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Clusterization and algorithmization of conflicts within the framework of integrated territorial development

It has been established that the integrated development of territories is the basic direction of the construction industry. The main goal of this state programme is to improve the quality of life of citizens, renew and develop the urban environment based on the principles of sustainability, increase the efficiency of using territories and solve problems with emergency housing. There are many problems associated with the implementation of investment projects, including social, organizational, communication, financial, and regulatory risks. The imperfection of the mechanism of integrated territorial development leads to a multitude of conflicts that require classification, analysis, and management measures to resolve them. To do this, a system should be developed that allows the use of machine algorithms, that is, an automated conflict classifier. To this end, algorithms for typing and clustering conflict situations have been developed based on hierarchical analysis and spatial clustering based on hierarchical density, taking into account noise. Hierarchical analysis creates a tree-like structure of clusters, which can help, if necessary, create a common structure of information about projects and contradictions that have arisen. Density clustering allows you to determine "conflicts-departures" and is necessary for analyzing the internal structure of groups of typical conflicts. In addition, using a system of weights, a method is proposed for determining the integral assessment of significance, that is, the degree of influence of contradictions on the implementation of the project.

Keywords: *complex development of territories, investment and construction project, risks, conflict, clusterization, hierarchical analysis, spatial clusterization*

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The integrated development of territories (hereinafter referred to as the IDT) has long been part of state policy, but it was legally enshrined in the Urban Planning Code of the Russian Federation (hereinafter referred to as the UPC RF) by Federal Law as Chapter 10 of the UPC RF[1]. This process makes it possible to involve various degraded territories in economic activities with the most modern infrastructure [1].

The main goal of the IDT is to improve the quality of life of citizens, renew and develop the urban environment based on the principles of sustainability, increase the efficiency of using territories and solve problems with emergency housing. Within the framework of the IDT, new urban areas are being formed on the basis of integrated urban planning plans, which provide not only for the construction of new residential buildings, but also for providing citizens with access to newly built social facilities, i.e. schools, clinics, etc. the goals of integrated development of the territory. These processes involve not only budgetary, but also private financing sources, as well as experienced developers who implement development projects together with municipal and federal authorities. It should be noted that a single IDT mechanism operates throughout the Russian Federation, providing for the demolition of dilapidated housing and the construction of modern apartment buildings in these territories, and the resettlement of citizens in more comfortable conditions [2]. Representatives of the construction industry and the Government of the Russian Federation consider IDT projects as the most promising mechanism for urban renewal. For example, Irek Fayzullin, Minister of Construction and Housing and Communal Services of the Russian Federation, noted that the regions plan to apply IDT in more than 1,200 territories. In turn, Marat Khusnullin stated that the implementation of the national project "Infrastructure for Life" is aimed at the integrated development of at least 2 thousand settlements, and 120 billion rubles will be allocated for the implementation of the IDT projects [3]. The success of the implementation of the IDT projects is shown in Fig. 1. The diagram shows a steady increase in all indicators, an increase in the number of approved documents, and the expansion of territories involved in integrated development projects. The number of regions where the IDT is being implemented has also increased.

Thus, IDT is the flagship of the development of the construction industry, however, it is necessary to note the numerous contradictions in the mechanism of its implementation, which lead to various organizational conflicts [4]. This problem is related to the inevitable risks of the IDT programme, which are shown in Table.

Scientists investigating this problem list the bottlenecks of the legislative framework and the IDT method. For example, A.G. Vyazov in his work [5] indicates that "the decision to apply the IDT regime to a certain territory can be made regardless of whether such an area is intended for IDT in accordance with the rules of land use and development". The author also points out the lack of clarity about what percentage of the territory planned for IDT should be occupied by dilapidated and dilapidated housing in order for an informed decision on the project to be made. Other authors also point out the various disadvantages and risks that exist in the framework of the implementation of IDT projects [6–8].

