Efficiency Perfection of Organizational-Technological Decisions on the Basis of Information Flows in the Construction of Multi-Storey Residential Buildings

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Abstract. The article describes the introduction of the organizational and technological potential concept of a construction project in the form of numerical integral value enabling to make relevant managerial decisions at all stages of the construction project implementation. The article deals with the essence of information flows as an important component evaluating the integral organizational and technological potential of the construction project. The article also provides the examples of dividing information flows into groups according to various criteria and, as a result, the mathematical apparatus model, evaluating the construction project potential and taking into account the impact of information flows.

1. Introduction

At the present stage of the construction industry development, the crucial task is to specify the index, the use of which will enable to predict the construction project endpoint based on the organizational, technological and managerial decisions influencing it, that is, the organizational and technological potential of the construction project (P).

The most widespread economic method of evaluating the efficiency of the investment project is the use of net present value (NPV) index, whereby the project will be considered a successful one, if it covers all the internal costs. However, while using this approach, the final evaluation of the project efficiency is influenced exclusively by the financial parameters of the project implementation such as the discount rate and cash flows, without taking into account and predicting the organizational and technological parameters that occur in the process of its implementation.

The potential of the construction project (P), in turn, is formed considering the processes, which are directly or indirectly related to the industrial and technological specifics of the construction industry at all stages of the project development including design solutions, site preparation, general construction and finishing works, special works (installation of water and sanitation systems, installation of process equipment, electrical fitting and low-voltage currents, ventilation, air-conditioning and fire alarm security, elevators), getting external supply lines and landscaping.
The study of organizational and technological potential (P) of the construction project is carried out iteratively, with each step covering a larger scope of the factors that shape the value being studied in general, moving from particulars to generals [1]. For example, currently, the research has already been carried out, and the results for the organizational and technological solutions for the formation of the structure of the prime contractor, the environmental impact on the construction project and the formation of the construction site have been achieved.

A new factor affecting the formation of the quantitative integrated potential of the construction project, the information flow (IF), is being considered as part of the present study. IF refer to the flow of messages or data intended for the construction project implementation in the oral, documentary, electronic and other forms [2].

Despite the fact that the choice of technological and organizational solutions is made at the design stage, as a rule, in the process of the construction project implementation, the solutions adopted previously can be modified due to changes in the current situation. Most often the information flows appear to be the reasons of adopting or changing a certain decision.

Thus, the integrated evaluation of the information flow use efficiency at the enterprise plays an important role in ensuring the reliability and safety of the construction site as well as the competitiveness of the company.

Earlier only a limited scope of authors of the national literature considered the impact of information flows on the final efficiency (potential) of the construction project. However, in recent years, the authors of the foreign literature have paid much attention to this issue [4].

Information flows in the sphere of the construction project implementation may include the technical documentation of the project, the legal and regulatory framework and the internal documents of administrative use (minutes, orders, reports from the construction site, work performance and field supervision logs) [1-2].

According to the evaluation criteria information flows can be divided into the following groups:

- incoming or outgoing;
- descending or ascending;
- internal or external;
- vertical (directive-formal) or horizontal [3].

In general, the organizational and technological potential of the construction project (P) is a numerical discrete index obtained with the help of the corresponding mathematical apparatus [4]. The concept of “Organizational and technological potential of the construction project on the basis of information flows”, $P_{if}$ (potential information flows), is introduced to evaluate the efficiency of the information flow use in the construction project.

This index is a function of the determined set of indices (criteria), each of them characterizes the efficiency of information flow impact on the endpoint of the construction project implementation [5-6].

The requirements for the evaluation criteria are as follows:

A) The choice of criteria is based on expert assessments;
B) Each criterion has a high impact on the endpoint;
C) Each criterion may have three coding values: -1, 0, +1.

The following specified factors affect the value of $P_{if}$:

1) IF rate, depending on the administrative structure of a construction company;
2) information (documentation) carrier type;
3) information flow standardization degree;
4) IF confidence (verification) degree;
5) IF relevance degree;
6) IF urgency (timeliness) degree;
7) IF entry time;  
8) quantitative characteristic of the IF content;  
9) possibility of IF formalizing;  
10) IF receipt control degree.  

Due to the results of the analysis of the expert survey of competent specialists (using the expert evaluation method) of the construction industry in terms of compliance of the above mentioned factors simultaneously with three requirements and the maximum value of their weight characteristics six indices have been selected to be used for calculation of the organizational and technological potential of the construction project on the basis of information flows, including IF rate, depending on the administrative structure of a construction company, information (documentation) carrier type, information flow standardization degree, IF confidence (verification) degree, IF relevance degree and IF urgency (timeliness) degree. According to the expert evaluation, their total weight is more than 90% and it enables to create a mathematical model of the organizational and technological potential of the construction project on the basis of information flows, using the above mentioned factors [7].  

