

Urban Planning

DOI: 10.23968/2500-0055-2022-7-3-27-36

FAR EASTERN REGION: SUSTAINABLE DEVELOPMENT OF A LARGE CITY (CASE STUDY OF CHITA)

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Abstract

Introduction: The article considers competitiveness and sustainability concepts and formulates potential mechanisms of their relationship for a large city. In the context of globalization, the sixth wave of innovation, mass digitalization, and achievement of sustainable development goals, large cities are in a state of a constantly structurally changing system.

Methods: To ensure the realizable complex of their technical indicators, it is necessary to survey a city, which is achieved by the modern method of making a graphical-analytical model (digital twin). In the course of the study, we consider Chita, a city in Far Eastern Region, as an example of a large city. Chita has its own unique features and potential for development. To improve the indicators, some mechanisms of urban framework transformation are proposed, which set in motion all the levers of sustainability, which contributes to sustainable competitive development. **Results:** We elaborate stages of the technology of sustainable development of a large city of Chita in the conditions of Far Eastern Region, and provide recommendations for the development of new software for the actual city survey. **Discussion:** The final goal of applying the transformation technology is to bring all the levers of sustainable development, the functions of a large city, and competitiveness to united balance for the comfort of our and future generations, which corresponds to the main goal of sustainable development.

Keywords

Sustainable development, Far Eastern Region, large city, Chita, competitiveness.

Introduction

It is necessary to establish the framework of such concepts as sustainable development and large city as well as to determine the mechanism of their relationship. Sustainable development is, first of all, a model of moving forward, development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987). The strategy for sustainable development aims to promote harmony among human beings and between humanity and nature. Among those numerous researchers who studied sustainable development, it is worth noting *M. V. Shubenkov*. In his articles, the author defined sustainable development as a mechanism for ensuring the integrity of natural and anthropogenic systems (Shubenkov, 2020). A good urban planning system is one where social life is as diverse and intense as possible and the interaction of the urbanized environment with the natural environment is balanced (Shubenkov and Shubenkova, 2018). There are also descriptions of the concept of sustainable development of a small city, in which a model based on a minor intervention in its structure

but capable of reviving the uniqueness and viability of a small city, is accepted for consideration (Vavulin and Malaya, 2020). Vaytens and Shubenkov (2020) considered the problems of modern development of urbanized territories in Russia and proposed an urban ecology concept of development, which determines the opportunity of creating forms of urban structure that ensures balanced ecological exchanges of cities and settlements with nature. However, its implementation is hindered by the disinterest of the country's government at all levels, the almost complete absence of ecological culture in the population, and overall level of the economic development of the country. The problems of sustainable development of border cities were considered in various master's theses described in the article "Directions for the transformation and development of border cities in Leningrad Region (case studies of Ivangorod and Svetogorsk) in modern conditions" by Vaytens (2020). The goal of sustainable development strategy measures was to transform Ivangorod into a self-sufficient small border town that used various levels of cooperation with its foreign neighbor — Narva. The strategic priorities

of Ivangorod included transport, ecology, society, economy, and urban environment. Within each priority, the author formulated long-term development goals conducive to responding to one of the main challenges of the city — decline in population due to its migration.

There is an incomparably small number of studies on the issue of sustainable development of cities in Far Eastern Region, where the authors highlighted the main problems of development and research of the territories, such as fragmentation, narrowly disciplinary orientation, inconsistency, interregional and interdepartmental barriers, violation of the display integrity of the object of study, underdevelopment of a united database, lack of systemic interconnection throughout the “technological chain” from natural sciences to economics, inconsistency and incompatibility of the used parameters of the display of regional objects in their models, which are compiled for each scientific direction in the interests of one or another discipline. All these facts create serious obstacles to the effective scientific support of strategic assessments and forecasts of the rational system formation of the newly emerging region for its further sustainable development (Krasnopol'ski, 2018). Kalashnikova and Filippova (2019) described the inextricable connection between the sustainable socio-economic development of the Russian Far East regions and environmental situation and proposed decoupling calculated based on the use of the gross regional product, emissions of pollutants, and wastewater discharges as an express method of environmental assessment. The main corrective actions are related to the improvement of the legal framework

that ensures the operation of mechanisms to protect against undesirable environmental management; stimulating the introduction of advanced technologies and attracting private investment in the green production.

