Management of the Process of Modernization of Communal Infrastructure

E Balashov

1Moscow analytical center, Moscow

E-mail: balashov.evgenii@gmail.com

Abstract. The issues of the transition of housing and communal services to an innovative development model are among those actively studied by the scientific community and widely discussed in the Russian economic literature. Many works rightly note both significant advances in this direction and the remaining range of unsolved problems. Much less attention is paid to the study of the complexity of the tools used for the development of communal infrastructure in the life cycle of facilities. This article examines topical problems of the promising direction of development and functioning of communal infrastructure, tools for attracting investments, and increasing the effectiveness of PPM projects. It highlights aspects of the transition to the digital technology format. The necessity of an industry program for the development of smart systems and digital technologies and a set of cases are substantiated - standards of the normative configuration of the use and equipping with smart systems and digital technologies, depending on the state of facilities and modernization measures used to develop practical solutions synchronized with the design approaches for the modernization of communal infrastructure.

1. Introduction
Public utility infrastructure is the basis of sustainable municipal operation and it is determined by the strategic goals of territorial, spatial, and reproduction development, as well as the economic feasibility and the assurance of comfort and improvement of the urban environment. The system of public utility infrastructure is valuable to society, and the accessibility of utilities is a key component in the quality of life. [1,6.15].

The alignment of utility service standards assuring the reduced differentiation of the quality of life in cities, town, and rural settlements are based on the systemic eradication or reduction of disproportions between regions and municipalities in terms of upgrading the engineering and utility stock and investment interactions in the construction of new housing and commercial property of various uses, renovation projects of various scales and budgets.

The macroeconomic challenges and restrictions for the investment, budgetary, and monetary resources, accompanied by the increase in utility prices, aggravated during the pandemic because the utility sector experienced additional strains due to their excess usage to disinfect public spaces and blocks of flats, the security upgrade at the utility units, and a significant reduction of utility service consumption by the industrial sector, budget organizations, and businesses, as well as the deterioration of payment discipline of people and legal entities. Currently, the Government took several actions to support organizations and businesses, including tax and loan support, cost recovery subsidies, tax deferrals, and advance payments, and state guarantee for credits and bonded loans.
2. Relevance
Over the last 20 years, many Russian researchers focused on reforms in the utility sector. Various theoretical and practical aspects of the operation and development of municipal utility infrastructure, resource economy, action planning for resource providers, tariff policies, the implementation of targeted state, regional, and municipal programs, investment generation mechanisms, etc. were addressed in the works by V. B. Zotov, A. N. Kirillova, A. N. Ryakhovskaya, N. I. Trukhina, L. N. Chernyshov, et al. [1,6,8,10,14,20]. Nevertheless, the problems related to the efficiency improvement of the utility sector operation under the dramatically changing economic, innovative, and social conditions require further research. The increasingly complex social and economic processes cannot eradicate faults and accidents within the utility infrastructure. They can aggravate engineering system disproportions across territories in terms of their development and deterioration, as well as the insufficient use of the production facilities of the grid. They restrict investment opportunities and current costs along with the significant percentage of engineering infrastructure costs in the prime cost of 1 square meter of living space and utility payments. They require an outrunning increase in comprehensive reconstruction, modernization, renovation, and major repairs that would comply with the innovative technology and production requirements in the prospective period.

3. Statement of problem
The authors can identify several modular tasks to provide the comprehensiveness of the project approach and improve the efficiency of public utility infrastructure modernization management:

- Forming a new organizational structure based on the project office for the utility infrastructure modernization management;
- Finding new funding sources for utility lines upgrade;
- Improving the investment appeal of the utility sector;
- Clarifying the requirements for the concessionaire agreements of state-private partnerships and municipal-private partnerships;
- Improving the tariff policy;
- Forming a comprehensive inspection program for the municipal property;
- Developing an industry-specific development program for smart systems and digital technologies in utility infrastructure.

