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GIS HCS: Analytical Capabilities of the Open Section of the System for Educational Purposes

The paper discusses and explores the possibilities of using the open part of the GIS housing and communal services information system, the section “Analytics and reports”, as a source of large reliable data and tools for working with them. The use of such data and work tools is important and relevant in the training of future specialists, the formation of their analytical skills with information. The purpose of the study is the possibility of setting and implementing analytical tasks for educational purposes based on real reliable GIS HCS data. During the research, the main features of the system were studied and the formulation of analytical tasks for educational purposes was proposed. The sections of the system “Technical condition of apartment buildings” and “Bringing management organizations to administrative responsibility” were used. One of the tasks is solved completely using the built-in tools of the platform, the other — regression analysis — using the tools of the table processor. The built-in tools of the open part of the GIS HCS “Analytics and Reports” allow to sort data, move from aggregated data to detailed data and back, supplement tabular data with graphical models, which makes working with information simple and understandable. The lack of the ability to export data from the system makes it difficult to use third-party applications for subsequent data processing. Solving this class of analytical problems allows students to gain skills in problem formulation, solution, and interpretation of the results obtained. The considered examples of analytical tasks can be expanded by other tasks proposed directly by the students themselves. This research is of practical importance in the training of future specialists in the field of economics, management, real estate management and housing and communal services.

Keywords: *GIS HCS, data analytics, educational goals, information system, housing and communal services*

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INTRODUCTION

Digitalization of the economy impacts all sectors of economic activity and involves the widespread implementation of comprehensive digital technologies, the development of digital platforms for integrating information exchange participants and improving the efficiency of all processes. Modern technologies facilitate the accumulation, storage, and processing of vast data sets, enabling the analysis and resolution of various analytical challenges, particularly in real estate management and housing services [1]. The rapid development of technology necessitates the training of skilled professionals, who can work with big data, use analysis tools and solve analytical problems in the applied field. Methods and technologies of training future specialists are also changing [2].

For the sphere of housing and communal services, real estate management, the state information system — GIS of housing and communal services (GIS HCS) — has been developed and implemented[1] [3–5], which unites on its platform all participants in information processes and authorities of three levels [6, 7]. The effectiveness and prospects of using such an integrating platform are considered in a number of studies [8–16]. We are exploring this platform — GIS of housing and communal services — as an open database for obtaining information analysis skills in training future specialists.

The object of this research is the state information system of housing and communal services — GIS HCS. The subject of research is the database of the open part of the information system, the section “Analytics and reports”, for the study of the analytical capabilities of the system and its subsequent use it for educational purposes.

The purpose of this research is to explore the potential of GIS HCS tools, focusing on its technical components and analytical reports, for educational applications. The study aims to develop skills in analyzing reliable, real-world data.

The relevance of this work is determined by the need to train qualified specialists in the field of real estate management and housing and communal services, with the skills to solve analytical problems, the ability to correctly set them and interpret the results obtained. The applied nature of applying knowledge and skills to solve analytical problems using a real GIS HCS database and GIS HCS tools makes the acquired skills more important and valuable for students.

METHODS AND MATERIALS

The paper uses open information, posted in the GIS HCS, in the “Analytics and reports” section. The built-in tools of the system are used for working with information, as well as an office application, a spreadsheet software, for processing information and solving regression analysis problems.

GIS HCS has open and closed parts of its system. End users, residents of homes, can register in their personal account and receive services through the GIS HCS platform. In turn, management companies, resource supply organizations, and

1 GIS Of Housing and Communal Services. URL: https://dom.gosuslugi.ru.(rus.).

government agencies have their own access to a certain part of the platform and information resources necessary for implementing their part of the activity in the information system. Each of these users has their own analytics tools. Leveraging the extensive data available in the GIS of housing and communal services, each of the participants of this platform has the opportunity to analyze this or that information to improve the quality-of-service delivery and increase customer satisfaction, efficient use of resources, and solve a number of specialized tasks. For example, each resident of a house registered on the platform can see their own statistics of resource consumption, utilities such as cold and hot water, electricity, and gas, as well as the amount of money actually paid for оказанные housing and communal services rendered. Based on this data, any user can predict their future resource consumption with other factors remaining constant, or analyze resource costs and find ways to save them. These are simple analytical tasks, that most users of the platform can perform if necessary. On the other hand, the resource supply organizations, management companies, also see in the dynamics of various indicators for resources, finances, user requests and their satisfaction. Based on the analysis of such indicators, resource consumption, cash receipts can be predicted, or, for example, the main reasons for not paying for certain utilities can be identified. These are all the features of the closed part of the system.