Any large city that represents a modern competitive system cannot exist productively without a sustainable development strategy. A large city nowadays is a large settlement with a population of 250–500 thousand people (Regulations SP 42.13330-2016). It has a developed complex of commercial units and economy. It is a cluster of architectural and engineering structures that ensure the vital activity of the permanent and temporary population of the city. Kazakov (2014) provided a review of different theoretical views on the concept of a large city and gave his own definition of this concept based on the studied materials: “a large city is a maximally transformed ecological environment with a high concentration of anthropogenic factors”.

Two familiar concepts represent a single mechanism where the concepts are connected with each other by common aspects: ecology, social sphere, and economy (Figure 1). In his article, Barsukov (2008) addressed the connection of these concepts: “sustainable development of a large city is ensuring the interests of city residents in the implementation of management activities, the best realization of human potential, achievements in social and economic development, minimizing the negative impact of economic and other activities on the urban system, and ensuring the effective use of all types of resources in the interests of present and future generations”.

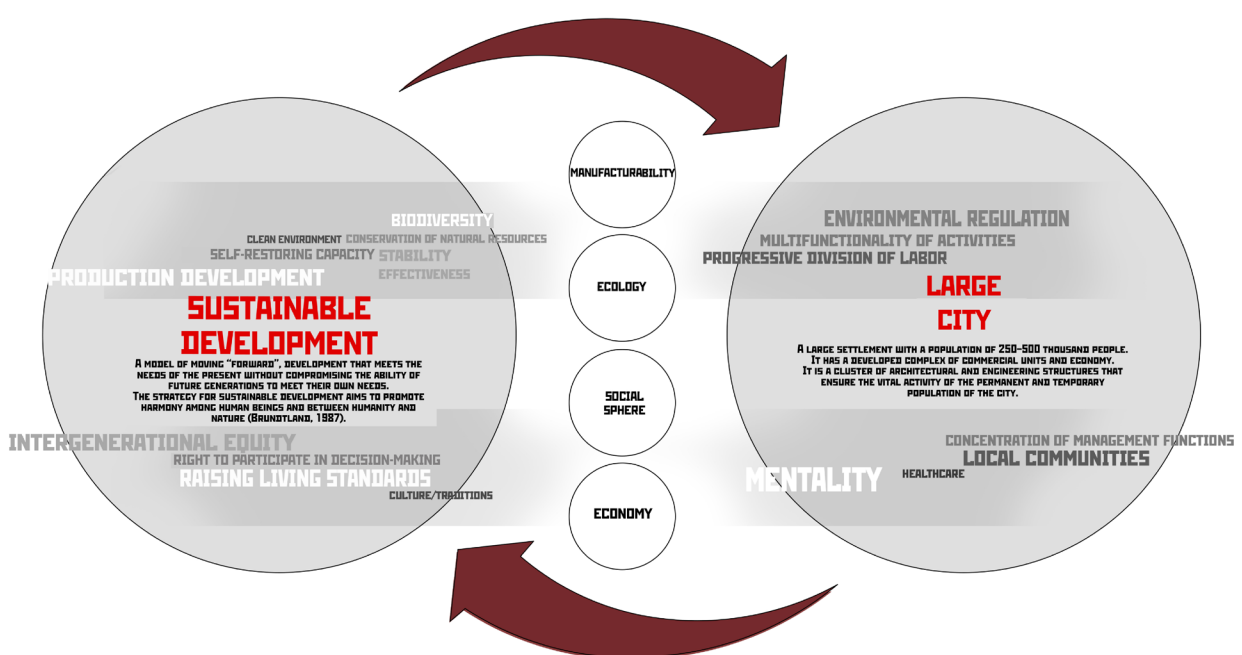


Figure 1. Scheme of the relationship between the concepts of sustainable development and large city

Cities that have a balanced set of these indicators are competitive. Starovojtov (2004) discussed the relevance of introducing competition between cities, leading to the activation of economic, financial, and human resources of cities, and provided directions in which competitiveness can develop. Bogomolova and Mashentsova (2015) presented their own method of classifying cities. This method includes a quantitative indicator — the number, and a qualitative indicator — functional affiliation, which makes it possible to visually systematize cities and identify the closest competitors, which, in turn, will allow to adapt the existing effective development models following the size and functions of the city and to build optimal strategies for sustainable development of territories in the long-term horizon.

