

■ Adamtseвич L.A.



**Adamtseвич
Liubov Andreevna,**
Candidate of Technical Sciences,
Senior Lecturer Department of
Information systems, technologies
and automation in construction;
Moscow State University of Civil
Engineering (National Research
University) (MGSU); 26 Yaroslavl-
skoe shosse, Moscow, 129337,
Russian Federation;
ID RSCI: 2537-0511,
Scopus AuthorID: 57190342498;
WoS ResearcherID: M-5000-2016,
ORCID: 0000-0002-5843-0076;
AdamtseвичLA@mgsu.ru

Lifecycle management of integrated territorial development projects based on organizational and technological solutions

The paper presents an approach to managing the lifecycle of integrated development of territories (IDT) facilities based on organizational and technological documentation. This approach includes the development of an algorithm for specialized software to automate planning, monitoring, and analysis processes. The proposed methodology enables the creation of a unified information space for all project participants and ensures end-to-end management from the design stage through to facility decommissioning. It is noted that during the operational phase, Organizational-Technological Solutions (OTS) are not required; their adoption becomes necessary only during repair and maintenance activities on facilities. Crucially, retrospective information about operational conditions plays a vital role in justifying such decisions, and this data can only be collected during the operational phase. The implementation of the proposed solution will enhance the manageability of IDT projects and establish a foundation for sustainable territorial development. Future research prospects are associated with integrating the proposed model with BIM-based software systems while considering facility autonomy levels, developing intelligent algorithms for predicting the technical condition of facilities, and creating economic-mathematical models for assessing the comprehensive efficiency of IDT projects throughout their complete lifecycle. **Keywords:** *life cycle of an object, sustainable development of territories, integrated development of territories, organizational and technological solutions, Project Organization Concept, Project Production Report, Decommissioning and demolition plan*

INTRODUCTION

Integrated development of territories (IDT) is a form of state-regulated spatial development management aimed at the structural transformation of urbanized areas. The goal of OTS programmes is to systematically transform areas characterized by inefficient use, degradation, deindustrialization or a complete lack of development, and to create a multifunctional, socially balanced, environmentally sustainable and economically viable urban environment. A distinctive feature of the IDT programme, compared to traditional approaches to urban development, is its integrative nature. IDT projects are implemented as a single programme-targeted complex in which all components are synergistically linked, from residential development, social infrastructure facilities (education, healthcare, culture), engineering and transport infrastructure to recreational areas and environmental requirements, etc. [1–4]. In international terminology, terms such as “urban redevelopment”, “comprehensive urban renewal”, “mixed-use development”, and “territorial regeneration” are used for the IDT concept. However, these terms focus on different aspects of the process: “redevelopment” — physical transformation and modernization, “mixed-use” — functional diversity, “renewal” — modernization of existing buildings, and “regeneration” — comprehensive socio-economic and physical revitalization of territories [5–17]. Thus, IDT is a strategic approach to urban planning aimed at creating a balanced and sustainable urban environment, where effective management of the life cycle of construction projects is a critical element for successful implementation.

The life cycle of a capital construction project encompasses a sequence of interrelated stages from the initial concept to the decommissioning of the facility. Each of these stages requires careful planning, coordination and control, which is particularly relevant for IDT projects, which are characterized by their complexity, scale and multifunctionality. Managing facilities at different stages of their life cycle within a single territory presents a particular challenge. The coordinated operation of facilities under construction, in operation and undergoing reconstruction requires the development of an integrated management system based on uniform principles and approaches. The lack of a unified methodology for managing the life cycle of facilities in IDT programmes can lead to imbalances in regional development, delays in implementation, and a decline in the investment attractiveness of the project. At the same time, the main tool for ensuring the manageability of construction processes at all stages of the life cycle is organizational and technological documentation (OTD), which allows for the optimization of resource planning, improvement of the quality of construction work and operational characteristics of facilities, as well as ensuring compliance with regulatory requirements and standards to minimize potential risks and unforeseen costs. Thus, the relevance of the study is determined by the need to develop comprehensive solutions for managing complex urban development projects that ensure the efficient use of resources, compliance with implementation deadlines, and high quality of the urban environment.

MATERIALS AND METHODS

CP 48.13330.2019¹ regulates the design, construction, reconstruction, major repairs, and demolition of construction projects in terms of construction organization. The document applies to work on projects involving civil and industrial facilities, and is also aimed at the redevelopment of industrial areas in existing built-up areas.

This document defines a “capital construction facility” as a building, structure, or facility whose construction has not been completed, with the exception of non-capital structures, facilities, and inseparable improvements to the land plot (paving, covering, etc.).

A facility is a collective term that combines capital construction facilities, facilities undergoing reconstruction, facilities undergoing major repairs, facilities subject to demolition, etc.