And open access information is also of some interest. The "Analytics and Reports" section contains significant amount of analytical information, presented in a convenient graphical design for the best perception, and is accompanied by tabular data. This data is valuable for teaching students analytical problem-solving skills using real-world information. When solving analytical problems, as a rule, one can distinguish the maine stages: problem formulation, selection of data and tool environment for solving the problem, the actual solution and obtaining results, and interpretation of the results obtained. We use the capabilities of the housing and utilities GIS as the source data and tool environment. We will try to set these tasks, perform them using the selected tools, and interpret the results obtained.

RESULTS

Problem Statement 1: analyzing the degree of wear and tear in MAB. It is necessary to use the GIS HCS tools, the section "Analytics and reports", "Technical condition of apartment buildings" to determine houses with a high percentage of wear and tear (more than 40 %) and in a state of emergency for one of the regions of the Russian Federation. Evaluate the dependence of the multi-apartment building (MAB) wear and tear percentage on the year of commissioning and the MAB management method by answering the following questions:

Which years of construction of buildings account for the highest percentage of wear and tear?

Does a high percentage of wear and tear always lead to an emergency condition of the MAB?

What is the MAB management method identified for emergency buildings?

GIS of housing and communal services provides immediately complete and clear information about the average percentage of MAB wear and tear for the selected region in the context of management methods (Fig. 1).