The object of the study is Chita. It is a large city in Zabaykalsky Krai with a population of 351 thousand people. It also has its own characteristics: production capacity, environmental situation in the region, as well as the mentality of residents, which is one of the important indicators of the social sphere. Its closedness, due to the large number of military units and percentage of military to the civilian population, is a strong aspect and problem as well. Few studies that were conducted for Chita mainly concerned the environmental aspect and addressed the problems of gardening the city (Martynova, 2020), analysis of atmospheric air (Samoilov, 2021), and ecological solutions to problems of sorting and recycling of wastes (Stremilova, 2015). All studies relate to narrow indicators of the ecological situation, but a comprehensive survey of the state of the ecological environment of the city has not been conducted (Kanga et al., 2022). Chita, as a historical city founded in 1653, has historical value, which implies the potential for development of a tourist cluster (Bolshakov and Gladysheva 2014). It is a huge recreational resource, which, in turn, can also be an object of attraction for rehabilitation. Its use can be expressed in figures as well: which operating resorts are in Chita and which need reconstruction, suitability of beaches, rivers, and lakes for vacationers, number of landscaped areas, to calculate the characteristics of the ecological framework for the spatial organization of settlement in Chita and the surrounding area (Dangi and Petrick, 2021).

Relevance

In the context of particular geopolitical events, the potential of the import substitution strategy for products and some services provided from abroad has become a priority: it is necessary to develop existing industrial capacities, preserve the potential available in all areas and develop new industries, which is possible using the post-industrial heritage of the regions. Currently, the Russian Federation is unevenly developed geographically, the influence of the predominance of the western part over

the eastern remains, as a result of which the concentration of high technologies, highly qualified personnel, and maximum comfort of essential services are pertaining to the capitals and nearby cities. A similar situation developed after the era of Fordism in Detroit (Perez, 2012). At the same time, Siberian Federal District and Far Eastern Region are territories lagging behind the western part of the country, therefore, the problem of population outflow naturally arises in the cities of these regions, which negatively affects migration processes in general. However, at the same time, the territories of these regions are rich in recreational and industrial resources, have historical value, therefore, with the use of some methods of leveling the urban environment, the potential of the eastern regions will become more expressed and receive its proper development to ensure a more competitive country with its own knowledge-intensive production. No studies concerning the integrated development of all indicators of sustainable development, as well as no working action plan to bring these indicators and individual characteristics of the city to a single balance, have been conducted for Chita.

Purpose of the study

We aim to elaborate the stages of the technology of sustainable (competitive) development of a large city in the conditions of Far Eastern Federal District (case study of Chita). A technology is a set of methods and tools to achieve the desired result, usually through stages or with a clear sequence of actions. This technology is being developed for cities of the Russian Federation with a population of 300–400 thousand people, for which the problem of population outflow and general situation of stagnation or regression of the city, or the predominance of any industry over the rest is relevant. The main **objectives** of the study are to conduct graphical-analytical analysis using software, elaborate stages of the sustainable development technology, as well as identify tasks for the development of necessary software for the survey of the city.