The document also specifies that organizational and technological solutions, calculations, measures and requirements for the performance of relevant types of construction and installation works are contained in the organizational and technological documentation.

Thus, the goal of OTD is to ensure that the facility is commissioned with the required quality, within the established deadlines and in compliance with safety requirements.

This goal is achieved through the following documentation: POC (project organizational concept), PPR (project production report), PORSiD (demolition or dismantling organization plan). Fig. 1 shows the life cycle of a construction project in relation to the process of transforming organisational and technological documentation and, as a result, OTS.

It should be noted that OTS are not required during the operation phase; their adoption becomes necessary when carrying out

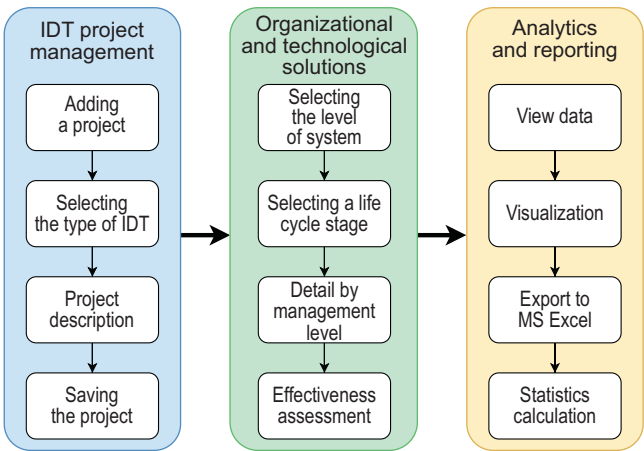
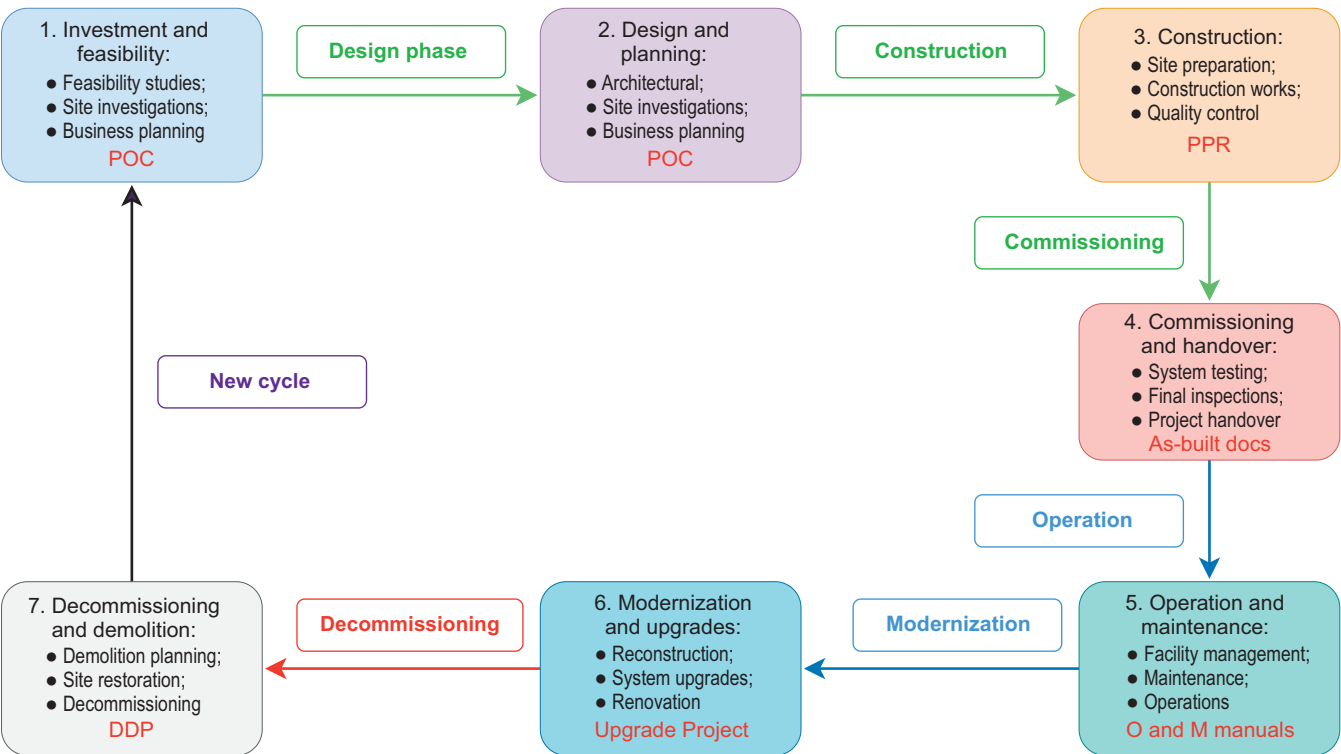


Fig. 2. Conceptual framework of an end-to-end organizational and technological solutions design system across all stages of the integrated territorial development facility lifecycle

repair work. At the same time, retrospective information about operating conditions, which can only be collected during this stage, plays a critical role in justifying such decisions. This relationship demonstrates the fundamental importance of implementing comprehensive management of the entire life cycle of facilities within the framework of integrated territorial development programmes.