The transition to the system of strategic program and target planning helped facilitate the implementation of state, regional, and municipal programs for engineering line development and modernization, and prepare a legal and organizational basis for providing financial support to municipal entities since 2013 to upgrade their utility infrastructure. It also provided the new methodological and legal content to the state policy on the mitigation of technical and economic differentiation of municipal units depending on the state of their engineering lines and excess resource losses, the compliance with the current standards for utility services, and the transition to innovative development models. The utility fund provided financial support to implement regional modernization programs for utility infrastructure to the tune of 76.3 million rubles in 2013-2015, and in 2016-2017, the funding amounted to 5.6 billion rubles, where 4.6 billion rubles came from private investments. According to the Minstroy of Russia, the government is formulating a federal 60+ program aimed at upgrading the engineering infrastructure if it is worn-down for over 60%. Its goal is to accelerate the upgrade process and attract private investments to support the budgeting. The main provision for the success is the uniformity and coordination of actions aimed at the implementation of external utility network modernization programs and projects, economic energy service contracts, and the improvement of energy efficiency of housing and non-housing facilities. [6].

The state-private partnership model (concession agreements and rent) is relevant in the utility sector because it stipulates the increase in investments, management efficiency, and project viability at all stages of their implementation through the use of digitalization and innovative management technologies, developing the competition principles, financial flow transparency, and control, and
coordinating the actions to implement external engineering network modernization projects and programs at the municipal level.[4,5].

4. Applicability
According to the data from the Russian Ministry of Economic Development, the rate of using the mechanisms of state-private partnership among the 85 regions of Russia is between 98.7 (Samara Oblast) and 6.7 (the Republic of North Ossetia - Alania). This signifies both a significant discrepancy in social and economic development and the investment opportunities of the institutional environment and the legal framework and the resulting lack of state-private partnership project implementation experience. At the beginning of 2020, the active or completed concession agreements amounted to 3.1 thousand and their cost amounted to 1.7 trillion rubles. Of these, 1.2 trillion rubles (over 70%) were received from private investors. This rating was created based on the project data provided by regions and municipal units to the Governmental Automated System for Management, and it can be used to assess the implementation rate of the state-private partnership projects on utility infrastructure with some restrictions. [9,12].

At the same time, the analysis shows that regional tariff regulation authorities face the problem of low-quality and formal preparation of concession agreements in the utility sector. For example, concession agreements might lack investment commitments, some crucial provisions set out by laws, and long-term activity indicators for the concessionaire approved by the regional tariff regulation authorities. A problem also occurs when the owner of state or municipal property enters into a contract for the lease or free use of this property and then formally renames these contracts as concession agreements. In some cases, formal concession agreements are made related to the utility sector facilities when they are assigned for use by unitary enterprises. [7].

To improve the efficiency of implementation for state-private partnership (SPP) and municipal-private partnership (MPP) projects in the utility sector, the concession agreement requirements must be clarified on the basis of the principle that such agreements can only be made provided that the private concessionaire/investor will upgrade the existing and build new utility infrastructure facilities. In this respect, it is important that the tenfold imbalance between the required and the actual annual funding for the reconstruction and modernization of engineering systems and the limited private investments raise the problem of finding new financial sources to extend the investment potential and provide the rapid upgrade of facilities. [13,16,17].

The attraction of private investments depends on the specific area of utility resource production with a natural monopoly status. It is not attractive for the investors to infrastructure projects because they typically have a long pay-back period, they are vulnerable to external factors and aggregate risks, the tariff investment potential is low, and financial flows are obscure, which leads to the inefficient use of resources. Investors consider the long-term effects of investing in design and construction, facility maintenance and life cycle costs, and the capital expenses on the upgrade of the existing facilities. All of these lead the problem of compensating investors' costs through tariffs. The current tariffs cannot provide for the profitability of projects. Low tariffs are good for accessing utility services but they increase the risks related to funding shortages for the required upgrades and cannot provide the financial stability necessary for the production and supply of resources. [18]. To solve this problem, it is necessary to use a comprehensive approach including the volume and quality audit of utility resources, the availability, and transparency of the valid information about the services provided, economically feasible tariffs, balancing current and investment costs, energy saving, tariff policy improvement, etc.

The analysis of the innovative potential of municipal entities shows that local authorities lack the functions related to private investment generation and investment project portfolio formation taking into account facility types and project solution types. For natural monopolies, it is difficult to provide strategic coordination and alignment of utility company activities in the implementation of investment programs and local authority activities in the implementation of targeted upgrade programs and municipal-private partnership investment projects. During the pre-investment stage of utility
infrastructure upgrade projects, it is recommended to analyze risk factors and assess the efficiency of the upgrade (profitability, investment payback period, loss reduction, service life prolongation, etc.).