Methods

What is the concept of competitiveness? Competitiveness is one of environmental factors, and the most important is the requirement for a modern city. The concept can be divided into competitiveness within the country and competitiveness at the global level. In order for competitiveness to reach its maximum, there are some aspects that characterize it and also have some of their own indicators. The most important aspect is essential services, which implies the creation of modern infrastructure for the city's population. This implies maintaining existing production capacities, improving the set and quality of public utilities and public sector services, and reducing prices for them. Responsible and effective urban management has a direct impact on all aspects, its development requires increasing

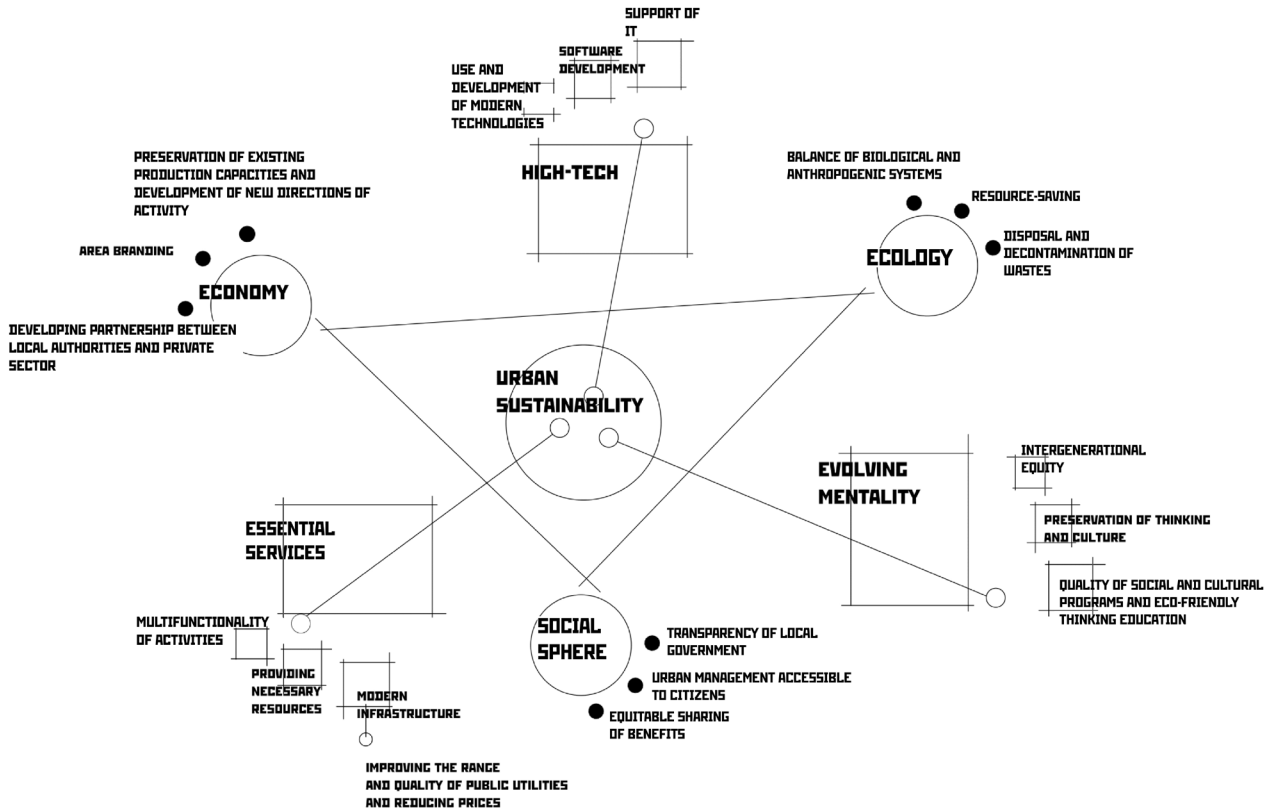


Figure 2. Scheme of competitive indicators of development sustainability

the openness of local authorities, developing partnerships between local authorities and the private sector, and using the best practices of urban management. One of the engines of the city’s development is the attraction of domestic and foreign investments, implying public and private partnership. The concept of development sustainability, in turn, is represented by three main indicators: ecology, economy, and social sphere, which are supported by high-tech, preservation of ecological thinking and productive essential services for the system. The combination of these indicators makes it possible to calculate and express in numbers the states of these spheres for the selected object of study. In the conditions of modern reality, in the context of high technologies, this approach has a high relevance, which implies the need to develop software for automated calculation of such indicators (Figure 2).