Thus, the conceptual diagram of the end-to-end OTS design system at all stages of the IDT facility life cycle can be represented in accordance with Fig. 2.

The author discusses object management levels in IDT projects in more detail in [18].



Project documentation management (PDM): POC-Project Organization Concept; PPR-Project Production Report; DDP-Decommissioning and demolition plan

Fig. 1. Life cycle of a construction project in relation to the organisational and technological documentation transformation process diagram

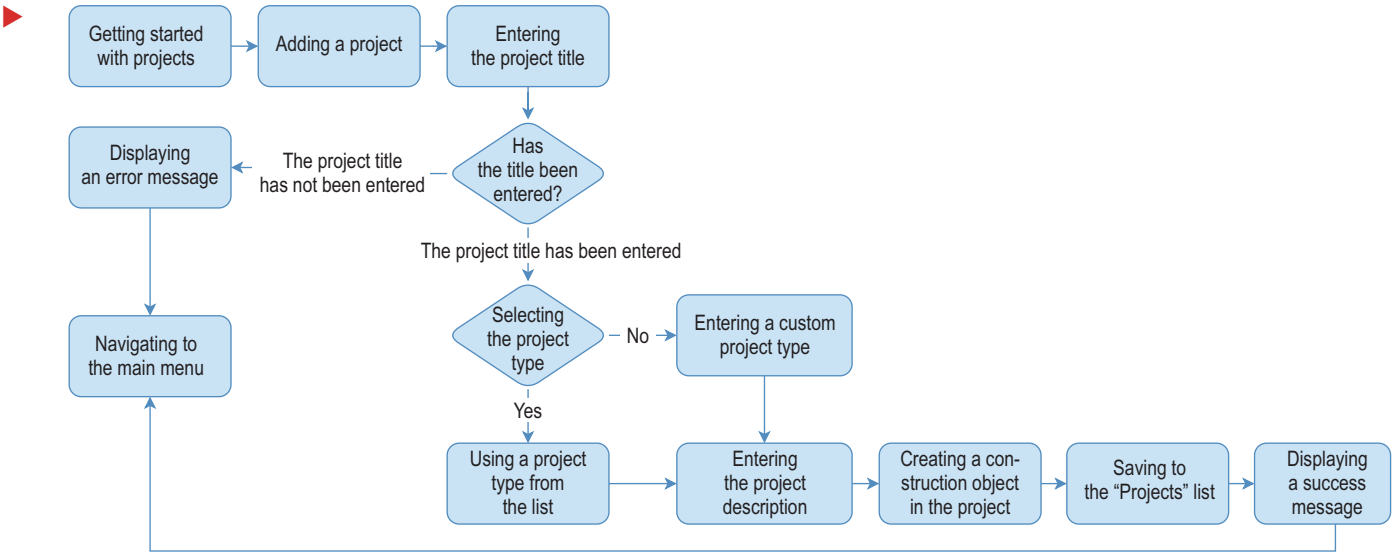


Fig. 3. Block diagram of the “IDT Project Management” module

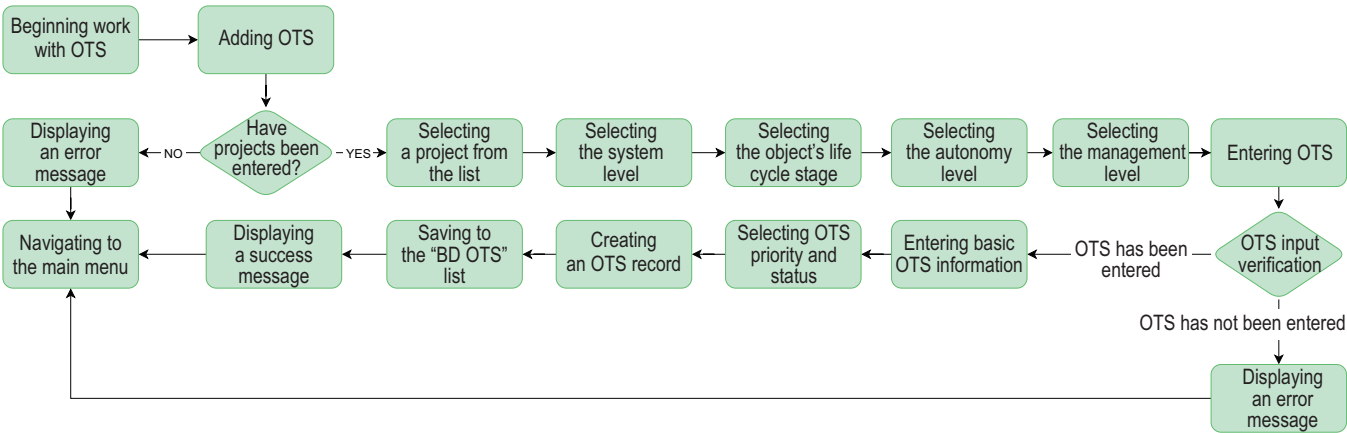


Fig. 4. Block diagram of the “Organisational and Technological Solutions” module

RESULTS

As a result of the research, detailed block diagrams of the operation of the OTS end-to-end design system blocks at all stages of the IDT facilities life cycle have been developed, which are presented in Fig. 3–5.

Fig. 6 shows the programme interface as one of the possible options for implementing software based on the proposed block diagrams.

The software interface is implemented as a modular system consisting of five interconnected functional blocks, each of which solves specific tasks within the framework of the unified methodology for managing the life cycle of objects in IDT programmes proposed in this work.

The IDT programme management module (marked with a red rectangle in Fig. 6) is designed to enter and systematize information about new projects. A key feature of the module is the implementation of cascading logic for selecting hierarchical levels, where the sequential selection of the system level automatically determines the options available at the subsystem level, and the selection of the subsystem level determines the options available at the component level, which ensures data integrity and eliminates the possibility of selecting incorrect combinations (which ultimately

reduces possible errors in working with the system). In addition, this module allows you to record financial characteristics and a detailed description of the project, as well as key life cycle milestones, thus forming a comprehensive view of each project. The main key features of the project can be added to the project description in order to subsequently correlate the project features with the effectiveness of the OTS adopted.

The module containing information about organisational and technological solutions (OTS) is shown in Fig. 7 (highlighted with a red rectangle).

In this module, you need to fill in the key aspects of the project (specifying the management level (strategic, tactical, operational, local), the object level (system, subsystem, component, element) and the object life cycle stage), as well as a description of the accepted OTS, including their effectiveness, indicated as a percentage.

The analytical module with data visualization capabilities is shown in Fig. 8 and contains several types of analysis:

- comparative analysis by management levels and system levels, showing average efficiency indicators and project distribution;
- analysis of time trends, a feature of which is the construction of graphs showing the dependence of efficiency on the actual commissioning dates of objects;

