Project management in construction while ensuring environmental safety

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Abstract. All stages of the object's life cycle consistently address environmental safety issues of construction projects in accordance with legal requirements. The analysis of environmental security problems in practice necessitates the consideration of multidimensional environmental challenges, emphasizing the significance of the research in this area. In the development and implementation of projects, emphasis must be placed on the sustainable development of the construction site and the surrounding region. Sustainable development in the construction industry entails the practical fulfillment of a set of indicators, including environmental, social, and economic factors, at the required levels. This study aims to investigate project management issues in the construction industry across all stages of the lifecycle, with a focus on ensuring environmental safety. The study involved analyzing current trends and approaches to the environmental component of construction projects, developing a project for an automated construction waste management system in Russian cities, conducting a SWOT analysis of the digital control project for construction and demolition waste management, assessing the economic efficiency of implementing the digital control project, and creating an algorithm for managing construction projects while ensuring environmental safety. The findings of this study offer practical recommendations that may be useful for project managers and civil engineers in the construction industry for ensuring environmental safety during project management.

Key words: project management, construction, environmental safety.

1 INTRODUCTION

The issues of environmental safety of construction projects are solved in practice by developing the so-called integrated safety systems of facilities. Environmental security is ensured through a series of actions and processes that do not cause any direct or indirect harm or threats to the environment.

Russian Government Order No. 1546-r of June 11, 2020, approved an action plan for a roadmap in the field of engineering and industrial design. The plan includes a direction for research and development in this area, as well as improving the staffing system of the engineering industry. This plan then assumes the implementation of the activities carried out there. These tasks need to be solved in order to ensure state regulation of the industry. The

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implementation of such a plan and the execution of these activities in practice are expected to promote the advancement of engineering in our country. In particular, it will aid in enhancing the system of staffing in this field, as well as promote the active development of professional standards. Construction is also seen as one of the directions. Simultaneously, the practical implementation of the plan will facilitate the education of national leaders in delivering engineering services across various domains.

While implementing the aforementioned plan in practice, it is crucial to keep in mind the international cooperation of our country with other nations, across various fields. The primary goal in fostering interstate cooperation among the participating states of the Inter-Parliamentary Assembly of the CIS Member States is to achieve convergence and harmonization of the national legislations of these countries. In the most general case, harmonization refers to the convergence of national legal systems and national standards. For example, the Inter-Parliamentary Assembly's Resolution "On Model Lawmaking in the Commonwealth of Independent States" approved a prospective plan for developing so-called model laws. Model laws are developed by international organizations as models for national legislation and legal regulation in specific areas. During the last three years (2020-2023), model laws have been adopted that focus on various aspects related to environmental safety and engineering activities in the construction industry.

This work aims to study the issues of project management in construction while ensuring environmental safety [1, 2].

The results of the study are the following tasks:
- to analyze current trends and approaches to the development of the environmental component of projects in construction;
- to develop a system project for automated control of construction waste in Russian cities;
- to conduct a SWOT analysis of the digital control project for the construction and demolition waste management process;
- to assess the cost-effectiveness of the implementation of a digital control project for the management of construction and demolition waste;
- to develop an algorithm for project management in construction while ensuring environmental safety.

2 MATERIALLS AND METHODS

The special, regulatory, methodological, and reference literature provides detailed coverage of the issues related to environmental calculations, justifications, and the necessary materials preparation for all stages of construction. Prepared performer can cope with environmental engineering independently and without problems. The table shows some of the regulatory and methodological documents that are used in various environmental calculations and justifications in project management. The analysis of current trends and approaches to the development of the environmental component of projects involved the study of both Russian and foreign regulatory standards [3, 4]. Table 1 lists the documents in sequential order to be used at different stages of the construction project life cycle.