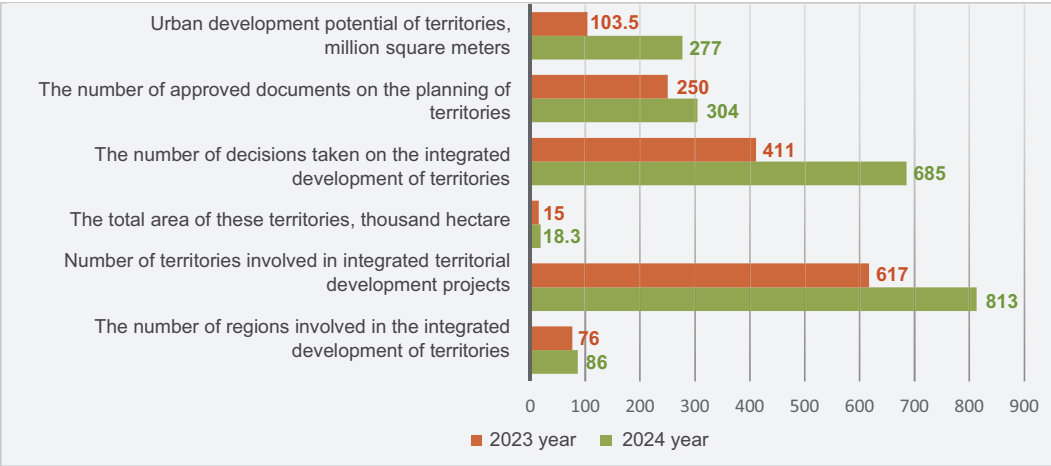

Fig. 1. Indicators of IDT projects in Russia for 2023–2024

Disadvantages and risks of the IDT programme

Social	Organizational and communication	Financial	Regulatory and legislative
• unwillingness of citizens to change their area and place of residence; • potential violation of the rights of citizens (1/3 of the owners) who voted against at the meeting on the issue of the inclusion of an apartment building in the IDT project; • lack of access of citizens to the territory where the IDT project is being implemented; • the risk of socio-economic displacement of the poor from a developed area; • the risk of unequal housing replacement, insufficient compensation	• delays in project implementation, postponement of construction dates; • poor interconnection of project stakeholders	• understatement the estimated cost of an apartment in a demolished building; • lack of project financing; • rising real estate prices, especially in economically developed regions; • instability of the real estate market due to the implementation of the IDT project and the uncertainty of the final cost per square meter of housing; • the risk of uneven development of IDT (in some regions, IDT is realized faster than in others)	• the decision on the IDT project can be made regardless of whether such an area is designated by the rules of land use and development; • there is no mixed-use development in the list of IDT territories (one of the most common forms); • the absence of a law on public-private partnership in the implementation of decisions on IDT; • obligations of investors to build social facilities; • weak investor protection; • it is not possible to determine all the essential terms of the IDT agreements at the time of conclusion; • the need to commit to projects that have not yet been formed, there is no approved documentation on the planning of territories and the final price at the stage of concluding contracts

A significant list of conflicts requires their systematization, analysis using machine mechanisms, automation of conflict typing and the search for possible standard solutions [9–11]. The object of such research is the management processes of investment and construction projects implemented within the framework of the IDT, and the subject is contradictions, problems and conflicts in these processes.

As part of the formation of a conflict classifier with an automated selection of corrective actions in order to resolve contradictions, it is necessary.

1. Entering into the classifier information about implemented IDT projects and conflicts that arose during the implementation, decisions taken to eliminate contradictions.

2. Two-stage clustering of conflicts.

3. Entering information about a newly arisen conflict in the field of IDT into the classifier.

4. Classification (typification) of the conflict according to various groups of features with an integral assessment of the significance, that is, the influence of each classifying feature (according to the system of assigning weights).

5. Selection of a solution based on the data already available in the database, and further adoption of the selected measures.

The general scheme of the process is shown in Fig. 2, and the detailed algorithm is shown in Fig. 3.

