Engineering and consulting services for project management in construction

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Abstract. Engineering is described as an engineering and consulting activity related to the solution of various engineering tasks during the development and creation, as well as the improvement of products, systems or processes. There is a concept of ‘practical engineering’. Usually, this characterizes a certain set of various types of activities carried out with a specific practical purpose. For example, within the specific project, these are professional services of a research, design, production and technological nature.

1 Introduction

There is the concept of ‘practical engineering’. Usually, this characterizes a certain set of various types of activities carried out with a specific practical purpose. For example, within the specific project, these are professional services of a research, design, production and technological nature.
conducted there. These tasks must be solved in order to ensure state regulation of this industry. It is assumed that such a plan and the implementation of these activities in practice will contribute to the development of engineering in our country. In particular, they will help improve the staffing system in this area, as well as encourage the active development of professional standards. Construction is also considered as one of the directions. At the same time, the plan putting into practice will ensure the training of national leaders in the provision of engineering services in a variety of areas.

However, when putting the plan mentioned above into practice, one should keep in mind the international cooperation of our country with other states, and in the most diverse fields. One of the main tasks in development of interstate cooperation of the member states of the CIS Interparliamentary Assembly is briefly formulated as 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 Decree On Model Lawmaking in the Commonwealth of Independent States issued by the Interparliamentary Assembly approved a long-term plan for the development of so-called model laws. Model laws are developed by international organizations as samples (models) for national legislation and legal regulation in specific areas. For the last two years 2020-2022 model laws have also been adopted that address some issues of ensuring environmental safety and engineering activities in construction.

The objective of this research is to study the issues of engineering and consulting in construction, the application of model laws on engineering and engineering activities in construction, questions about the need for engineering and consulting services for project management in construction [1, 2].

The research results are the following tasks:

− to identify and justify the need for the introduction of engineering and consulting services for project management in construction;
− to identify the checkpoints of processes at the stage of completion of the construction digitalization project (by project participants), the required provision of engineering and consulting services;
− to identify indicators to assess the effectiveness of the construction digitalization project;
− to develop criteria for assessing the effectiveness of the implementation of the construction digitalization project.
− to develop an algorithm for the integrated functioning of a consulting engineer in construction.

2 Materials and methods

According to the GOST R 58179-2018 Construction Engineering. Terms and Definitions purpose of engineering in construction is [3]:

− development of various documentation for a facility or process (design, engineering, process, etc.);
− development of recommendations on the project, consultations, audit of documentation;
− performing the functions of a technical customer (for example, it is possible under an agreement with a customer-developer);
− author's supervision during the construction of a facility (for example, it is conducted by the project documentation developer represented the general designer);
− selection and ordering of equipment;
− management of commissioning works on the facility;
− training of personnel for the operation of the constructed facility.
The standard assumes the possibility of providing engineering and consulting services within the listed directions. The goal of providing such services will be to ensure the necessary level of efficiency of the finances invested in the project (subject to the achievement of the best indicators of the investment and construction project). Professional consultants or engineering organizations (companies) specialize in providing such services. Moreover, these services can be provided at various stages of the project implementation (life cycle of the facility). The subject of engineering is not the facility (process) itself, and engineering companies are not engaged in design as such. The subject of engineering is the intellectual process itself, for example, the search for new (effective) engineering solutions.

Services in construction are presented in the GOST R 57488-2017 Services for business. Classification and Requirements and are presented in the technical services section [4]. Table 1 shows these data.

Table 1. List of technical service types for business

<table>
<thead>
<tr>
<th>Professional services group</th>
<th>List of service types for business</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Design services;</td>
</tr>
<tr>
<td></td>
<td>Engineering and design, architectural services;</td>
</tr>
<tr>
<td></td>
<td>Construction works (services);</td>
</tr>
<tr>
<td></td>
<td>Technical consulting services, communication services, including telecommunication services</td>
</tr>
</tbody>
</table>

According to the standard, technical services include design, engineering and architectural services, as well as construction work and technical consulting services. Thus, in this standard, technical consulting (in construction) appears as a service. Therefore, organizations and individuals involved in this type of activity, first of all, need to understand that the process of providing a service is significantly different from production activities.