| Table 1. Brief list of regulatory documents used for environmental justification at various stages of project implementation |
|:-----------------|:----------------|
| Stage            | Regulatory and methodological documents                                                                 |
| Pre-project studies and designs | 
| Engineering surveys | 2. GOST R 58917-2021 "Technological engineering and design. Feasibility study of the investment project".  
5. SP 502.1325800.2021 "Engineering and environmental surveys for construction. General rules of the work". |
| --- | --- |
7. GOST R 5891902921 "Technological engineering and design. Comprehensive analysis of the potential hazard of a facility during design"  
8. Environmental protection: practical manual for developers of construction projects / FGUP "CENTRINVESTproject".  
10. Order of the Ministry of Natural Resources and Environment of Russia No. 1118 "On approval of methodology for developing norms of permissible discharges of pollutants into water bodies for water users" of December 29, 2020.  
11. Order of the Ministry of Natural Resources and Environment of Russia No. 581 "On approval of the methodology for development (calculation) and establishment of standards of allowable emissions of pollutants into the atmosphere". of August 11, 2020.  
12. GOST R 58577-2019 "Rules for establishing allowable emissions of pollutants".  
14. GOST R 58556-2019 "Assessment of water quality of water bodies from environmental positions"  
16. GOST 31427-2020 "Residential and public buildings. Composition of energy efficiency indicators"  
17. GOST R 56828.24-2017 "Best available technologies. Energy saving".  
18. SP 48.13330.2018 "Organization of construction"  
19. GOST R 54964-2012 "Conformity assessment. Environmental requirements for real estate" |
The list provided includes recently published documents. It is also necessary to refer to the documents in the status of valid, issued much earlier and use in practice. A preliminary analysis of several foreign "green" documents, in particular the American LEED, the British BREEAM and the German DGNB standard, showed that they were based on a common assessment procedure approach based on rating point systems [5, 6]. For the most part, the standards are based on their country's regulatory framework alone. In the process of addressing environmental safety concerns in construction within our country, the aforementioned Russian "green" environmental technologies standards have been thoroughly studied.

### 3 RESULTS AND DISCUSSION

In accordance with regulatory documents, it is necessary to address the issues of environmental safety of construction projects at all stages of the object's life cycle. To ensure effective management and engineering solutions for a project, it is recommended to consider modern engineering and consulting methods and approaches or seek assistance from a professional consultant with expertise in this field. Such tactics can significantly improve the efficiency of work on the design (construction) of the object, as well as the level of its environmental safety.

Starting with ensuring the requirements of technical regulations in the project is recommended when dealing with issues of environmental safety in construction. In practical analysis of environmental security issues, it is necessary to consider the various environmental challenges that are faced. Therefore, it is important to adopt a comprehensive and systematic approach. Currently, integrated facility security systems are utilized for the operation of facilities in construction. General information about such systems is presented in the standard GOST R 54906-2012 "Complex security systems. Ecologically-oriented design. General technical requirements". Professional consultants can provide more professional assistance in dealing with such tasks as they possess a broader knowledge and can take into account the nuances involved in the development of the environmental component of projects [7].
When developing and implementing projects, it is crucial to prioritize the sustainable development of the construction site and its surrounding area. Sustainable development in the construction industry entails the practical fulfillment of a set of indicators, including environmental, social, and economic factors, at the required levels. Also, performers often have to analyze quite large amounts of information. Professional environmental safety consultants can help determine what information is needed and how it can be requested. This shows the perspective and the demand for such specialists in the market at the moment [8].

Also, as part of the practical recommendations for project management while ensuring environmental safety, the project "System of control over the process of handling construction and demolition waste" was developed. The purpose of developing the system design and software for automated control of construction waste was the following tasks:
- preventing harmful effects of production and consumption waste on human health and the environment in the territory of the Russian Federation;
- reducing the amount of waste and involving it in the economic turnover;
- control over compliance established unified norms and requirements for the organization of waste management activities for construction and demolition of buildings and structures, including soils in the territory of the Russian Federation;
- establishment of a system to record and control the handling of waste management activities for construction and demolition of buildings and structures from their generation to their disposal and recycling;
- preventing unauthorized dumps.

The product of the project is a system and software for automated control of construction waste.

The investment intent is the introduction and implementation of this product on the market.

The concept of the project is to create a fully automated construction waste control system, including an independent application for issuing electronic tickets (waste permits), based on a variety of autonomous sensors monitoring the volume and class of waste installed at construction sites and city landfills.

Table 2 contains the SWOT analysis carried out as part of the project development.