The third stage is performed on the basis of hierarchical analysis and spatial clustering algorithms. Hierarchical analysis will create a tree-like structure of clusters, which can help, if necessary, create a common structure of information about IDT projects and contradictions that have arisen, that is, separate groups of typical conflicts. HDBSCAN (Hierarchical Density-Based Spatial Clustering of Applications with Noise) is a density–based clustering algorithm that finds clusters of different densities and noise in datasets. This approach allows you to identify “conflicts-crashes” that are too different from the others. This algorithm is necessary for analyzing the internal structure of clusters (conflict groups) [12–15].

Let's identify all possible signs of conflicts that arise during the implementation of integrated territorial development projects, including Y, and all feature groups are a subset of X, which belongs to the set $Y(X \subset Y)$. x_{ij} is the i-th feature of the j-th group of n-possible groups, ν_{ij} is the weight of each feature that belongs to the range of values from 0 to 1. Then the integral assessment of the significance of the conflict is determined by the formula:

$$ZK_{int} = \sum_{i=1,j=1}^{n} x_{ij} \cdot \nu_{ij}; \quad \nu_{ij} \in [0,1]. \qquad (1)$$

Entering a data array that contains information about construction projects that have already been implemented, organizational conflicts that have arisen during their implementation, causes and remedial measures, as well as the results of the measures taken

Conflict clustering based on hierarchical analysis with the formation of an external end-to-end dendrogram structure

Conflict data is structured and ranked according to any combination of features in a single tree (for example, a specific Russian region — the most frequently occurring conflicts in IDT projects for this region – causes of conflict – measures taken – result)

Spatial clustering of conflicts with detection of "crashes" based on hierarchical density, taking into account noise (analysis of the internal structure of clusters based on the HDBSCAN algorithm)

1. The density of the distribution of points within each cluster is determined (the typification of the conflict within the group is determined).
2. The hierarchy of clusters is being clarified in terms of their density levels.
3. The most stable clusters at each level of the hierarchy (groups of typical conflicts) are determined.
4. Data points, that is, conflicts that cannot be attributed to a stable cluster (group), are considered "crashes", that is, noise

Entering an array of data about a new conflict and analyzing the data

Comparison of the input information with the data-base	Conclusion about	Decision-making options
	1. The conflict belongs to existing clusters (groups). 2. Similarities with the existing "departure" (the beginning of the formation of a new cluster). 3. The complete atypical nature of the conflict (placed by the system as a new "departure")	1. A standard decision is made on a standard conflict. 2. Information on other "departures" is taken into account. If there is a similarity between the new data array and the parameters of at least one of the existing ones, a new cluster arises, that is, a new group of typical conflicts. The conflict resolution is formed taking into account decisions on a similar "departure". 3. The conflict is classified

Selection of a solution and adoption of selected measures to resolve the conflict