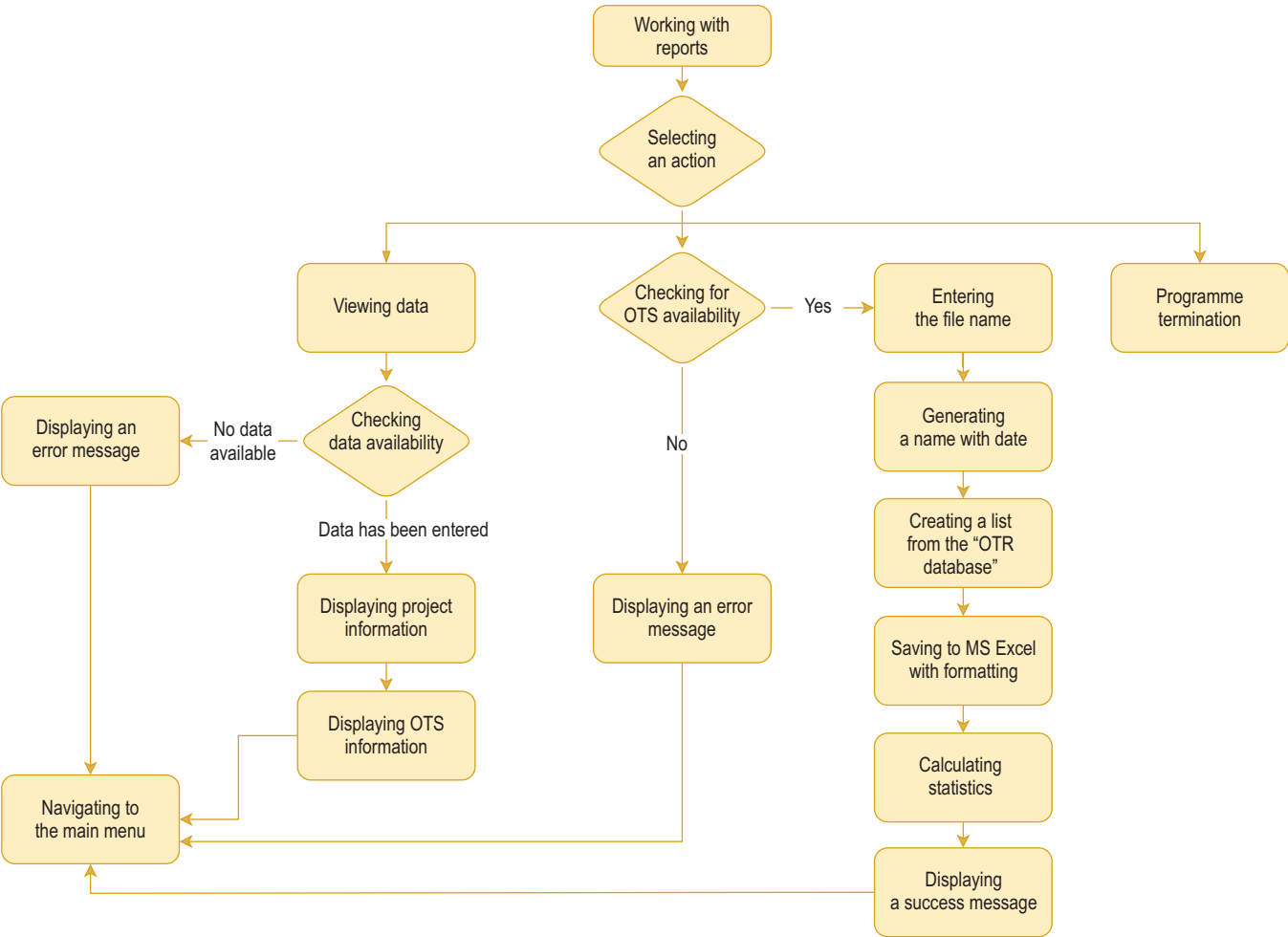


Fig. 5. Block diagram of the Analytics and Reporting module

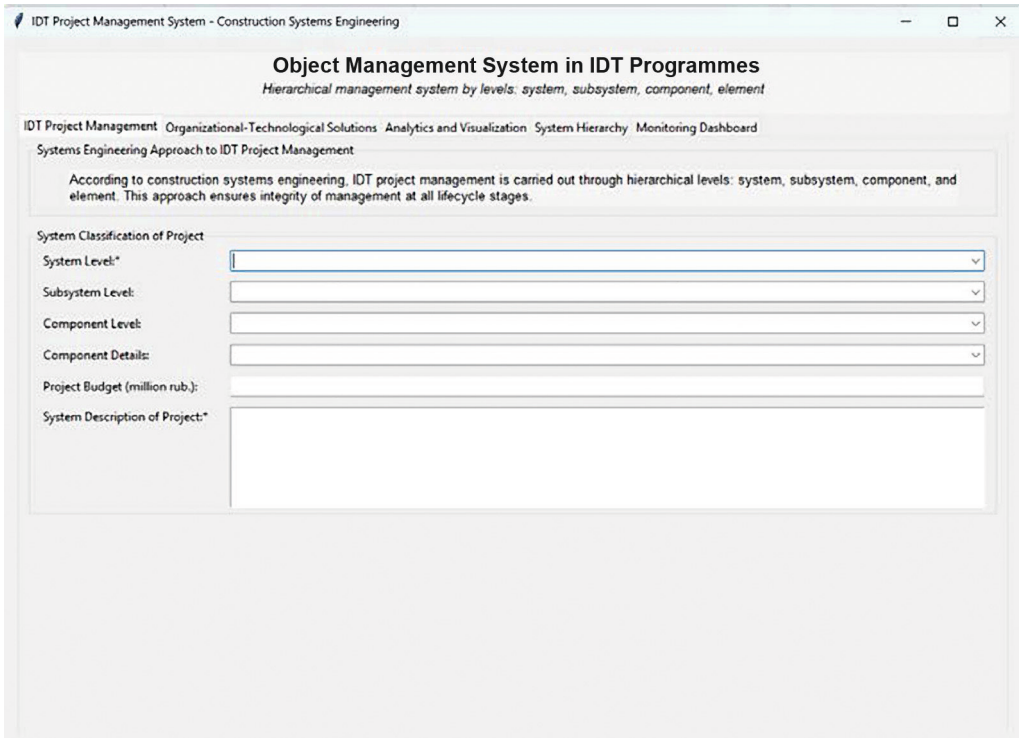


Fig. 6. Interface of the object management programme in IDT programmes