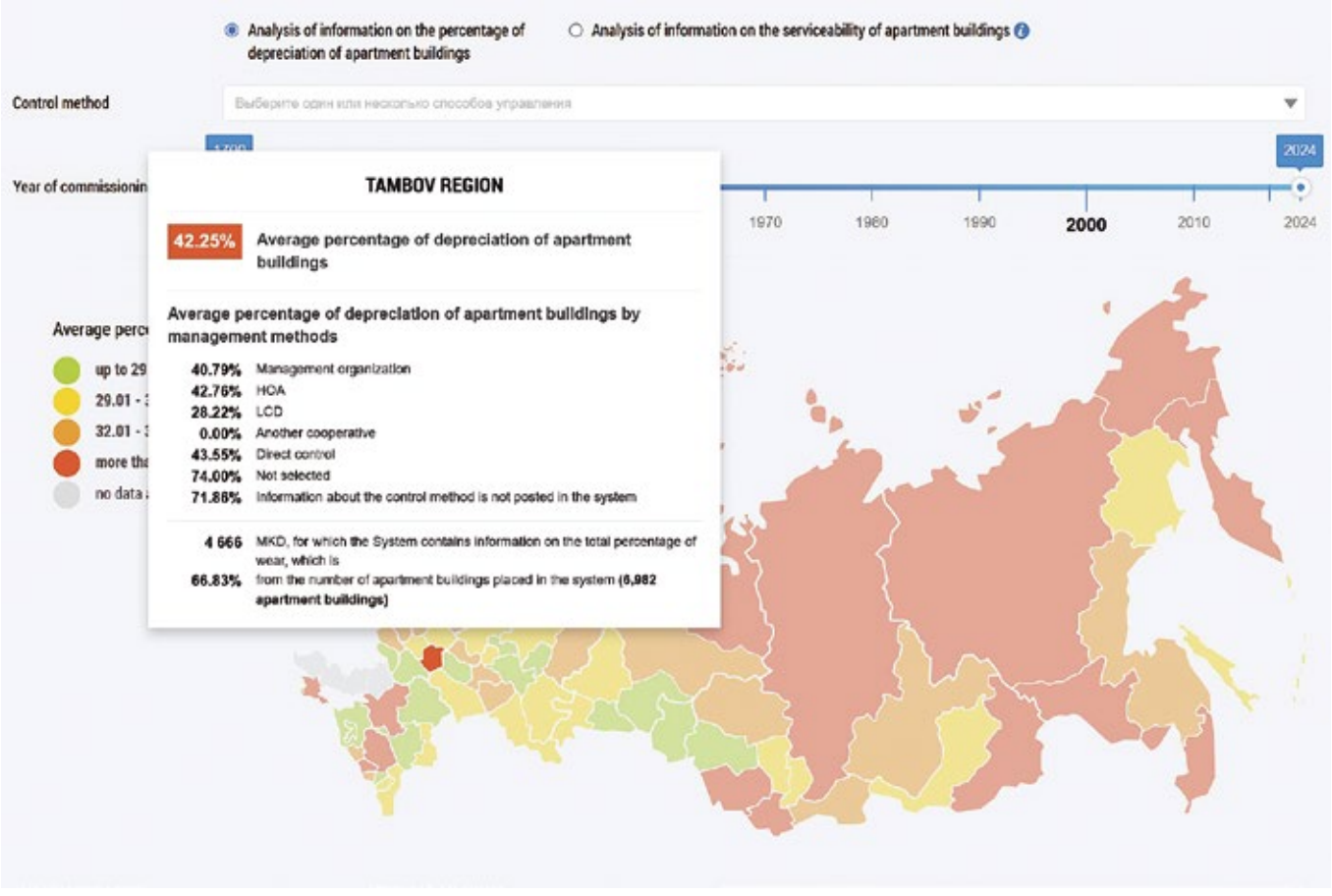

Fig. 1. GIS HCS: Analysis of information on the percentage of MAB wear and tear by management methods

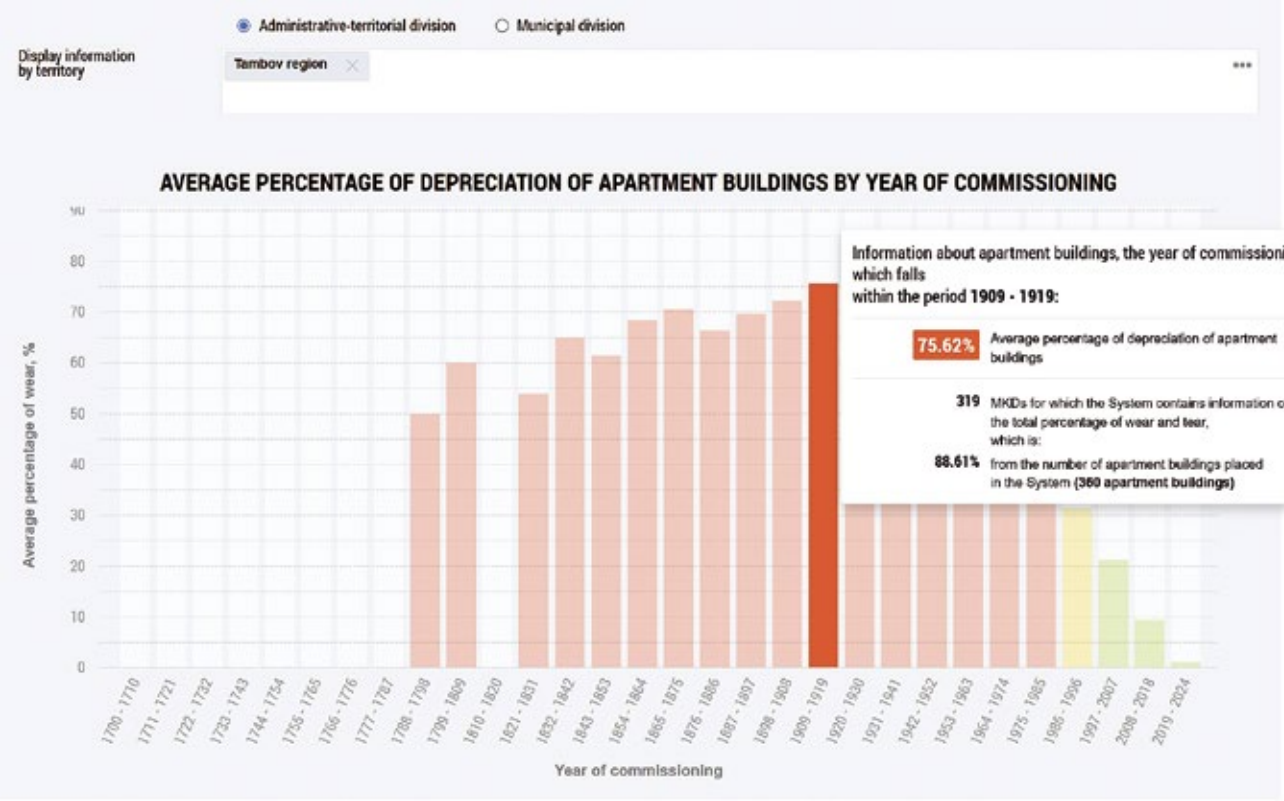

Fig. 2. GIS HCS: Average percentage of MAB wear and tear by year of commissioning

This data shows that some of the houses with a high percentage of depreciation either did not choose the management method, or the data in the system was not provided. Data on the average percentage of MAB wear and tear over the year of commissioning are also clearly presented (Fig. 2). As can be seen in Fig. 2, in this region (Tambov region), a fairly high percentage of wear and tear falls on the years of construction from 1788 to 1985, the maximum wear of 75.54 % falls on houses built in 1909–1919.