Fig. 2. Clustering and conflict typing scheme

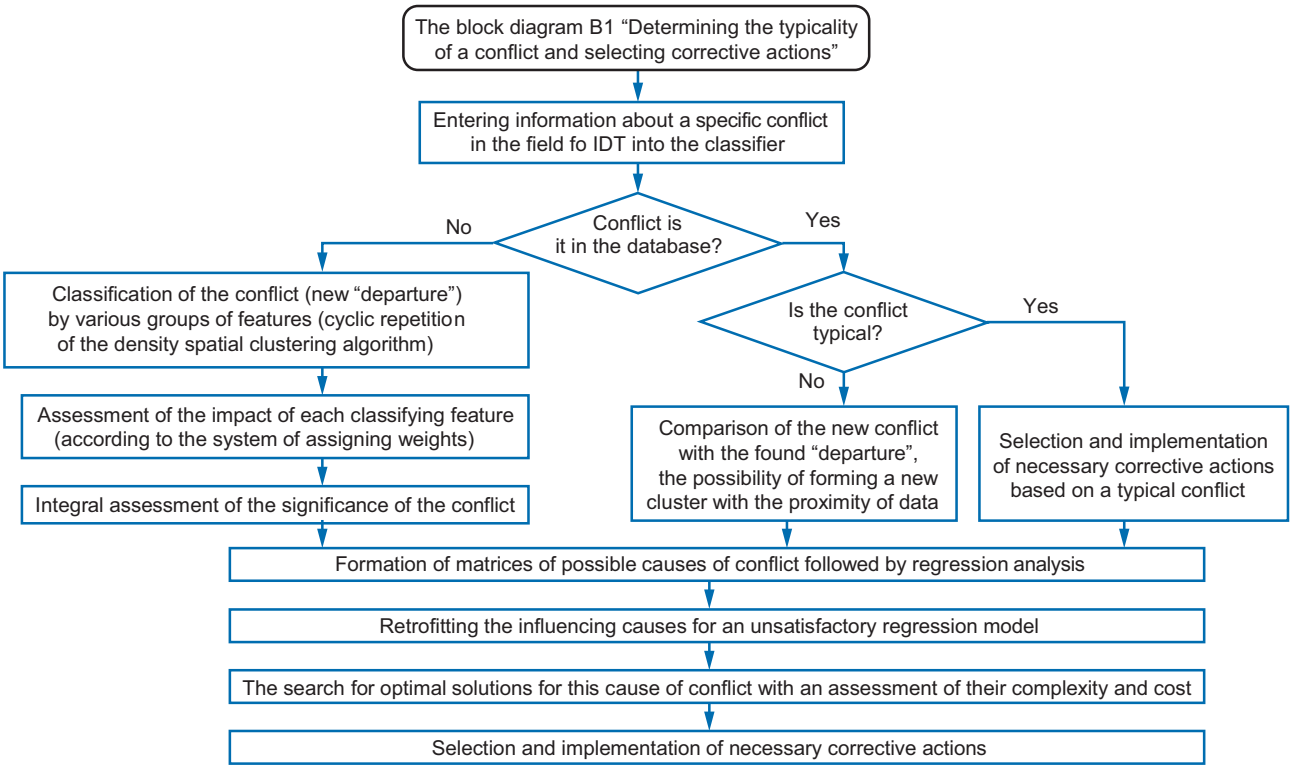

Fig. 3. The algorithm for determining the typicality of the conflict, the integral assessment of its significance and the selection of solutions

The selection of the solution is also carried out using machine methods and auxiliary algorithms.

It has been established that the integrated development of territories is the basic direction of the construction industry, however, in the process of implementing investment projects, many conflicts and contradictions arise that require classification, analysis and decision-making. Algorithms for classifying conflicts and a method for determining the integral assessment of significance, that is, the degree of influence of contradictions on the implementation of the project, are presented.

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Кластеризация и алгоритмизация конфликтов в рамках комплексного развития территорий

Установлено, что комплексное развитие территорий является базовым направлением строительной отрасли. Основной целью данной государственной программы является повышение качества жизни граждан, обновление и развитие городской среды на принципах устойчивости, повышение эффективности использования территорий и решение проблем с аварийным жильем. С реализацией инвестиционных проектов связано множество проблем, среди которых социальные, организационно-коммуникационные, финансовые и нормативно-законодательные риски. Несовершенство механизма комплексного развития территорий приводит к множеству конфликтов, требующих классификации, анализа и принятия управленческих мер с целью их решения. Для этого следует разработать систему, позволяющую применять машинные алгоритмы, т.е. автоматизированный классификатор конфликтов. С этой целью на базе иерархического анализа и пространственной кластеризации на основе иерархической плотности с учетом шума разработаны алгоритмы типизации и кластеризации конфликтных ситуаций. Иерархический анализ создает древовидную структуру кластеров, что может помочь при необходимости создать общую структуру информации о проектах и возникших противоречиях. Плотностная кластеризация позволяет определить «конфликты-вылеты» и необходима для анализа внутренней структуры групп типовых конфликтов. Кроме того, с помощью системы весов предложен способ определения интегральной оценки значимости, т.е. степени влияния возникших противоречий на осуществление проекта.

Ключевые слова: *комплексное развитие территорий, инвестиционно-строительный проект, риски, конфликт, кластеризация, иерархический анализ, пространственная кластеризация*

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