The success of the provision of services by the contractor largely depends on his ability to maintain contacts with various groups of people involved in the project and interested in its implementation. When providing a service, it is important for a consultant to be able to properly build their relationship with the customer, who ultimately pays for the service provided. The legal aspect of the relationship between the contractor and the customer is fixed by the contract.

The project customer can involve consultants on a wide range of issues, and these can be specialists of different profiles. Before the start of the design, the services of consultants may be in demand, for example, during surveys (geological, hydrological, environmental), then during the design, then during the project examination, construction and commissioning of the facility. Some researchers also try to link certain types of engineering in construction with the main phases of an investment and construction project. The project initiator (customer-developer) is initially focused on the professional management of the project, its risks, timing, cost and, if necessary, seeks to engage qualified consultants.

Focusing on the successful foreign experience of engineering in construction, the following types of engineering and consulting services can be distinguished [5]:

− consulting engineering (consultations in the design, planning of work, its organization and control during construction, field supervision);
− process engineering (transfer to the customer of the process information necessary for the construction and operation of the facility, as well as the transfer of technologies and patents to him);
− construction engineering.
3 Results and discussion

Upon the project completion, its files are coordinated and approved in accordance with the procedure established by law, after which they proceed to the direct construction of the facility. According to the Order of the Ministry of Labor of the Russian Federation No. 747n dated October 21, 2021 On Approval of the Professional Standard ‘Construction Arrangement Specialist’ the main goal of a construction arrangement specialist is to organize the production of types and individual stages of construction work in accordance with the requirements of regulatory legal acts, regulatory technical documents in this area, as well as in accordance with the requirements of construction contracts and developed project documentation [6].

During construction, one can talk about assessing the compliance of the materials and equipment used with environmental performance and certificates. It is also necessary to arrange the control of the storage of materials and equipment supplied to the site in such a way as to avoid damage to the environment when they are placed on the site. Thus, when arranging the construction of an object in order to ensure its environmental safety, a construction arrangement specialist should pay attention to the requirements of legal and regulatory documents governing this area. He also needs to know the requirements of documents (standards) for energy efficiency and rational use of energy resources. The consultant on environmental safety should be guided by the same documents [7].

The completion phase of the project includes the following steps:

− project start-up;
− set results achievement by the project;
− termination of project financing;
− work to close the project and make changes that are not provided for by the original plan;
− participation in the project facilities operation.

The main criterion for making a decision on withdrawing from the project should be the expected level of profitability in the changed conditions of its implementation. The implementation should be continued when the following condition of the formula is met:

\[ Pp > Dir + RP + LP \]  

where

- \( Pp \) — the expected profitability of a real project in the changed conditions of implementation;
- \( Dir \) — the average rate of deposit interest in the money market;
- \( RP \) — the level of ‘premium’ (additional profitability) for the risk associated with the implementation of real investment;
- \( LP \) — the level of ‘premium’ (additional profitability) for liquidity, taking into account the projected increase in the duration of the real project implementation.

Post Project Appraisal — appraisal of the success and effectiveness of the completed project. It also includes the accumulation of new experience and data for future projects. Post Project Appraisal is performed in order to check whether the promised has become a reality, and if not, why not. In all cases, without exception, it is performed at the client’s initiative, although for the sake of impartiality or due to technical specifics, the appraisal may be entrusted to a third party [8].
During the implementation of all projects, certain materials are accumulated. They are directly related to the project records, telling about its timeline, reminding about changes to its plan, confirming who, what and when should do in the process of its implementation and talking about what methods and systems we use. They represent a kind of chronicle of the project.