The table below in the Housing and utilities GIS provides aggregated information on apartment buildings (MAB) in this region with an indication of the average percentage of depreciation for individual districts and cities of the Tambov region (Fig. 3).

The study can be conducted for the entire Tambov Region, or for a separate district or city. For example, let's examine the areas with the highest average percentage of wear and tear. To do this, we will order the entries in descending order by the column *"Average percentage of wear"* (Fig. 3). The highest average percentage of MAB wear is 83.37 %, Bondarsky district. At the same time, the method of managing such MAB is *Direct management*. By clicking the "MAB List" button, you can get detailed information. Thus, for the Bondarsky district, the maximum wear and tear of 90 % falls on one building of the 1978 year of commissioning, and another 40 buildings have 85 % wear and tear with the period of commissioning from 1962 to 1986.

Based on these data, it can be concluded that regardless of the construction period, MAB under *direct management* are in poor condition in this area and require increased attention.

We are investigating information about the MAB accident rate in this region. To do this, in the filtering parameters, specify "Analysis of information about the health of the MAB". The system provides a visual representation of data on the average percentage of MAB wear over the year of commissioning (Fig. 4) for the entire Tambov region.

Referring to the data table for detailed information on the area of interest, we observe (Fig. 5) that one building of the MAB under *the direct control* of the 2004 year of commissioning is in disrepair.

Territory	Number of apartment buildings placed in the system	MKDs for which the System contains information on general depreciation			Number of apartment buildings for which the management method is placed in the System	Management organization		
		Number of apartment buildings	%	Average percentage of wear		Number of apartment buildings	%	Average percentage of wear
Tambov region	6 982	4 666	66.83	42.25	4 534	3 387	74.70	40.79