**Table 2. SWOT analysis of the project "System of control over the process of handling construction and demolition waste"**

<table>
<thead>
<tr>
<th>Advantages (strengths)</th>
<th>Disadvantages (weaknesses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quality services</td>
<td>1. Financial restrictions</td>
</tr>
<tr>
<td>2. High quality of manufactured goods</td>
<td>2. Insufficient market experience</td>
</tr>
<tr>
<td>3. Originality of ideas</td>
<td>3. State regulation</td>
</tr>
<tr>
<td>4. Minimum turnaround time</td>
<td></td>
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<tr>
<td>5. Ongoing technical support for the product</td>
<td></td>
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<tr>
<td>6. Profitability of the business</td>
<td></td>
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<th>Features</th>
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<tbody>
<tr>
<td>1. System entry in RF cities</td>
<td>1. Additional checks and obtain clarifying documents may be needed</td>
</tr>
<tr>
<td>2. Providing broader services (on digitalization in construction)</td>
<td>2. Inflation</td>
</tr>
<tr>
<td></td>
<td>3. Need to adjust to the start of work on the construction site</td>
</tr>
</tbody>
</table>
4. Change in the Department of Construction's construction waste control policy legislation.
5. Threat of inefficient operation due to the unfair performance of obligations by developers

A business plan was developed and the cost-effectiveness of the project was evaluated (Table 3).

**Table 3.** Assessment of economic efficiency of the project "System of control over the process of handling construction and demolition waste"

<table>
<thead>
<tr>
<th>Indicator</th>
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<tr>
<td>Payback period</td>
<td>Payback period is the period of time during which the investment is fully recovered from the input net cash flows. For the project this period is 4 years.</td>
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<td>Profitability index</td>
<td>Profitability index (PI) is a measure of the amount of profit for each unit of money spent. The profitability index is 1.81 &gt; 1, which satisfies the condition of efficiency</td>
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<td>Internal rate of return</td>
<td>Internal rate of return (IRR) is the maximum discount rate at which the project remains breakeven. Another discount factor of 17.7% was taken (taking into account the increase in the Central Bank rate and inflation). IRR = 36.48%</td>
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<td>Safety coefficient of the investment project</td>
<td>The safety factor of an investment project makes economic sense in the range of values from 0 to 1. The value of the safety factor, equal to 0, indicates a profitless project, more profitable project corresponds to a larger value of the safety factor. Safety factor 0.45</td>
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The completion and exit strategy contains the following types of work [9, 10]:
- Conducting final tests of the application;
- Reforming the structure of the programmers department;
- Participating in the development and support of the adoption of the federal law on the regulation of construction waste;
- Participating in the development and support of the adoption of the federal law on the regulation of construction waste;
- Calculating correspondence of actual and design capacity of the system;
- Preparing of all necessary documents for transfer to the customer.

The main criterion for making a decision to withdraw from the project should be the expected level of profitability in the changed conditions of its implementation. The implementation should be continued if the following formula condition is met [11]:

\[ Pp > Dir + RP + LP \] (1)

Where
- \( Pp \) — the expected profitability of the real project in the changed conditions of implementation;
- \( Dir \) — the average rate of deposit interest on the money market;
- \( RP \) — the level of "premium" (additional profitability) for the risk associated with the implementation of real investment;
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P_P > D_i + R_P + L_P
\]

Where:
- \(P_P\) — the expected profitability of the real project in the changed conditions of implementation;
- \(D_i\) — the average rate of deposit interest on the money market;
- \(R_P\) — the level of "premium" (additional profitability) for risk associated with the implementation of real investment;
- \(L_P\) — the level of "premium" (additional profitability) for liquidity, taking into account the projected increase in the duration of the real project.

In the course of the study, an algorithm was developed for the integrated functioning of project management in construction while ensuring environmental safety [12]. The algorithm is shown in Figure 1.

![Algorithm of integrated project management in construction while ensuring environmental safety](image)

4 CONCLUSIONS

Typically, the project management process in construction begins with the initiation of the project. Initiating a project involves, first, justifying the need to develop a project and the possibility of its implementation in practice. Second, initiation involves business planning (development of a business plan), and then the selection and appointment of a project manager in construction. The project manager is responsible for overseeing and managing the process at all stages of the project implementation. The project manager is also responsible for organizing the work to ensure environmental safety of the facility, starting from the earliest stages of the project. The demand for professional consultants in our country is increasing due to the current trends in construction. We are not only talking about environmental support services for the project, but also the development of new, non-standard technical, technological, and organizational solutions aimed at minimizing environmental damage at the construction site.

The study provides practical recommendations that may be in demand by project managers and civil engineers in the management of projects in construction to ensure environmental safety.
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