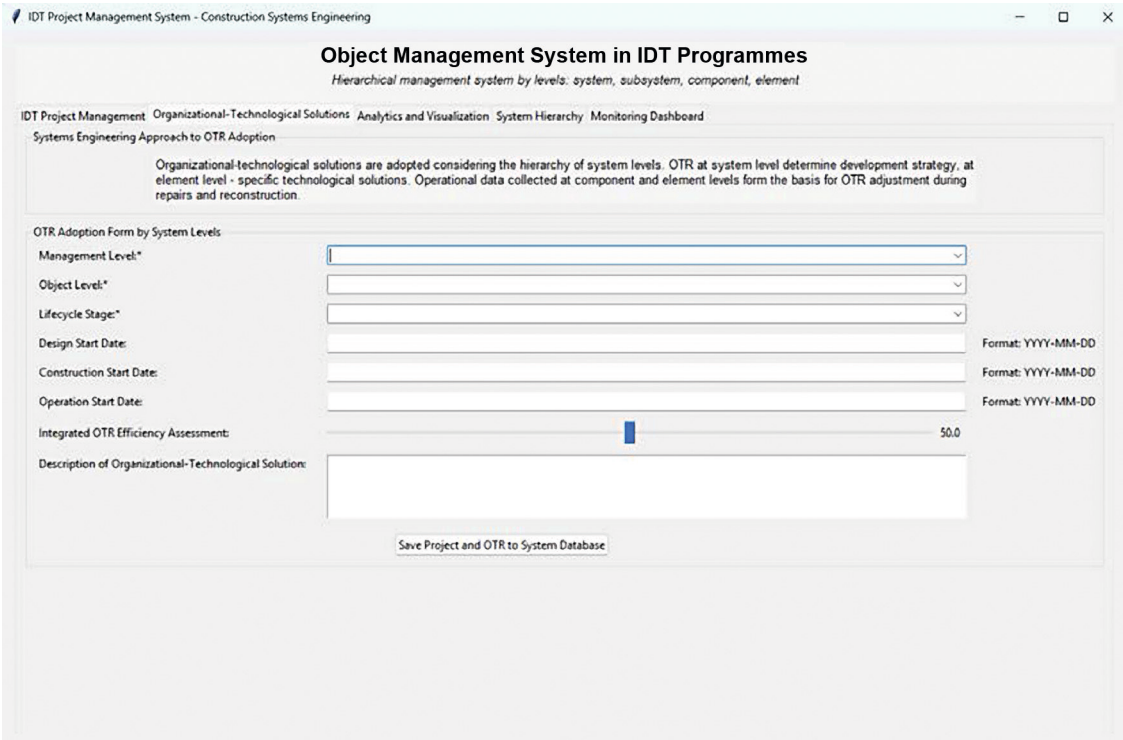


Fig. 7. Module “Organisational and Technological Solutions”

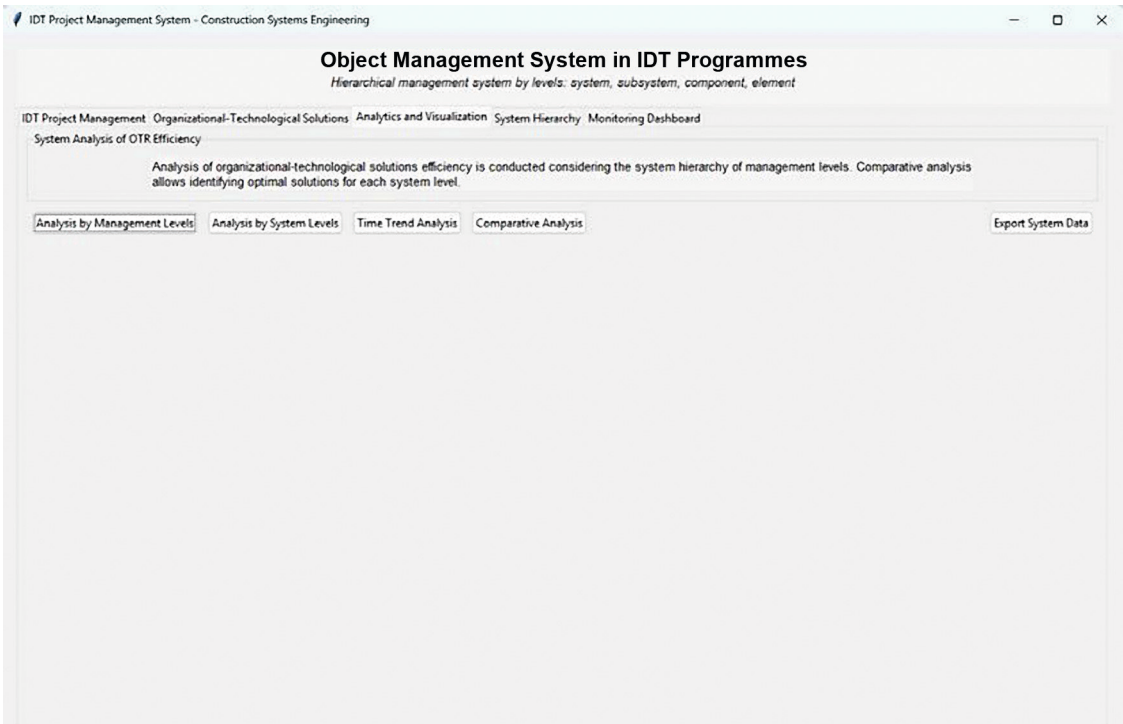


Fig. 8. Analytics and Visualization Module

- calculation of weighted average efficiency indicators, taking into account the financial characteristics of projects;
- comparative analysis of efficiency distributions using box-and-whisker plots.

