Monitoring of the development of urban areas with the use of information technology

Pavel Kagan^{1,*}

¹Moscow State University of Civil Engineering, Yaroslavskoe shosse, 26, 129337, Moscow, Russia

Abstract. This article describes the concept of building the technology for analysis and monitoring of urban development. It validates the relevance of creating such a technology. Parameters that affect urban development of city zones have been systematized. Important point of consideration was given to the ecological, social, economic, architectural and aesthetic factors that influence the development of urban zones. This developing technology for analysis and monitoring of urban development will enable the forecasting and planning for complex urban development of regions, depending on the existing context. It will also help control the implementation of targeted government programs in each municipal district of a city, through the use of automated generation and evaluation of operational and projected metrics.

1 Introduction

Unregulated growth of cities brings about the changes in land use in urban areas and suburbs around the world. Population increase leads to the uncontrolled growth in urbanization levels, while the infrastructural adequacy falls behind. In the last 50 years, the world has seen a steep increase in the number of city dwellers. The level of urban population was higher than that of the rural population in 1997, and is expected to reach 5 billion people by 2030. Important is the fact that this tendency mostly applies to the developing countries, where the urban territories are expanding significantly and the number of metropolitan centers is increasing. Improper use of urban land leads to environmental degradation, road congestion, shortages in city services, utilities and other consequences. Continuous monitoring of ongoing changes will help understand the dynamics of various spatial and temporal indicators for the effective management of urban development.

Modern-day Moscow is one of the world's most densely populated cities. Moscow is a large international center, with high levels of scientific research, education and culture. One of the most important challenges for city management is the imbalance between slow development of civil infrastructure, transportation, social services and the rapid growth in construction of commercial and residential real estate. To solve this problem, the Moscow government is implementing a number of public programs with different directions. The success of such programs largely depends on the coordination of activities by all involved participants. Systematic monitoring of the planned measures and their results is needed

* Corresponding author: kagan@mgsu.ru

because it will help improve the quality of life by supplying residential areas with all necessary social and transportation infrastructure. In this regard, it is important to pay special attention to the effectiveness of the current ongoing programs, specifically to its essential elements, such as:

- generation of operational and projected indicators;
- development of automated projection methods and methods of managing investments and construction;
- creation of an integrated control system for monitoring the implementation of the public urban development programs.

2 Literature review

Today, many different specialists deal with the challenges of urban development, offering modern solutions applicable within specific industries. For example, in one paper, the authors suggest their own unique strategy for restoring historic sites using elements of “green” architecture [1-5]. Kirnos V. M. and Kravchunovskaya T.S. [6-9] point out the organizational and technological factors that affect the complex reconstruction of residential areas. In an article about architectural and structural potential of real estate objects [10, 11], they coined the term “architectural-constructional potential of a real estate object”. The authors suggested this term as an indicator that can be thought of as an instrument for effective property management during restoration, renovations, and sale of real estate.

During the progress of the work, it is planned to conduct analysis of general principles of urban development in different areas of the city, in the context of municipal districts, using the materials created with:

- geoinformational technologies;
- aerial surveys;
- thermal-imaging research;
- development models for areas of the city;

Area of research is concentrated on the territory development modeling [12-19], taking into account the functional assignments of these territories, using methods of remote probing.

3 Materials and methods

Taking on consideration the theoretical and practical inventions in this field of research, the analysis of current urban development situation should take into account the influence of the following:

- ecological factors;
- social factors;
- economic factors;
- architectural and aesthetic factor.

Ecological factors manifest in the existing housing not adhering to the requirements of proper sanitary and hygienic standards, and also to the requirements of environmental protection. Modern conditions of ecological situation require new decisions for the most essential matters: creation and maintenance of clean environment for human population; separation of residential zones from industrial territories where the operations don't comply with proper health standards; establishment of sanitary protection zones; recycling of the waste produced by both production and consumption activities.

Social factors include inadequate levels in supply of social and welfare services to the city population. This condition is usually a prerequisite for starting the analysis of the current situation and finding solutions to eliminate the occurred disproportions.

Economic factors are determined by the imbalance between the amount of newly constructed residential housing and the modern standards of functionality, convenience, and housing safety.