Fig. 3. GIS HCS: MAB Depreciation Data

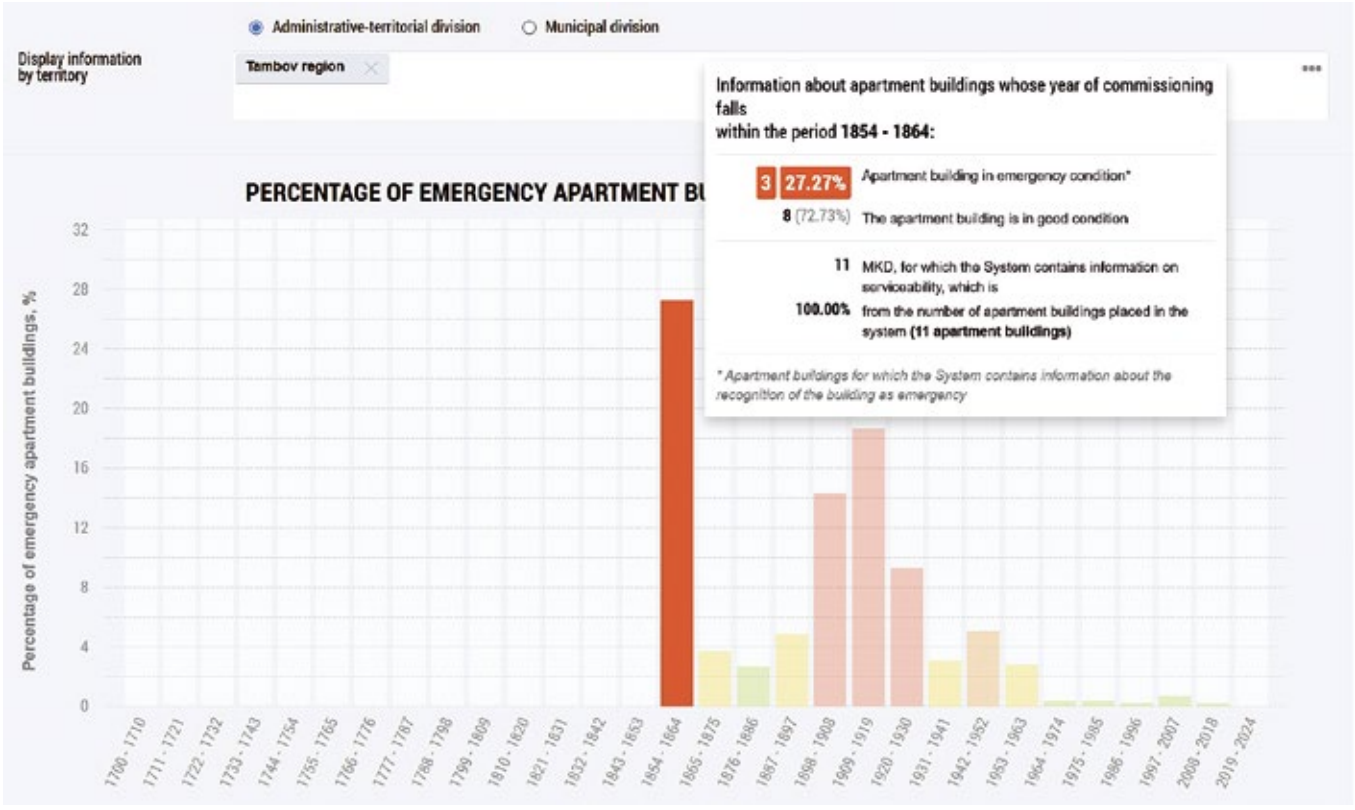

Fig. 4. GIS HCS: Percentage of MAB wear and tear by year of commissioning

This information indicates that with proper management of the MAB, regardless of the construction period and the percentage of wear and tear, the building can maintain its serviceability.

Thus, using this example, students can gain skills in analyzing real reliable information, moving from aggregated data to detailed data, use GIS HCS tools, and correctly interpret the results of the analysis.

One of the methods of analytical data processing is regression analysis and forecasting based on it. Problems of modelling [17, 18], regression analysis based on big data [19], and forecasting, including for the housing and utilities sector [20], are increasingly being developed. However, in the open part of the GIS HCS system, access to data, for example, of a dynamic nature, reflecting the dynamics of changes in indicators over time, is extremely limited, which makes it difficult to set tasks in this class for students using the system. The system also does not have the ability to export data from tables for subsequent work in third-party applications and programs. This also imposes the limitations noted in [14]. Taking into account such features of GIS HCS and wanting to give students the skills of regression analysis and forecasting based on real data, we will use the information in the section "Bringing management organizations to administrative responsibility".

Problem statement 2: analysis of Trends in Administrative Accountability of Management Organizations Using GIS HCS Tools. It is necessary to use the GIS HCS tools, the section "Analytics and reports", "Bringing management organizations to administrative responsibility" to assess the trends in bringing management organizations to responsibility over the past three years, to conduct a regression analysis for various indicators, to assess the value of reliability and the ability to predict indicators.

To analyze information, you can use both aggregated data and detailed data for a specific federal district, for example, or more detailed data for territories in districts. GIS HCS analysis immediately provides a clear picture of the number of MAB management organizations brought to administrative responsibility in dynamics for the period from 2016 to 2024 (Fig. 6)

Let's analyze the aggregated data shown in Fig. 6. Changing the "Period of administrative responsibility" — one of the filtering parameters, we will collect numerical information for the years from 2016 to 2024 and enter it in the Excel table (Table).