The indicators will be applied to a large city, which is a whole system consisting of management, economy, ecology, social sphere, and essential services. This system should work as a balance, primarily for the comfortable living of residents and for the benefit of future generations. Hence, a paradigm arises: to achieve a set of technical indicators of sustainability and competitiveness, an in-depth survey of the city is required (Heinrichs, 2021).

What methods can be used to survey the city, in addition to full-scale, photographic, graphical-analytical, and statistical ones? The most relevant

method is the construction of graphical-analytical models of cities with the introduction of some of the studied indicators. For this purpose, existing software packages such as QGIS, Grasshopper, and SpaceSyntax are used. With the introduction of indicators of population, production capacities, recreational resources, development of the territory, and their various functional uses, the graphical-analytical model itself changes, and we can clearly see how the indicators affect the development of the city, and find the right balance in percentage terms for uniform sustainable development.

As mentioned earlier, Chita has its own individual characteristics associated with the closedness of some planning structures of the city, prevailing evolving mentality, formed territories of religious and economic purposes, valuable architectural historical environment, and the border position relative to China. Such indicators should be taken into account when surveying the city to obtain an actual comprehensive assessment of the city’s state. QGIS software package was used in the graphical-analytical research method. The first layer of the constructed city map is the “building” layer, which shows the functional purpose of buildings and structures. This layer does not work correctly since it does not show all buildings or have up-to-date information. The indicators characterizing the individual characteristics of the city are not taken into account in the subsequent available layers of the

simulated digital map. After building a digital model of Chita, it was supposed to study the indicators of the territory using the Openstreetmap service, which became impossible due to the conditions of some geopolitical events. This proves the priority of the development of the strategy for import substitution of products and some services provided from abroad: the necessary development of IT sphere, development of its own modern technologies as well as architectural and urban planning software complexes.

Results and Discussion

The first stage of the urban framework transformation technology is a survey of the city, which includes an in-depth historical and genetic analysis, which makes it possible to identify the discrepancy between the urban environment quality index (an already developed tool with 36 indicators) and the actual state of the set of indicators aimed at implementing the concept of sustainable development. Such indicators include: the number of reference points of sustainable development both in architectural and planning, volumetric and spatial, as well as in social, economic, environmental context; the number of implemented social and cultural programs, their qualitative state and potential of spatial and temporal development; and others (indicators and criteria generally relate to external and internal competitiveness of the urban environment of Chita) (Urban Environment Quality Index, 2021). Based on the totality of the obtained indicators, it is necessary to proceed with the second stage of the transformation technology, which includes the development of an approbation model by means of simulation modeling with subsequent verification. The approbation model is variable and essentially a mechanism for transforming the urban environment. They can be economically regulated mechanisms, as well as planning mechanisms for

leveling the urban framework, social, and aimed at regulating the ecological state with the subsequent development of eco-thinking and eco-potential (e.g., by means of eco-tourism), as well as including criteria for the preservation of industrial and historical heritage (Gulotta and Toniolo, 2019). The third stage includes the development of original software complexes, which are the prism of activation of connections and components, which will serve as the basis for innovative technology formation for the real transformation of the urban environment (Borovikova, 2019). It is worth noting that an important stage, from the ecological side, is the screening of communications since the city has a historical core, therefore, it is very important to connect water-soil purification and subsequently replace existing communications with more environmentally friendly methods of water treatment systems.

All three stages of the transformation technology work together, and for each city the technology and the sequence of stages will be unique (Figure 3).