The factors are analyzed as follows:  
1. Information flow rate, depending on the administrative structure of a construction company.  

The administrative structure of a construction company significantly affects the transmission rate of the information flow from the source to the final destination. In particular, the linear administrative structure is logical, formally defined, but it lacks flexibility due to the lack of horizontal links and the excessive bureaucracy slows down the managerial decision-making process.  

The possible values are as follows:  
1) Linear, functional-linear structure - IF is slow enough. Value is equal to -1  
2) Divisional structure, matrix structure - IF has an acceptable rate. Value is equal to 0  
3) Project structure – IF rate is at maximum. Value is equal to +1  
2. Information (documentation) carrier type.  

According to the existing requirements for production works, the design solutions on the construction site are implemented in the presence of the formal mark “Approved for construction” [5-6]. At the same time, the documentation in electronic form enables to change the manufacturing process rather quickly, although its presence is not required by regulations. The best results are achieved in the presence of documentation on both paper and computer media [7-8].  

The possible values are as follows:  
1) Computer media. Value is equal to -1  
2) Paper media. Value is equal to 0  
3) Computer and paper media. Value is equal to +1  
3. Information flow standardization degree.  

The issues concerning the information flow standardization are of great importance; hence the maximum value is achieved, if the information flow corresponds to the approved standard [11-12].  

The possible values are as follows:  
1) IF doesn’t correspond to the approved standard and can’t be processed with the help of additional actions. Value is equal to -1  
2) IF doesn’t correspond to the approved standard and can be processed with the help of additional actions. Value is equal to 0  
3) IF corresponds to the approved standard. Value is equal to +1  
4. IF confidence (verification) degree.  

In case of ascending internal information flows, the following situation may occur: the reports coming directly from the construction site to the company’s management do not go through the intermediate
reliable filters. Thus, the company’s management runs risks of receiving invalid data on the basis of which inefficient decisions can be made [9].

As a rule, employees or departments of the company serve as such intermediate filters [8-9].

The possible values are as follows:
1) IF doesn’t pass through the intermediate filters. Value is equal to -1
2) IF passes through the intermediate filters but not on a regular basis. Value is equal to 0
3) IF passes through the intermediate filters on a regular basis. Value is equal to +1
5. IF relevance degree.

The information contained in the information flow, on the one hand, should promote the adoption of managerial decisions, and on the other hand, it should correspond to the stated purpose.

If the received commercial offer of the potential subcontractor lacks information about the time frames and job costs, such a proposal can be considered to be irrelevant [10-11].

The possible values are as follows:
1) The information in the IF is irrelevant. Value is equal to -1
2) The information in the IF is partly relevant, but the usefulness of the information is questionable. Value is equal to 0
3) The information in the IF is relevant and useful for decision-making. Value is equal to +1
6. IF urgency (timeliness) degree.

The construction project suggests quite a dynamic participation of all its members in the decision-making process. The information received at the construction site should be as timely as possible, but, sometimes, the dynamics of the project development is ahead of the urgency of the information received [12-15].

The possible values are as follows:
1) The information in the IF is outdated. Value is equal to -1
2) The information in the IF is partly outdated and partly urgent. Value is equal to 0
3) The information in the IF is completely timely and urgent. Value is equal to +1

Now assume, that a function, characterizing the dependence of the required potential on the abovementioned factors specified in using the expert evaluation method, is the formal description of \( P_{if} \) parameter. The mathematical model is formed as follows:

\[
y = f(p_1, p_2, ..., p_n) \quad (1)
\]

where:
y is the resulting index;
\( (p_1, p_2, ..., p_n) \) is the combination of factors.

Taking into account different degrees of influence of the selected weights on the endpoint of \( P_{if} \) potential, let’s assume the \( a_i \) parameter describing this influence,

where:

\[
a_i \in [0,1], \quad \sum_{i=1}^{n} a_i = 1
\]

Thus, the function of determining the potential of the construction project on the basis of information flows is as follows:

\[
P_{IF} = \sum_{i=1}^{n} p_i a_i = p_1 a_1 + p_2 a_2 + ... + p_n a_n \quad (2)
\]

The abovementioned stage enables to create the group of factors that determine the required potential on the basis of information flows. The use of the described tool makes it possible to make rapid and
relevant managerial decisions at all stages of the construction project implementation. Our research is carried out in this direction. The further materials will contain the information concerning this subject.

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