Fig. 5. GIS HCS: Table of data on the state of MAB

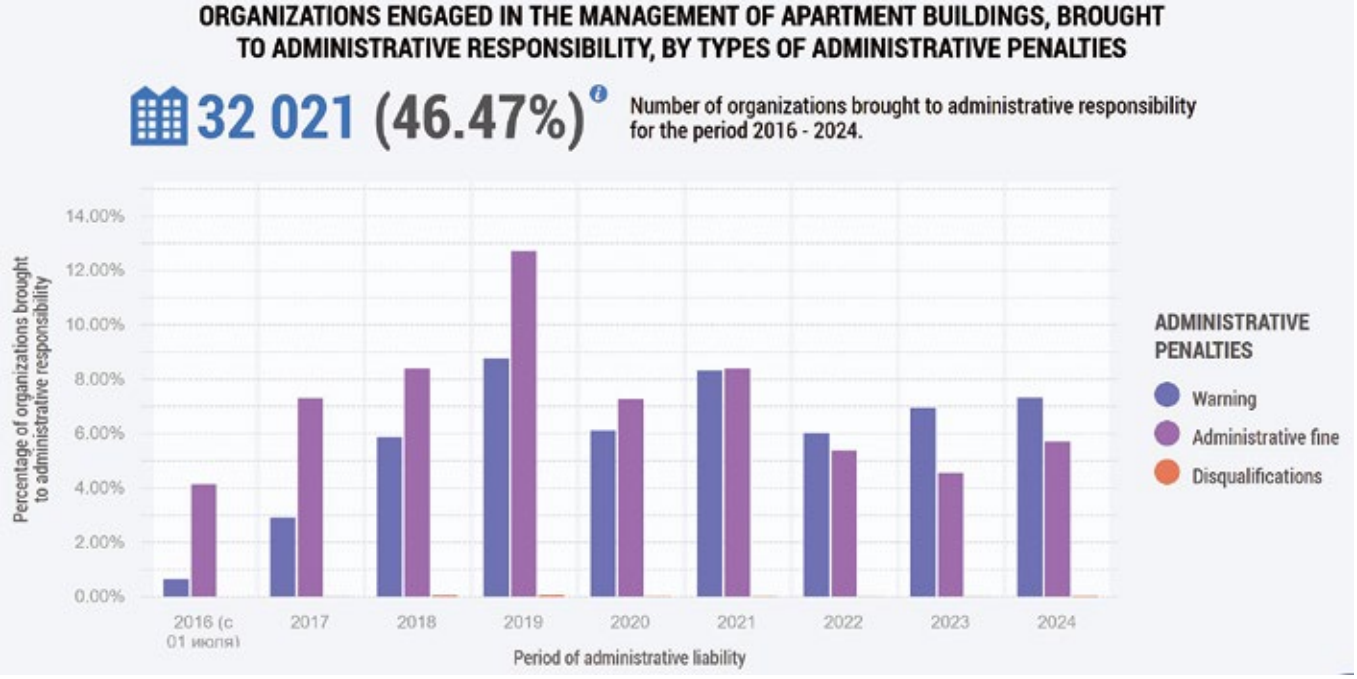

Fig. 6. GIS HCS: Organizations engaged in the management of MAB, brought to administrative responsibility, by types of administrative penalties

Organizations engaged in the management of MAB, brought to administrative responsibility, by types of administrative penalties and years

Year	Number of administrative penalty decisions	Number of managing organizations				
		Warning	Administrative fine	Disqualification	Total brought to responsibility	Registered in the GIS HCS at the end of the year
2016	11.527	385	2.553	0	2.849	57.481
2017	19.063	1.712	4.413	–	5.722	58.000
2018	23.898	3.833	5.522	38	8.313	63.081
2019	49.685	5.975	8.851	49	13.043	66.834
2020	24.395	4.350	5.300	17	8.508	69.514
2021	40.441	6.236	6.452	17	10.684	73.007
2022	21.631	4.640	4.247	11	7.649	75.209
2023	20.999	5.114	3.406	9	7.209	72.024
2024	18.256	4.150	3.330	16	6.438	70.415

Numerical data show that over the past 3 years, there has been a downward trend in the number of management companies held accountable, while the number of registered organizations in the GIS HCS is slightly decreasing. We can assume that there are still better-quality, conscientious management organizations.

A graphical interpretation of the table data is shown in Fig. 7, where trend lines are added for individual indicators. When adding trend lines, we selected those mathematical dependencies for which the confidence value coefficient of determination (R^2) was the maximum. These are second-degree polynomials. An analysis of the approximation curves and the confidence value shows that it is impossible to predict the indicator "Number of decisions on the appointment of an administrative penalty" for the future 2025 in this way, due to the small value R^2 = 0.5505, which is significantly less than 1.

The forecast for the indicator "Total sued" is more reliable, R^2 = 0.785, and suggests a slight decrease compared to the previous year. The forecast for the indicator "Registered in GIS Housing and communal services at the end of the year" (for 2024 at the current date of the year) is highly reliable, R^2 = 0.9312, and the forecast value will remain approximately at the same level as a year earlier.

