiative planning taking into account the interests of residents, business, scientific and public institutions [10-11].

A study of the international experience demonstrates that in modern practice, many cities widely use master planning for the development of new planning units and elements [12]. Master plans have been also actively developed to conduct major events [13]. The situation is different with the development of master plans of the cities and regions themselves. The experience of such planning is local and individual [14]. Master planning of large urban facilities is based on the use of methods of public participation, identifying the aggregate emotional assessment of residents, forming a scale of emotional perception and level of comfort, etc. When preparing master plans for the development of cities and regions, interactive and other digital forms of surveys, studies and dialogs are carried out, analytical information databases of initiatives are introduced, focus groups and design and analytical sessions, open discussions, conferences, and other events are organized [15-16].

The results of the performed scientific work show that the urban planning information platform should become a successful tool for aggregating the mechanisms and methods of strategic urban planning, modeling the graphic identity of a territory and master planning, taking into account the possibilities of its smart monitoring, analysis, forecasting, programming and design of the spatial system. Such a platform should integrate the principles, methods, and approaches of various types of planning, taking into account all-round views of both professional communities and residents, business and public institutions on the development of the territory. Such a platform, formed on the model of
the “digital twin” of the territory, allows us to consider the spatial image of a planning, design and management facility and align the work of services and specialists of various fields of knowledge in this sphere. In this meaning, the term “spatial development” acquires a broad understanding, much more capacious than “territorial development”.

The term “spatial planning” itself has been introduced into the sphere of territorial development relatively recently. An important role in its implementation was played by the international document - European Spatial Development Perspective 1999 (ESDP) [17]. In 2008, the UN Economic Commission for Europe prepared a provision on spatial planning, where spatial development was considered as changes in the distribution of activities in space and the linkages between them through the conversion of land and property [18]. The UN Conference on Housing and Sustainable Urban Development (UN-Habitat III) notes that spatial planning should cover issues of different scales - from the level of a quarter, city/municipality, city/district/agglomeration to the national and supranational and even cross-border levels [19]. Notably, in 2015, UN-Habitat defined urban and territorial planning as a decision-making process aimed at realizing economic, social, cultural, and environmental goals through the development of spatial visions, strategies and plans and the application of a set of policy principles, tools, institutional and participatory mechanisms and regulatory procedures [20].

In scientific, educational and professional publications and in project documentation, the terms “spatial” and “territorial” planning are sometimes freely replaced and considered to be synonyms. To this end, the generally accepted consolidation of these concepts is necessary, taking into account the urban planning levels, tasks, and objectives, as well as their implementation deadlines.

The most relevant issues in the theory and practice of spatial development of an urban planning facility are the problems of probabilistic contingency planning and design, including proactive planning, which takes into account the interests of residents, business, scientific and public institutions, as well as the task of creating a comfortable, safe and landscaped living environment.

Over the past decade, the introduction of computer technologies in the issues of forecasting, programming and design of complex urban systems has significantly changed the methodology of planning, design and managing their development. With the appearance of such scientific areas as the “theory of systems” and “cybernetics”, the very perception of the city and the region as a complex urban development system has changed. They ceased to be regarded as a closed object and began to represent “a process taking place in a specific spatial environment, but not as a medium taken as such” [21].

Understanding the issues of planning the urban planning system as a prediction of its probabilistic development led to the evolution of the master plan methodology. The concepts of the “final master plan” (according to M. Branch) or “static concepts” (according to G. Mazaev) did not meet the requirements of the time and the ever-growing tasks of regulating the development of the urban planning system, its subsystems, and elements [22-23]. There appeared new “dynamic concepts of the master plan” (according to G. Mazaev) developing from “variant master plans” to the concepts of “tracking (continuous) master plans” and further to “eventual concepts of a flexible master plan” (according to I. Iodo) and “concepts of a probabilistic master plan” (according to G. Mazaev) [24-25]. A special role in the development of the planning and design methodology was played by digital information technologies, where one of the main tasks was managing the implementation of the master plan of a city. The introduction of the urban planning information platform and the “digital twin” should be aimed at creating a “dynamic” model of the development of the urban planning system, its subsystems and elements, and ideally should ensure a significant increase in the predictability and managing the behavior of such a system for the medium- and long-term development period.

At the same time, any urban planning system, as a stochastic social community, requires the widespread use of the principles and methods of proactive, institutional and participatory planning and management. Numerous theoretical and practical works have dealt with this area, where issues of applying informatization and digitalization technologies are of particular importance. Urban planning information platform can be an ideal mechanism for goal-setting, forecasting, and implementation of the sustainable development of space based on the digital democracy principles. Such a platform
should serve as the basis for proactive planning, design, and management, taking into account the interests of residents, business, scientific and public institutions, as well as the task of creating a comfortable, safe and landscaped living environment.

The obtained results of the study show that the transition to advanced digital and smart technologies has become one of the main priorities of global scientific and technological development. Such development should be focused, inter alia, on the improvement of the theory and practice of spatial planning and managing the sustainable development of urban planning systems. In this case, the main tasks of design are to ensure the independence and competitiveness of cities and regions, taking into account their wide international cooperation, increase resources in the interests of the present and future generations, develop the information environment, culture and new technologies, improve the mechanisms to stabilize population growth and eliminate threats. An important tool in the successful solution of the set tasks may be the urban planning information platform based on the “digital twin” of the spatial system of each of the hierarchical levels of planning and management, from the planning unit to the cross-boundary scale.

3. Conclusion
As a result of this study, we have established that the introduction of the urban planning information platform, including the model of the “digital twin” of a spatial system, is an advanced and promising tool for territorial and spatial planning, design and development of the urban planning system of any hierarchical level. Such a platform allows us to successfully monitor, analyze, and model the development, taking into account the automation and intellectualization of these processes. At the same time, the technologies of digital forecasting, programming, and designing the development of an urban planning facility allow us to determine its probabilistic development both for the short-term, medium-term and long-term prospects. These technologies are focused on the effective use of initiative, institutional and participatory planning and management, taking into account the improvement of the living standards of the population and the optimal ratio of state, public and private interests. It is essential that they take into account and develop the traditions of urban planning culture in the practice of urban planning and design.

The technology of the urban planning information platform allows us to integrate and aggregate the principles and methods of different urban planning and sector-wide planning approaches. The promising directions and approaches of the spatial organization of the urban planning system based on the urban planning information platform are strategic urban planning, modeling the graphic identity of the territory and master planning, taking into account digital information systems and information and communication technologies.

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