Organizational structure of unified information system for network engineering and technical support in urban areas

Natalia Samsonova^{1,*}, Olga Shevtchenko¹

¹Don State Technical University, 344002, Gagarina square, 1, Rostov-on-Don, Russia

Abstract. Municipal government needs a full objective information about the state of technical support and engineering systems network. Thus, geographic information systems are currently in demand in the communal sector. If we consider the territory of any municipal entity in Russian Federation, the control of all processes without the automated system is very difficult. Geographic information systems operate spatial objects, as well as the full set of reference information about these objects. The right decision is possible only if there is all the necessary information in spatial and attributive form.

1 Introduction

One of the most important features of modern life is the rapid growth of cities and, as a consequence of this, the growth of urban population [1].

Urbanization is associated with the transformation of urban and rural areas, which is based on the development of industry, transport, housing, mass communications, service industries, as well as the spread of urban lifestyles [2].

The current level of citizens' life is inconceivable without a complete set of engineering improvement of the urban environment.

The increasing attention to the development of network engineering and technical support (ETS network) in urban areas due to both a worsening technical condition of utilities problems, and the need to transition to coherent planning urban development as a unified engineering complex [3].

2 Management of ETS Network on the basis of GIS technologies

The city should have a guaranteed reserve of engineering capacities for sustainable development [4]. One of the most significant effects of an integrated approach to solving problems of cities' engineering support is to develop management systems, aimed at their work in real time.

* Corresponding author: kafedra.vgif@yandex.ru

For efficient management and planning of network engineering and technical support in urban areas it is necessary to organize a system for collecting, storing, processing, geographically “bound” information on all managed objects [5]. To solve this problem are often used geospatial databases that are based on GIS technologies and information systems.

ETS Network management is a task that requires a constant monitoring and analysis of the management object data. In fact, it is an analytical task, and the ability to solve it depends on the quality of management [6].

Consider a typical situation. In some departments, it is going the collection of data which is needed for their own activities. Analytical documents and draft decisions are prepared based on these data. Situation becomes more complicated when a preparing of draft decision needs to collect data from several departments [7].

Due to the fact that data collection is not coordinated between departments, this leads to the following consequences:

- The data is collected in different formats.
- The frequency of collection (updating) data differs.
- The data is duplicated.
- The data contradicts each other.

As a result, the data, which is collected in several departments, cannot be combined without losing reliability. Also, combined data is doubtful because of the primary data objectivity inconsistency.

Thus, the data reflects the real situation only partially, if it is collected in different departments and the data is consolidated on the agencies level. An error accumulates when you combine imprecise data from several agencies [8].

That is why at the present exponential growth of information managers are not able to see the real picture of the events in the accountable agencies [9]. The higher is the level of control, the farther it is from the place of primary data collection, and the lower is one of the common information for planning.

Thus, the leaders do not receive complete information of the ETS network status or get it delayed. They are to make decisions based on a truncated, distorted and fragmented data, and that has a negative effect on the quality of management [10].

It is important to note that the situation occurs irrespective if there were implemented information systems in departments or not. Because even the neighboring departments often use incompatible information systems, the integration of which was not initially provided.

Thus, to optimize ETS network management of urban areas in terms of information-analytical approach is needed [11]:

- Ensure the managers at all levels with reliable information for making decisions.
- Speed up the preparation of documents.
- Optimize function of working with information.

3 Data support of ETS network information system

At the analysis and evaluating different types of data sources as a basis for providing ETS network information system their common properties should be considered:

- Spatial extent.
- Scale, resolution.
- Quality.
- Relevance and capacity for renewal.
- Features and cost of acquiring.

- Format of performance.
- Compliance with standards.

The results of the external information environment analysis and technical means determine the choice of information sources and technologies of data collection. In many cases, it is necessary to use multiple sources of information that complement each other.

There can be identified the following methods of the non-unified data collection [12]:

- Continuous monitoring of processes and phenomena.
- Statistical analysis of the information on objects of engineering and technical support.
- Receiving information on the systems of telecommunications.
- Search in information networks.
- Information intelligence service, etc.

During the monitoring the observed data should be recorded in a user-friendly form for control and post-treatment [13].

The purpose of the statistical analysis is obtaining parameters and characteristics estimates of the external or internal environment in the studied system.

Reception and registration of the collected primary data on the system input can be done manually or automatically [14]. With any method of recording input information should be controlled to avoid duplication or discovery in its erroneous data.

The collected information is a primary data. Then, this data is a subject to further formalization and unification.

When designing an ETS network information system the task of choosing the collecting information method should be addressed in the context of the general problem of the feasibility study [15]. This is due to the possible dependence of the subsequent processing cost of information on the form of its presentation dictated by the chosen method of collecting.

4 Structure of unified information system for ETS network in urban areas

The subsystem of information collection performs accumulation of graphic and attribute data. Graphic information is a set of spatial coordinates of objects that can be obtained with modern technical and technological means [16].

Primary processing subsystem is used to optimize the processing, storage, and exchange of heterogeneous data, resulting in a unified view of information. The outcome of the subsystem is a simplification, elimination of redundancy, analysis, elimination, or reduction of errors.

Operational update of data ensures the viability of the information system and correspond to its quality of functioning [17].

The subsystem of analyzing and modeling allows to calculate the value of a parameter or phenomenon on all ETS objects in urban area based on discrete distributed data [18]. The simulation that operates with multi-temporal data will allow to estimate the dynamics of network development and provide quality forecast.