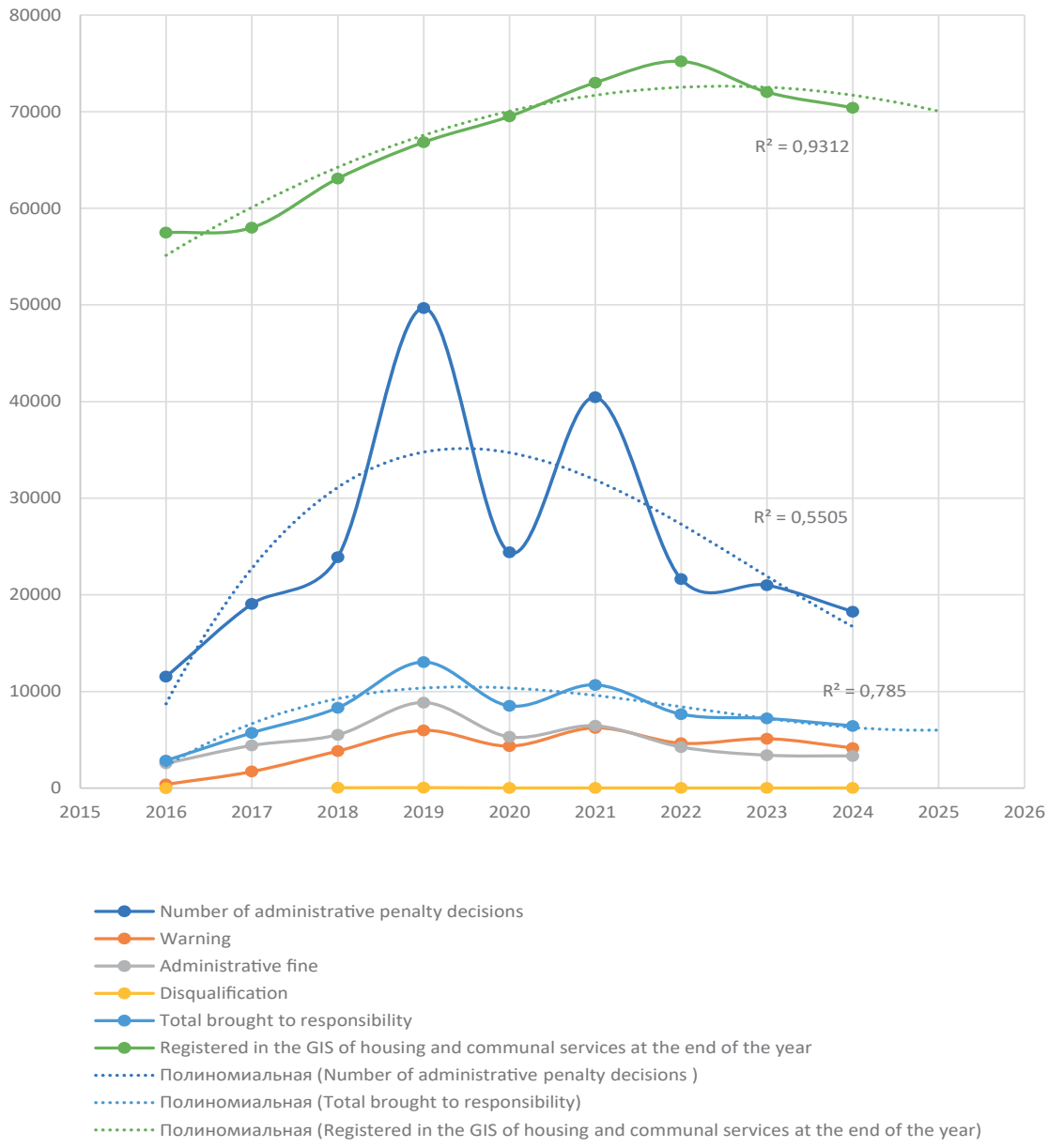

Fig. 7. Graphs of the dynamics of bringing MAB management organizations to administrative responsibility by type of responsibility

Thus, the open part of the GIS of housing and communal services allows you to solve real analytical problems and this opportunity can be used in the educational process when training future specialists.

CONCLUSION

These findings underscore the practical importance of integrating real-world data into educational processes to enhance the analytical capabilities of future professionals. The open part of GIS Housing and communal services, the section "Analytics and Reports", has built-in tools for working with real data, the use of which for educational purposes allows students to set analysis tasks, test hypotheses, get results on a real database, and interpret the results obtained. The given examples of setting analytical tasks can be extended by other tasks proposed directly by the students themselves. These findings underscore the practical importance of integrating real-world data into educational processes to enhance the analytical capabilities of future professionals.

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ГИС ЖКХ: аналитические возможности открытой части системы для образовательных целей

В статье рассматриваются и исследуются возможности использования открытой части информационной системы ГИС ЖКХ, раздела «Аналитика и отчеты» как источника больших достоверных данных и инструментов работы с ними. Применение таких данных и инструментов работы важно и актуально при подготовке будущих специалистов, формировании у них навыков аналитической работы с информацией. Целью исследования является возможность постановки и реализации аналитических задач для образовательных целей на базе реальных достоверных данных ГИС ЖКХ. В ходе исследования были изучены основные особенности системы и предложены постановки аналитических задач для учебных целей. Использованы разделы системы «Техническое состояние многоквартирных домов» и «Привлечение управляющих организаций к административной ответственности». Одна из задач решается полностью с использованием встроенных инструментов платформы, другая — регрессионный анализ — с привлечением инструментальных средств табличного процессора. Встроенные инструменты открытой части системы ГИС ЖКХ «Аналитика и отчеты» позволяют сортировать данные, переходить от агрегированных данных к детализированным и обратно, дополняют графическими моделями табличные данные, что делает работу с информацией простой и понятной. Отсутствие возможности экспорта данных из системы затрудняет возможность использования сторонних приложений для последующей обработки данных. Решение такого класса аналитических задач позволяет обучающимся получить навыки постановки задачи, решения и интерпретации полученных результатов. Рассмотренные примеры аналитических задач могут быть расширены другими задачами, предложенными непосредственно самими обучающимися. Данное исследование имеет практическое значение при подготовке будущих специалистов в области экономики, менеджмента, управления недвижимостью и ЖКХ.