Based on the research results obtained by the method of constructing a graphical-analytical model, it can be concluded that it is necessary to develop software that is both a method of surveying the territory and a mechanism for transforming the urban framework (Cappai et al., 2018). New software will meet modern software requirements (convenience and clarity for users, security, completeness, consistency, satisfaction of all necessary needs, etc.). First of all, the developed software should contain the following functions:

- display of zones of urban planning regulations for construction;
- analysis of the need to build kindergartens, schools, and transport stops following the accessibility for the nearest residential areas;
- display of current routes between locations, construction of the shortest path (for pedestrian,

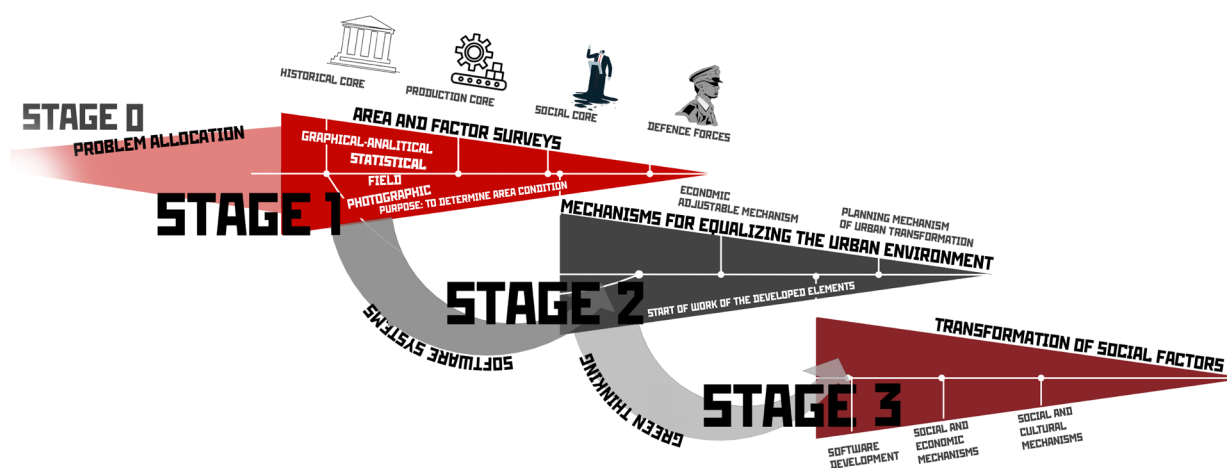


Figure 3. Stages of the urban framework transformation technology

automobile, and public transport);

- analysis of the height and compositional placement of construction facilities, the possibility of voting and making proposals at the concept stage;

- up-to-date, high-quality, and realistic data on the survey of the city's state: buildings, parks, recreation areas, infrastructure (the use of flying drones);

- open general urban plan, developed master plan;

- the state of the transport infrastructure, the quality of roads, current parking places;

- clear disclosure of planning projects for a citizen who is not involved in architectural and urban planning concepts;

- terrain data;

- weather and climate data interactively in real time;

- current population and density data (dynamic map of concentration points);

- data on monitoring the environmental situation and active actions for volunteers to improve the quality of the urban environment;

- the opportunity to edit and add new information for users of different social components, which will provide a constant update of data about the city;

- the opportunity of voluntary replenishment of the city's fund for beautification (charity, creation of a fund to improve the quality of urban infrastructure);

- communication with the main Internet information resources (Chita.Ru, Podslushano Chita, Zab.Ru);

- a tab about social programs and cultural events, the opportunity of creating an event and registration;

- the opportunity of open communication with local authorities;

- feedback in applications and software complexes should be built with the principle of stimulation;

- support Initiatives tab for entrepreneurs (to support small businesses, a user can post the project and request support from both local authorities and users on a voluntary basis);

- a social and cultural program for the education of children through involvement in the game process (virtual walk around the city and search for artifacts that tell the history of the city, sights, opportunities. Communication with social media accounts for accrual of points, votes, OK);

- assistance to retired and disabled people (Services tab, where a user can write about the necessity for support).

The opportunity of using the software should be implemented both on a personal computer and in an application for a smartphone. The application, as well as its interface, should be accessible and understandable to each category of users (Figure 4).

In his article, Barsukov (2008) suggested a similar review mechanism of city management "management for the interests of city residents",

which consists in transforming blocks of interests of residents (taking into account the order of their implementation, and within the framework of the provisions of the sustainable development theory about the limitations and necessity of reproduction and conservation of resources) into a system of goals and objectives of city management bodies.