The accumulation of data for the implementation of subsequent projects allows to:

1. Take into account the mistakes made in the implementation of previous projects;
2. Make more effective management decisions;
3. Study the influence of various components and factors on the course of planning and implementation of the project;
4. Use the available forms of documents, reports for the preparation and implementation of a new project;
5. Provide a system for improving the quality of project implementation.

As part of the construction digitalization project, checkpoints of processes were identified at the project completion stage by project participants, required to provide engineering and consulting services of specialists, presented in Table 2.

Table 2. Process checkpoints at the end of the project for the provision of engineering and consulting services

<table>
<thead>
<tr>
<th>Project participants</th>
<th>Process checkpoints at the end of the project for the provision of engineering and consulting services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Preparation for the project start and the provision of services for the commissioned servers;</td>
</tr>
<tr>
<td></td>
<td>Comprehensive testing of equipment; Adjustment of processing; System commissioning on time;</td>
</tr>
<tr>
<td></td>
<td>Provision of services and development of design capacities within the statutory deadline</td>
</tr>
<tr>
<td>Developer organizations</td>
<td>Compliance of capacities and other technical and economic indicators of facilities with the project. Design issues</td>
</tr>
<tr>
<td>Research organizations</td>
<td>Compliance of the initial data issued by them for design with the achievements of scientific and technological progress</td>
</tr>
<tr>
<td>IT organizations</td>
<td>Quality and timing of program work; Individual testing of the installed equipment; Punch points elimination;</td>
</tr>
<tr>
<td></td>
<td>Timely commissioning of production facilities and objects</td>
</tr>
</tbody>
</table>

As part of the project development, the following indicators for assessing the effectiveness of the digital transformation of the urban economy were identified:

– the average value of the efficiency index of the digital transformation of the urban economy – the IQ of cities;

– the share of urban residents over 14 participating in decision-making on urban development issues using digital technologies (the share should be not less than 60% of the population by 2024);

– the share of organizations managing the housing stock in the heat supply, water supply, sanitation, using automated control room systems (should be not less than 15% by 2024);

– the share of apartment buildings connected to automated accounting systems for the consumption of utilities with the ability to transfer data online (should be not less than 80% by 2024);

– the share of information in the housing and utilities sector, transferred into a machine-readable format (should be 50% by 2024).
One of the indicators of the effectiveness of the ‘smart city’ elements implementation is the definition of the IQ of cities, which is associated with the variable t (time). Time is understood as what a person spends and how he manages it, where he spends time.

For example, before the urban environment digitalization, the population spent most of their time moving in transport, at work (to the office), in the clinic, in the house (apartment) and the least time was spent walking in the park, visiting the pool, sports facilities, theaters, museums etc. Thus, the population is in office premises most of the time.

After the urban environment digitalization, the population will spend most of the time on the street and in cultural institutions and spend less time in office premises.

Therefore, the efficiency function will look like:

\[ IQ = f(t) \]

(2)

where IQ is the efficiency index of the digital transformation of the urban economy, t is time.

If we apply the index method for estimating the IQ of cities, we get the following formula:

\[ IQ = \frac{t_v - t_{min}}{t_{max} - t_{min}} \]

(3)

where IQ is the efficiency index of the digital transformation of the urban economy, \( t_v \) – actual time, \( t_{max}, t_{min} \) are the maximum and minimum values of time for the period under study.

The elements of digitalization of the socio-economic space of the city were analyzed and compared with the indicators of the effectiveness of the implementation of the ‘digital construction’ project, presented in Table 3 [11]. The criteria for assessing the effectiveness of the construction digitalization project implementation are summarized in Table 4.