The result of data visualization subsystem is a series of thematic maps, charts and tables that are easy to understand and easy to give answers to many questions. Maps can be either two-dimensional, reflecting a phenomenon or a synthesis of different indicators, and three-dimensional, representing a virtual 3D- model of the city's ETS networks.

5 Conclusion

The Specificity of the municipal ETS network is that it contains a wealth of information about technological objects of various purpose such as the information about gas networks, energy networks, heating system, water supply networks and water distribution. In this case, nowadays there is practically no coherent and readable picture of the network system's current state, their functioning and development opportunities.

The information is usually presented in a fragmentary way like the scattered tables, graphs, etc. [19]. That means there is no unified information system that would bring together and present in a convenient form all the necessary data for analysis.

In this situation, the information processing is a quite time-consuming process that involves the use of a plurality of computational modules, carrying out mathematical modeling of technological processes, special implementation of data sampling algorithms, performing a complex of analytical procedures.

Given such characteristics of engineering communications as a large extent of networking and territorial distribution of objects on them it is needed to use geo-information technologies to create a unified information system of ETS networks. GIS-technologies have proven as an effective tool to support decision-making in these cases [20].

GIS allow to form a single visual space of municipal ETS networks. Using GIS, the user can capture the whole view of geographically distributed organization in the relationship of its elements such as linearly extended and point objects based on the cartographical materials.

Basic features, which are provided by the ETS information system of urbanized territory, are:

- Readable representation and analysis of computational and analytical data for network dispatchers.
- Support of decision-making management for managers of the municipality.

ETS network information system will create a unified information space, which integrates all the data about the system of cities' and towns' engineering communications as well as the performance of their service at all levels, that ensures more coherence of their actions.

References

1. A. M. Kazakov, *Development features of Russian cities at the present stage of urbanization: diss. on comp of Cand. Sociology. Sci. degree (22.00.04)* (Moscow State University, Moscow, 2004)
2. E. N. Pertsik, *Geourbanistika: the textbook for the students* (Publishing Center "Academy", Moscow, 2009)
3. *GIS and engineering services: formulation of the problem* (http://loi.ssc.ru/gis/am-fm/GIS_INcom.htm).
4. *How to use the engineering networks effectively* (<http://www.elektroportal.ru/articles/art-264-12.html>).
5. *Network of engineering support* (<http://stera.su/gorod/inzheneriya/seti.html>).
6. *Engineering communication* (<http://old.progis.by/works/inzh-communikacii.html>)
7. A. I. Baimetov, *Some aspects of engineering networks certification on the example of thermal power enterprises* (http://www.rosteplo.ru/Tech_stat/stat_shablon.php?id=2333).

8. M. B. Guvennov, *GIS using to improve the coordination of procedures for the location and performance of utilities* (http://infotech14.ru/articles/ready/guvennov_engineering_survey_2-2011.pdf).
9. A. K. Kovalchuk, S. V. Shaytura, *Fundamentals of geographic information systems* (Rudomino, Moscow, 2009)
10. N. A. Kurdyushkina, E. S. Petrova, *Geographic information systems in the activities of the municipal administration* (http://sisupr.mrsu.ru/2009-2/pdf/20_Kirdiazhkina.pdf).
11. N. V. Samsonova, O. Yu. Shevchenko, *Economy and Ecology of Territorial Entities*, **2** (2016)
12. N. V. Samsonova, O. Yu. Shevchenko, *Economy and Ecology of Territorial Entities*, **3** (2016)
13. *Municipal geographic information system* (http://ugi.ru/services/gis/municipal_gis/geoinformation_system_MGIS/)
14. I. L. Spivak, *Solving problems of urban utilities operation based on GIS* (http://www.remmag.ru/upload_data/files/05-06-2014/neolant.pfg).
15. D. S. Sarychev, *Modern information systems for engineering network* (<http://sun.tsu.ru/mminfo/000063105/280/image/280-358.pdf>)
16. V. V. Stadnikov, Y. L. Zatynayko, A. A. Shpilevoy, O. J. Stepovaya, A. E. Lozinski, *GIS of gas economy engineering network in Odessa region* (https://www.dataplus.ru/news/arcreview/detail.php?ID=1448&SECTION_ID=40).
17. V. V. Tomilin, G. M. Norievskaia, *The register of utilities in the municipal geographic information system* (<https://www.politerm.com/articles/comnet/gissurestr>).
18. O. Yu. Shevchenko, A. B. Borichevskiy, A. N. Golubova, *Building-2014: urban planning and architecture: proceedings of the international scientific-practical conference* (University Press, Rostov n/D, 2014)
19. O. Yu. Shevchenko, V. S. Geydor, *Geographic Information System* (RGSU, Rostov-on-Don, 2012)
20. V. E. Hakshold, *Introduction to urban geographic information systems* (Oxford, 1991)
21. A. Bogoviz, S. Lobova, Y. Ragulina, A. Alekseev, S. Litvinova, *Mediaobrazovanie-Media Education*, **4**, 83-91 (2017)
22. A. Bogoviz, S. Lobova, Y. Ragulina, A. Alekseev, V. Garnova, *Mediaobrazovanie-Media Education*, **3**, 7-14 (2017)
23. A. V. Bogoviz, S. V. Lobova, Y. A. Bugai, *Advances in Intelligent Systems and Computing*, **622**, 30-36 (2018)
24. A. V. Bogoviz, S. V. Lobova, Y. V. Ragulina, A. N. Alekseev, *International Journal of Energy Economics and Policy*, **7(5)**, 93-101 (2017)