The development of the technology for the transformation of the urban framework is the main and relevant tool for ensuring sustainable competitive development of the country in general. The stages of the technology are a variable mechanism that can change depending on the object (city) of application. The final goal of applying the transformation technology is to bring all the levers of sustainable development, the functions of a large city, and competitiveness to united balance for the comfort of our and future generations, which corresponds to the main goal of sustainable development.

Conclusions

The main conclusions based on the results of the study include the following: 1) it is advisable to conduct a survey of settlements remote from the center on the basis of regional architectural and construction research organizations, which will largely take into account the regional peculiarities of the place and preserve them; 2) the context of digitalization and post-industrial development of the urban environment determines the need to add the key of technology to the three main keys of sustainable development; 3) the totality of existing programs does not always have a positive effect on the real transformation of the urban environment due to the lack of transparency mechanisms and the adjustment of such programs adequate to modern requirements; 4) modern means of simulation modeling (Information System Designed for City Planning, ISOGD) do not fully provide an understanding of the real state of the territory, which leads to the need for the development of applications, software, and software complexes; 5) potential competitiveness, as a rule, will consist of positive indicators of the economic, environmental, and social aspects of an architectural and urban object (in particular, a city), which is one of the key mechanisms for determining the sustainability of the object's development. It follows from this that the development of the stages of the sustainable development technology for a large city should be carried out taking into account its regional peculiarities, as well as in the context of high-tech with the development of software necessary for the survey of the city territory and transformation programs. In the context of the development of the smart city technology, the tightening of the use of the Information System Designed for City Planning (ISOGD), the creation of the National System of Spatial Data (NSPD) (in fact, the registry) as general requirements for software, the following can be