Architectural and aesthetic factors manifest in the lack of comprehensive approach to architectural organization of urban environment and the need for preservation and rational use of historic and culturally valuable objects of existing real estate. For many residential districts, raising the standards of public services and amenities is an urgent problem.

Based on the discussed above factors, it is possible to systematize the parameters that influence the development of urban territories. The basic groups of such parameters are:

- improvement of housing conditions;
- sufficient levels of utility and infrastructure supplies;
- development of road and transportation networks;
- development of social services system;
- modernization of amenities.

Taking into account these parameters that determine the comprehensive development of city territories on every stage of planning (including during the pre-project and investment research stages) will allow for making rational and economically effective decisions that will facilitate the development of both separate urban areas and the city as a whole.

The main goal of this research is to develop a technology for analysis and monitoring of the urban development on city territories. The suggested technology implies the establishment of an integrated system of control in the field of urban development. Integration of information collected from different participants of investment and construction process will help in projection and planning for comprehensive urban development based on current situation.

The developing data collection and analytics web portal for urban development will aid in solving such matters as:

- evaluation of an area's investment potential;
- analysis of existing conditions and projection of the potential burden on social and transportation infrastructure of the district;
- automated information support for implementation of the government programs in the context of municipal districts;
- remote access to the attributes of a municipal district and projects under construction through the use of appropriate Internet resources.

Currently, there are targeted programs for integrated development of administrative regions that contain detailed descriptions of current conditions and prospective development plans for territories in the region. The development of such documents aims at coordination of government programs in the cities and creating consensus between municipal management and industry interests. The manifest of the targeted program presents the main goals, tasks, result indicators and expected outcomes. It also presents stages and the timeline of implementation and describes the overall amount of funding.

Similarly, it is suggested to develop manifests for urban development of administrative regions. For this, the analysis has been conducted for existing programs of integrated development, the websites of prefectures, and also proposed and published programs and concepts for social and economic development. For example, the programs and concepts for administrative region development reflect the aspects of social and economic activity on the territories of the region. Programs of integrated development of administrative regions illustrate confirmed plans for construction (reconstruction) and projection in various industries, omitting mutual interconnectedness and influences. The common disadvantage of these documents is the absence of adequate evaluation of current conditions and analysis of prospective advancements in urban development based on unique specificities of local territories.

The important part of research is determining the dynamics of area development with consideration for the forecast for future city development. Aside from this, in order to successfully manage the process of city planning, it is necessary to analyze it and create a model of its influence on future urbanization.

In this framework, the following methods of research can be used:

- modeling of the dynamics of city development (using satellite imagery and geoinformation systems);
- analysis and planning of management activities that will facilitate integrated development of all city systems.

In large cities, many informational and analytical systems are currently in use, independent from one another. The data from such sources reflects indicators and components that are specific for its managing authorities.

This lack of coordination between these data sources leads to incoherence of decisions made in both the investment and construction activities, and the process of civil development.

4 Results

Establishment of a unified monitoring system for the development of urban territories (Fig. 1.) will provide an opportunity for continuous control over urban development activities in a city. The innovation of the suggested system lies in its complete representation of city information made possible by using wideband data lines for the integration of existing information systems. It also provides an opportunity for remote access with the purpose of both information review and direct data processing. Establishing access to an integrated system of storage, processing and exchange of data with various content will help avoid using false information and making incoherent decisions. Availability of valid source information about a developing area can help achieve higher quality results in investment and construction projects.

The stages for establishing such a system include the collection, analysis and processing of source insights, and rendering of data analytics. Integration of diverse information from different sources will provide necessary indicators and parameters in a unified, structured form. Using methods of statistical analysis, forecasting, qualitative and quantitative methods for decision making is the base for creating recommendations for correction of current projects or for rendering projected outcomes of area development. Further, the information model can be created to represent the interconnectedness of data that flows from the sources to the end users. Databases of various municipal and city services can be used as information sources. The end users can be the specialists working on urban development projects as well as potential investors and contractors.

Fig. 1. Concept scheme for the functioning of the integrated monitoring system for the development of city territories.