The adjustment of numerous factors impacting the investment appeal of utility infrastructure and the development of actions to improve the quality of municipal upgrade projects require the use of the complex approach to social and economic development programs for municipal entities on the federal and regional levels. The achievement of performance indicators for national projects should provide for the integration of investment and innovation appeal of municipal entities. Figure 1 shows a structural model for factors impacting the investment appeal of the utility infrastructure sector.

To improve the efficiency of the list of the key project management problems, it must include the following: creating a new organizational structure based on the project office to identify problems with utility infrastructure, preparation of engineering line upgrade projects, and rationalization of the key profitability indicators, competitive selection of concessionaires, project support, and developing real performance indicators for projects.

The analysis shows that only about 20% of the investment projects break even if concession agreements are implemented without a significant tariff increase, while the presence of risks allows to fund only 3% of the projects. It is necessary to find new sources of funding to keep the tariffs set by the respective regulator throughout concession and achieve the project pay-back periods that would be acceptable for concessionaires. The authors believe that the actions aimed at finding extra sources of funding, the investment component in tariffs, and the lack of funds to achieve the acceptable pay-back period for investment projects require justification. [6,16].

Figure 1. A structural model for factors impacting the investment appeal of the utility infrastructure in municipal entities.

Apart from the investment potential diagnostic for municipal entities, the key elements include the formation of a systematic inspection program for the municipal property. It can help assess the actual physical wear of utility infrastructure facilities on the local (specific facility) and municipal level, monitor defects, flaws, and faults and promptly eliminate them; analyze operational conditions; perform major and current repairs; facilitate decision-making concerning the feasibility and the list of
necessary upgrades; manage utility sector facilities taking into consideration their remaining service life; forecast changes in technical conditions based on the current physical wear and obsolescence levels; evaluate reliability, energy efficiency, and functional capacities of all equipment, lines, facilities, and utility resource transportation.[14]

The authors note that decision-making concerning the feasibility and selecting the set of works and upgrade methods for all types of engineering lines is difficult due to the relatively high depreciated value of utility infrastructure facilities. However, the selection of methods and procedures for engineering line upgrade and reconstruction can be economically feasible if their physical wear is below 65-70% and the upgrade expenses do not exceed 70% of the construction costs for new facilities. The development of instrumental diagnostic and automation procedures for monitoring and measuring the technical condition of facilities over the recent years resulted in the increased list of indicators that become increasingly prominent in diagnostics and upgrade method selection. [11,19,20].

5. Conclusions
A system for technical diagnostics of utility infrastructure must closely cooperate with the official dispatcher services that collect the real-time data on the operating utility service providers, as well as the databases of housing-and-utility agencies of local authorities, and the state housing inspectorate. In the long term, improving the efficiency of the municipal property management and the information and forecast support services that facilitate decision making in the selection of reconstruction, upgrade, and major repair activities, worn-out and damaged line replacement, applying BIM technologies in construction and operation, and the 3D printing of urban environment elements will require a consolidated situation and dispatcher center to monitor, regulate, and accept recommendations concerning the upgrade projects for utility infrastructure.

Currently, the transition of the utility sector to the innovative development model is a widely discussed issue, and experts see both its advances and unsolved problems. The modern age requires the transition to digital organization and management of the social and economic development of territories. The research of 2019 over 79 regions shows that the digital transformation of the utility and energy sectors in the regions of Russia has reached 56%.

Since the actual technical conditions of a significant proportion of engineering lines are poor and the rate of facility upgrades in targeted programs is very high, it is necessary to develop an industry-specific development program for smart systems and digital technologies in the utility infrastructure sector. The authors also deem it feasible to develop a set of benchmark cases for the standard smart system and digital technology application and arrangement depending on the state of facilities and modernization actions that can be used to develop practical solutions aligned with project approaches to improving the efficiency of utility infrastructure and the quality of housing and utility services.

The optimization of utility infrastructure upgrades depends on the successful implementation of the suggested solutions concerning the use of a limited set of actions and mechanisms. The stages of this process depend on the preparation of engineering infrastructures and the external environment, and the selection mechanisms for various smart projects and digital solutions in fast decision making, emergency prevention, etc. The efficiency of the suggested actions can be determined through a generalized utility infrastructure upgrade index stipulating the reduction of physical wear by at least 10-25% and maintaining the proportion of innovative technologies in project solutions at 5-15%. The algorithm for the implementation of the suggested actions may include changes to the existing legal acts that regulate the utility sector.

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