Ключевые слова: *ГИС ЖКХ, аналитика данных, образовательные цели, информационная система, жилищно-коммунальное хозяйство*

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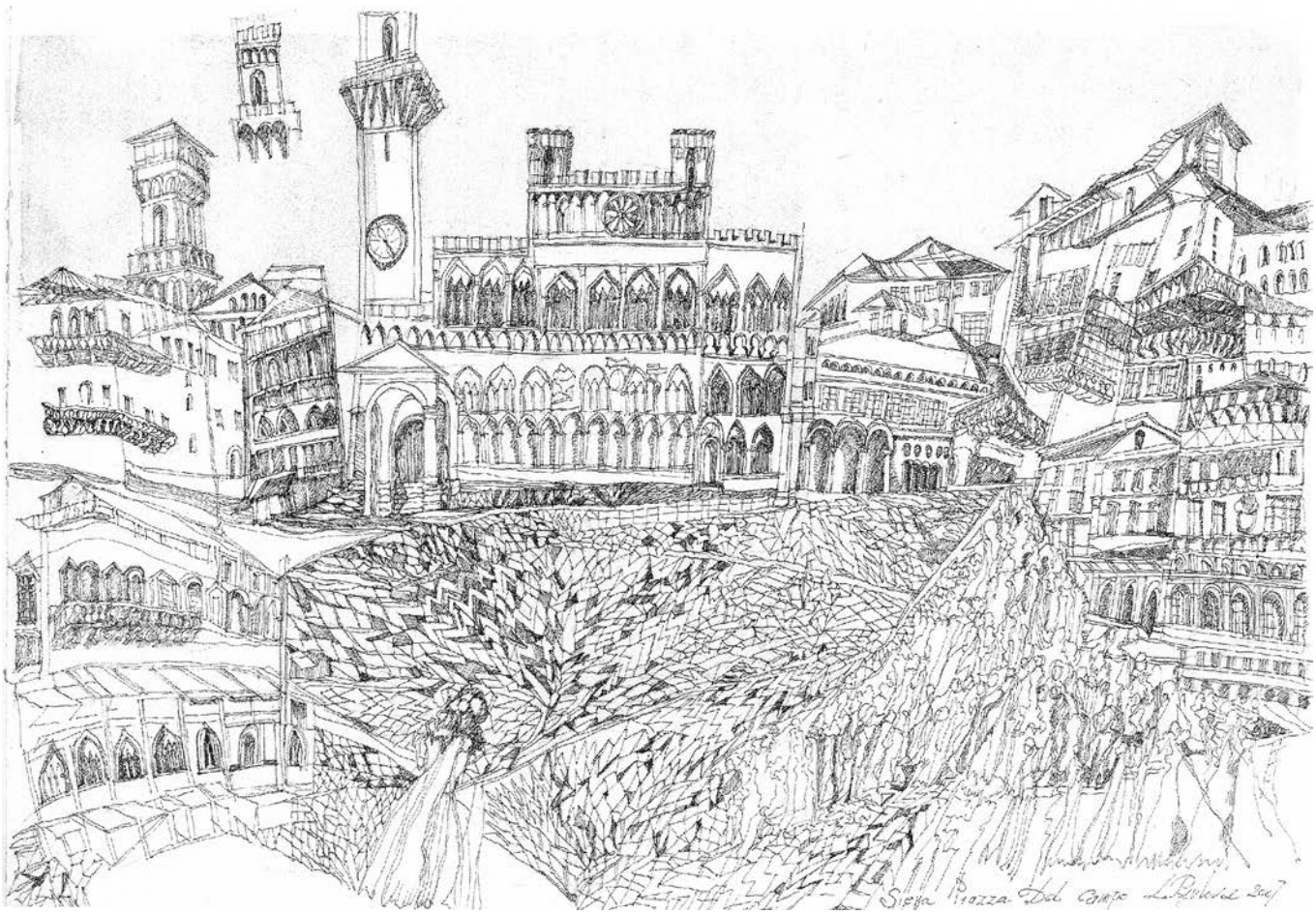

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