5 Discussion

The suggested structure of the data analytics portal will allow for the combination of allocated resources which will help create integrated information supply for the planning, control and implementation of urban development processes on city territories. The structure of this web-portal represents the integration of related blocks that are aimed at providing the user with relevant and valid information about city areas. The main principle of the web-portal’s work is organizing the interactive activity of the users and remote access to the needed information as well as providing the opportunity to obtain comprehensive data represented in various media forms. Implementation of modern interactive technologies into the web-portal will put into effect a new form of interaction between participants of investment and development process in a city. Also there is an opportunity to provide the general population with the objective and comprehensive information about city areas with regards to social infrastructure, environmental safety, and other factors that affect the wellbeing of city inhabitants. The discussed web-portal can be created with Microsoft InterDev and Microsoft FrontPage, using such technologies as ASP, ADO, XML, Microsoft Indexing Service on the Microsoft Windows Server and Internet Information Server platforms.

6 Conclusions

The developed methodology is based on the unified system of control in the field of urban development and aims at solving such contemporary challenges as:

- control of city-planning documentation development;
- analysis of existing situation and projection of the potential burden on an area’s social infrastructure;
- automated information support for implementation of government programs in the context of municipal districts.

The use of suggested technology will help achieve the goals of the research and set in action the established objectives. The integrated control system in the field of urban development will allow to control the implementation of government targeted programs in each municipal district of the city by employing automated collection and evaluation of operational and projected metrics.

References

1. I.V. Dunichkin, A.V. Volodina, *Industrial and civil construction* **3**, 48-50 (2011)
2. O.I. Poddaeva, I.V. Dunichkin, O.A. Kochanov, *Vestnik MSSU* **10**, 221-228 (2012)
3. I.V. Dunichkin, A.B. Volodina, *Vestnik MSSU* 1-2, 59-67 (2011)
4. P.K. Kalashnikov, A.O. Golovachev, R.I. Nadyrov, R.E. Potachin, E.A. Suverina, I.V. Dunichkin, *The 29th Asian-Pacific Technical Exchange and Advisory Meeting on Marine Structures*, 214-218 (2015)
5. I.V. Dunichkin, P.K. Kalashnikov, *Applied Mechanics and Materials* **713-715**, 205-208 (2015)
6. V.M. Kirnos, T.S. Kravchunovskaya, *Industrial and civil construction* **9**, 36-38 (2010)
7. A. Zheltenkov, A. Mottaeva, I. Kubrak, *Bulletin of the Moscow state regional university. Series: Economy* **1**, 6-10 (2017)
8. T. Kravchunovska, E. Zajats, S. Yepifantseva, *Bulletin of Prydniprov's'ka State Academy of Civil Engineering and Architecture* **11(176)**, 4-8 (2012)
9. V.I. Bolshakov, T.S. Kravchunovska, S.P. Bronevyskyi, *Bulletin of Prydniprov's'ka State Academy of Civil Engineering and Architecture* **5(218)**, 61-70 (2016)
10. V.G. Khaikin, S.V. Argunov, N.G. Starostina, *Industrial and civil construction* **10**, 9-12 (2011)
11. V.G. Khaikin, N.G. Starostina, *Industrial and civil construction* **12**, 8-11 (2011)
12. An. Mottaeva, As. Mottaeva, *Internet journal Science* **4(23)**, 131 (2014)
13. B.K. Pavel, V.G. Kulikov, *Applied Mechanics and Materials* **1**, 951-954 (2013)
14. A. Bolotin, V. Bakayev, *Journal of Physical Therapy Science* **29**, 1092–1094 (2017), doi:10.1589/jpts.29.1092
15. K.E. Anatolevna, K.P. Borisovich, *International Journal of Applied Engineering Research* **10(23)**, 43456-43460 (2015)
16. E. Korol, P. Kagan, T. Barabanova, *Applied Mechanics and Materials* **738-739**, 444 (2015)
17. A. Mottaeva, V. Lukinov, A. Mottaeva, *Strategy of Management of state and municipal ownership: theory and practice* (Moscow, MGSU, 2015)
18. P. Kagan, *Procedia Engineering* 25th., "25th Polish - Russian - Slovak Seminar Theoretical Foundation of Civil Engineering, 2016", 261-265 (2016)
19. A. Ginzburg, L. Shilova, A. Adamtsevich, L. Shilov, *Journal of Applied Engineering Science* **14-4**, 457-460 (2016)