MATRIX OF CONVERSION PROGRAM USERS

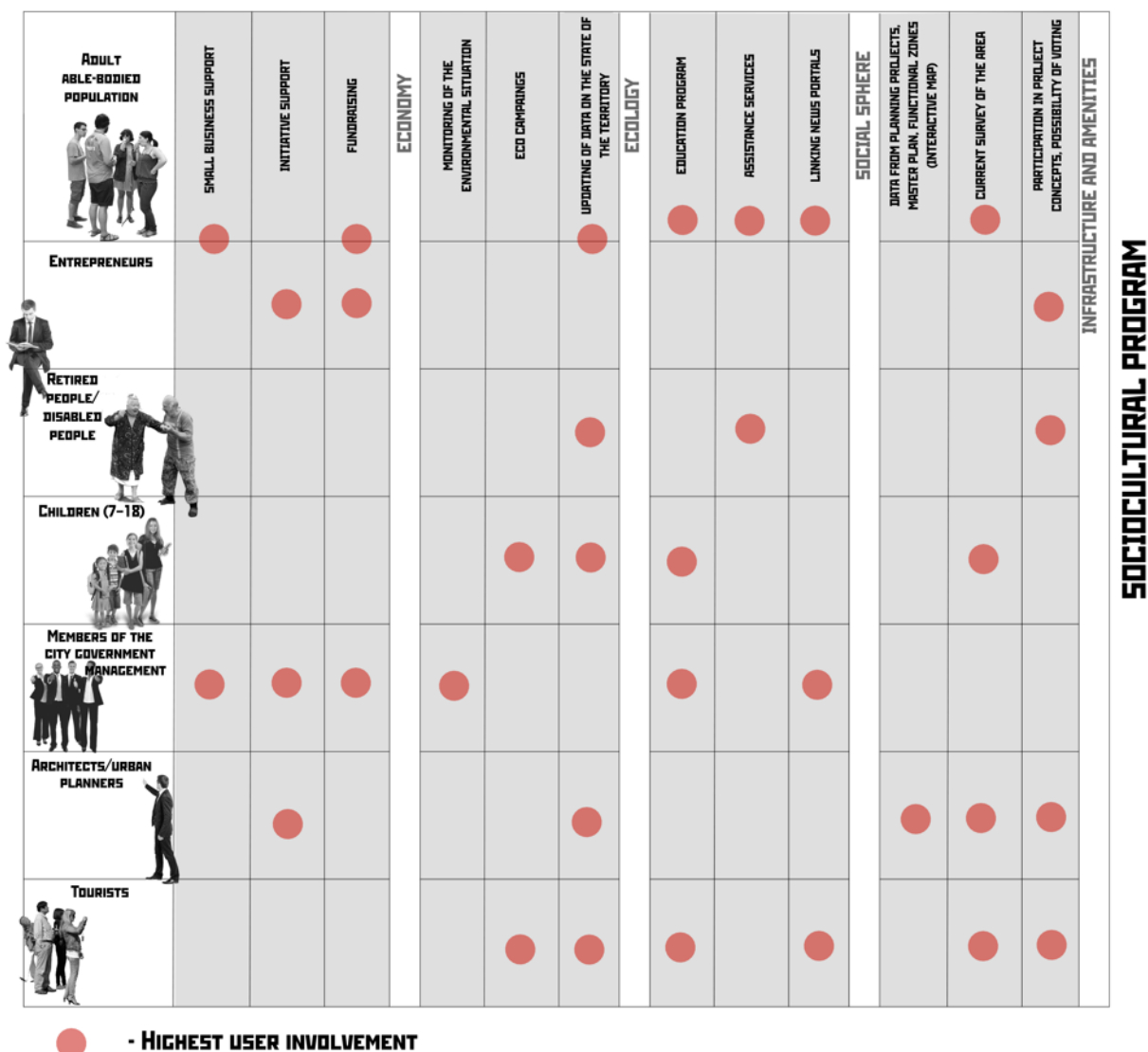


Figure 4. Matrix of conversion program users

designated: 1) maintaining the layering of GIS tools; 2) using Openstreetmaps-type open data; 3) the presence of machine learning or artificial intelligence elements in the software structure, which is primarily associated with a large amount of data processing; 4) using server or cloud data storage technology; 5) using CAD or BIM resources; 6) potential consideration of ISO-standardization of CIM (City

Information Model) and PIM (Planet Information Model); 7) use of data processing engines implying the output of information in XML format; 8) development of a shell accessible to both non-professional and professional users; 9) availability of a resource (WEB or Mobile) for organizing feedback (as an example, open master plans, when a citizen can offer the idea or make certain changes).

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ДАЛЬНЕВОСТОЧНЫЙ РЕГИОН: УСТОЙЧИВОЕ РАЗВИТИЕ КРУПНОГО ГОРОДА (НА ПРИМЕРЕ ГОРОДА ЧИТА)

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Аннотация

В статье рассматриваются понятия конкурентоспособности и устойчивости развития, а также формулируются потенциальные механизмы их взаимосвязи для крупного города. В условиях глобализационной политики, шестого технологического уклада, массовой цифровизации и достижения целей устойчивого развития, крупные города пребывают в состоянии постоянно структурно-изменяющейся системы. Для обеспечения реализуемой совокупности их технических показателей необходимо обследование города, которое достигается и современным **методом** построения графоаналитической модели (цифрового двойника). В качестве примера крупного города рассматривается город Чита в Дальневосточном регионе. Город Чита имеет свои уникальные особенности и потенциал к развитию. Для повышения показателей предлагаются некоторые механизмы преобразования городского каркаса, которые приводят в движение все рычаги устойчивости, что способствует устойчивому конкурентоспособному развитию. **Результатом** исследования является разработка этапов технологии устойчивого развития крупного города Чита в условиях Дальневосточного региона, а также приведены рекомендации для разработки нового программного обеспечения по актуальному обследованию города. **Обсуждение:** Окончательной целью применения технологии преобразования является приведение всех рычагов устойчивости развития, функций крупного города и конкурентоспособности к единому балансу, в котором будет комфортно проживать наше и будущие поколения, что соответствует главной цели устойчивого развития.

Ключевые слова

Устойчивое развитие, Дальневосточный регион, крупный город, город Чита, конкурентоспособность.