It is also possible to export data in MS Excel format with a structured presentation of information, including source data and summary statistics.

The reference module contains a system hierarchy of objects in IDT projects and serves as a visual reference guide based on the hierarchical classification of objects built into the system (Fig. 9). The information on the tab is presented in a tree structure, sequentially displaying all levels — from system to element — providing users with the ability to navigate the classification system and promoting a uniform understanding of structural elements.

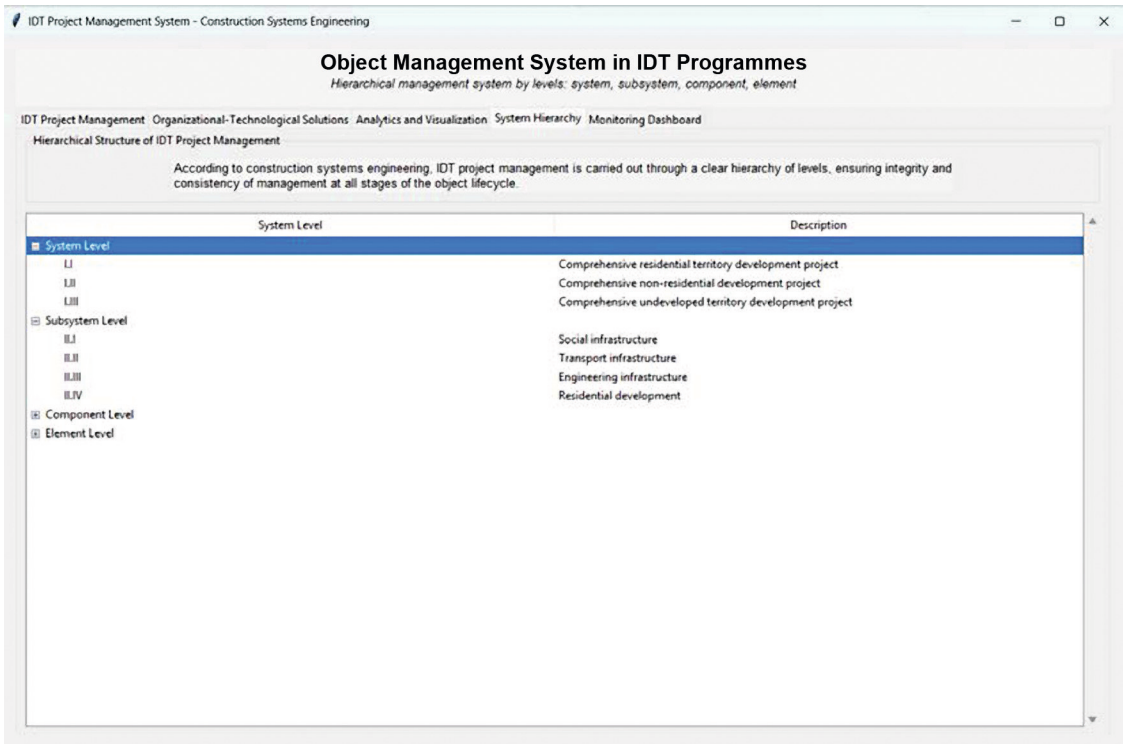


Fig. 9. Reference module “System hierarchy”



Fig. 10. Monitoring Panel Module

The integrated monitoring panel (the last module of the system) (Fig. 10) is implemented as an overview dashboard that provides summary information about key system indicators. This dialogue box displays aggregated statistical data, including the total number of projects, average efficiency values, and aggregate financial indicators (e.g., project budget).

The presented architecture of the software complex provides end-to-end management of information about IDT projects — from entering initial project data to complex analytical analysis, which complies with the principles of a systematic approach and meets the requirements of comprehensive and integrated management.

CONCLUSIONS

As a result of the research, a system for end-to-end design of organisational and technological solutions for comprehensive development projects at all stages of their life cycle has been developed and presented in the form of detailed block diagrams.

One of the software options is presented, in which the basic logic of the methodological principles of the proposed approach is implemented, but the block responsible for the level of autonomy of the facility is not integrated.

The practical significance of the research lies in the fact that the developed methodological principles and block diagrams can be directly implemented in the practice of IDT project management.

Their application will improve the soundness of decisions, reduce unforeseen costs by lowering the probability of risks, and create a basis for the digitalization of territorial development management.

The proposed solutions form the methodological foundation for the creation of modern systems for managing the life cycle of IDT facilities and ensure the transition from reactive management (elimination of consequences) to proactive management (prevention of problems based on data analysis).

Prospects for further research are related to the integration of the proposed model with software complexes based on BIM modelling, the development of intelligent algorithms for predicting the technical condition of objects, and the creation of economic and mathematical models for assessing the integral effectiveness of IDT projects, taking into account the entire life cycle.