Table 3. Effectiveness of the ‘digital construction’ project implementation

<table>
<thead>
<tr>
<th>Elements of digitalization of the socio-economic space of the city</th>
<th>Effectiveness of the ‘digital construction’ project implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digitalization of the local governments work (appeals of citizens and feedback)</td>
<td>Increasing the efficiency of city systems and services management</td>
</tr>
<tr>
<td>Digitization of city infrastructure (lanterns, cameras, housing and utilities system, etc.)</td>
<td>Transition to large-scale application of information and computer technologies</td>
</tr>
<tr>
<td>Involving city residents in learning, creating innovations</td>
<td>Growth of innovations and innovative high-tech production; Formation and use of new knowledge; Growth in the number of educated people in the territory; Reducing the environmental load on the territory</td>
</tr>
<tr>
<td>Industry digitalization and transition of industrial facilities, business and entrepreneurship to new technologies</td>
<td>Application of new technologies for the full cycle of urban waste processing</td>
</tr>
</tbody>
</table>

The identified indicators of Tables 2, 3, 4, considered at the project completion stage, indicate the need to involve consulting engineers in the management of investment and construction projects. According to foreign approaches to the interpretation of the role of a specialist consultant, as well as his place in the development and implementation of the project, the consulting engineer in construction is a significant figure. The successful activity of the consultant will ultimately affect the overall effectiveness of the project being developed. His professional competence can largely affect the effectiveness of various decisions on the project (technical, organizational, environmental), and at various stages of the project, from its development to the construction of the facility. The main goal of providing engineering and consulting services in construction is to increase the efficiency of projects.
Table 4. Criteria for assessing the effectiveness of the ‘digital construction’ project implementation

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Input Data</th>
<th>Output Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Formation of the project team</td>
<td>Resource requirements</td>
<td>Project Organizational Structure</td>
</tr>
<tr>
<td></td>
<td>Availability of resources</td>
<td>Project plans</td>
</tr>
<tr>
<td></td>
<td>Role Description</td>
<td>Assignment of project personnel</td>
</tr>
<tr>
<td></td>
<td>Employment contracts</td>
<td></td>
</tr>
<tr>
<td>Project Team Management</td>
<td>Project plans</td>
<td>Project Organizational Structure</td>
</tr>
<tr>
<td></td>
<td>Description of roles in the project</td>
<td>Progress Data</td>
</tr>
<tr>
<td></td>
<td>Personnel performance</td>
<td>Personnel assessment</td>
</tr>
<tr>
<td></td>
<td>Change Requests</td>
<td>Corrective actions</td>
</tr>
</tbody>
</table>

Fig. 1. Algorithm for the integrated functioning of a consulting engineer work in construction

As part of the study, an algorithm was developed for the integrated functioning of the work of Russian engineering and consulting services in construction [12]. It can be seen from the diagram that the activity of a consulting engineer is possible only with the functioning of all levels. The algorithm is shown in Figure 1.

4 Conclusion

The work of engineering and consulting services is already underway in our country, but there is no developed appropriate professional standard for the profession of a consultant yet. At present, it is only possible to legally rely on the draft order of the Ministry of Labor and Social Protection of the Russian Federation On Approval of the Professional Standard ‘Consulting Engineer in Construction’ dated June 03, 2016. An explanatory note has also been

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specialists, and the work itself was performed by them on their own initiative. The National Association of Consulting Engineers (NACE) acted as the design organization. Since 2015, this Association has been a member of the International Federation of Consulting Engineers (FIDIC).

After analyzing the explanatory note to the draft professional standard, focusing on the experience of international practice, we can identify the main aspects of engineering and consulting activities:

− services of a consulting engineer in construction are an internationally recognized activity (at present, there are many international associations of consulting managers);

− such services are classified as a specialized type of engineering services; they involve consulting a wide range of people who are involved in the project implementation at one or more stages, such persons involved in the project include its initiator, investor, customer, technical customer and some other persons;

− these services are referred to the intellectual type of activity of an engineer in construction;

− the specificity of consulting services in construction allows them to be provided not only to engineering companies, but also to individuals as consultants;

− as a rule, such services are provided under agreements concluded with the customer (the developer, investor, chief designer and other persons involved in the project can act in this capacity).

References

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4. GOST R 57488-2017 “Services for Business. Classification and requirements”