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Управление жизненным циклом объектов комплексного развития территорий на основе организационно-технологических решений

В статье представлен подход к управлению жизненным циклом объектов строительства в программах комплексного развития территорий (КРТ) на основе организационно-технологической документации, включающий алгоритм специализированного программного обеспечения для автоматизации процессов планирования, контроля и анализа. Предлагаемый подход позволяет создать единое информационное пространство для всех участников проекта и обеспечить сквозное управление от стадии проектирования до вывода объектов строительства из эксплуатации. Отмечено, что на этапе эксплуатации организационно-технологические решения (ОТР) не требуются, их принятие становится необходимым при проведении ремонтных мероприятий по объектам. При этом критически важную роль в обосновании таких решений играет ретроспективная информация об условиях эксплуатации объекта, сбор которой возможен лишь непосредственно на этапе эксплуатации.

Внедрение предложенного решения позволит повысить управляемость проектов КРТ и создать основу для устойчивого развития территорий.

Перспективы дальнейших исследований связаны с интеграцией предложенной модели с учетом уровня автономности объекта с программными комплексами на основе BIM-моделирования, разработкой интеллектуальных алгоритмов для прогнозирования технического состояния объектов и созданием экономико-математических моделей для оценки интегральной эффективности проектов КРТ с учетом полного жизненного цикла.

лирования, разработкой интеллектуальных алгоритмов для прогнозирования технического состояния объектов и созданием экономико-математических моделей для оценки интегральной эффективности проектов КРТ с учетом полного жизненного цикла.

Ключевые слова: жизненный цикл объекта, устойчивое развитие территорий, комплексное развитие территорий, ПОС, ППР, ПОРСид

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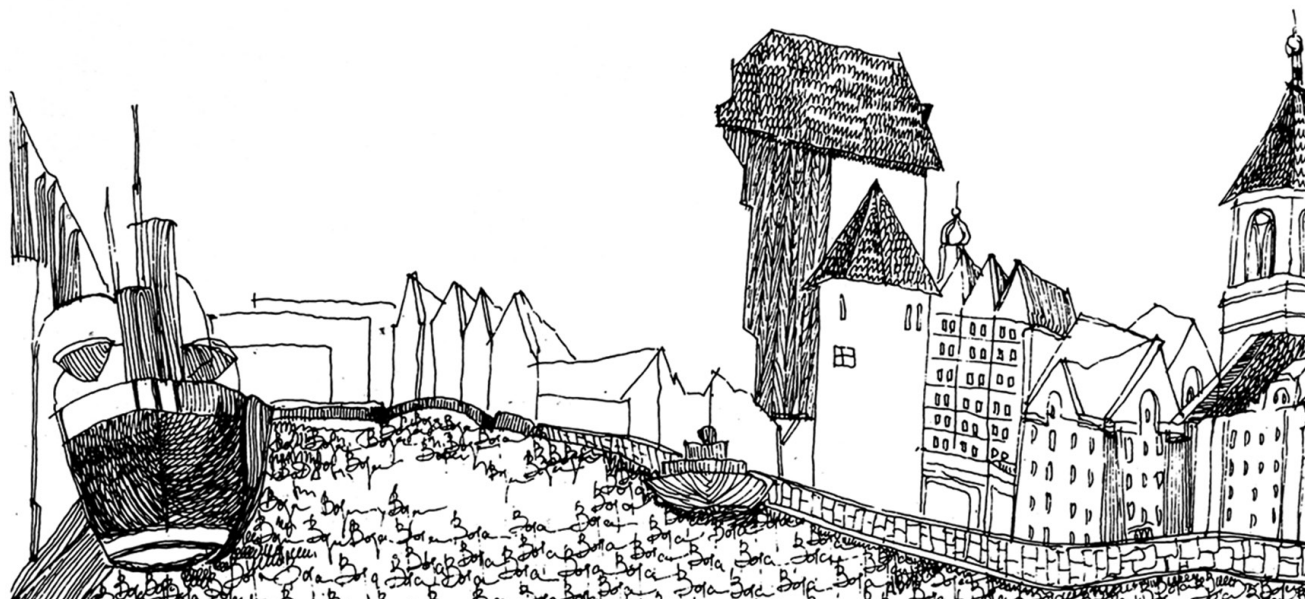
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Об авторе: Адамцевич Любовь Андреевна — канд. техн. наук, доцент кафедры ИСТАС; Национальный исследовательский Московский государственный строительный университет (НИУ МГСУ); 129337, г. Москва, Ярославское шоссе, д. 26; РИНЦ ID: 2537-0511, Scopus AuthorID: 57190342498; WoS ResearcherID: M-5000-2016, ORCID: 0000-0002-5843-0076; AdamtsevichLA@mgsu.ru.

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