DOI: 10.63550/ICEIP.2025.40.33.099

A System of Optimal Rationing of Related (Indirect) Works Within the Framework of Construction and Installation Works

Belyaeva O.V.[1][a], Elfimova A.D.[1][b], Brynko V.A.[1][c], Shagunova N.A.[2][d]
[1]*Department of Management and Innovation, National Research Moscow State University of Civil Engineering (NRU MGSU), Moscow, Russian Federation*
[2]*Department of Financial Management, Independent researcher, Belgrade, Serbia*
bels21973@yandex.ru, elfimovaad@mgsu.ru, Vsevolodbrynko@mail.ru, Natalia_Shagunova@outlook.com

Keywords: Construction, Management, Cost control, Installation work, Rationing, Metal structures, Problem solving methods.

Abstract: Construction is one of the most complex branches of the national economy. This is due to the long duration of the construction of a real estate object (forming the final product of the industry), the content of a large and diverse amount of work in the process of creating material goods. Works and their payment are regulated by the project documentation. Project work is paid for directly by the customer under the contract, but some of the work can not be included in the estimate, but is required for construction work. These works are not paid for by the customer, and the contractor bears the costs for them himself. To effectively manage the construction site and manage the organization's expenses, companies need to implement mandatory standards and control systems for these works. The article discusses possible related works at each stage of construction, and suggests a system of accounting, control, and rationing of these works.

1 INTRODUCTION

The construction sector is one of the most labor-intensive in the national economy. This complexity is explained by the long period of creation of a real estate object and a wide range of work performed in the production of material values.

Due to the large volume of various works, starting from the preparatory documentation, ending with finishing works and putting the object into operation, it is customary to distinguish several main stages that allow you to simplify and systematize all the work necessary for the construction of civil and industrial facilities (Table 1).

Table 1: Necessary works for the construction of civil and industrial buildings.

Name of the stage	Works with the object carried out at the stage
of Investment stage	At this stage works are not carried out
Design stage	At this stage of work
Land works are not carried	out Development of soil
	Moving of soil
	Compaction of soil
	Artificial fixing of soil
	Arrangement of drainage structures
	Planning of foundation bases
	Backfilling
Foundation works	Pouring concrete under the foundation or laying slabs for temporary construction
	Waterproofing of the foundation and structural
Structures Installation of load-bearing and enclosing structures	Slinging of mounted elements
	Installation of structures in the design position

[a] https://orcid.org/0000-0003-2549-1013
[b] https://orcid.org/0009-0004-0963-0698
[c] https://orcid.org/0009-0009-7659-147X
[d] https://orcid.org/0009-0004-8013-0063

	Ensuring stability and immutability of the position of structures
	Ensuring the accuracy of the position of structures (Geodesy)
	Control of connections during installation
Installation of roof and internal partition	laying of roofing material
	installation of roofing elements
	installation of vapor barrier and waterproofing
	installation of drainage systems
	Construction of frame partitions with plasterboard covering
	installation of partitions made of glass blocks, bricks,
	sound insulation of walls and partitions
ST works	Introduction of pipelines into the building
	Wiring of pipelines inside the structure
	Construction and installation of
	Installation of plumbing equipment
	Commissioning works
ET works	installation of distribution boxes
	laying of cables and wires inside and outside premises
	installation of additional supports
	installation of earthing
Finishing works	putty and plaster works
	leveling of floor with screed
	plasterboard works
	painting, painting of walls and ceilings
	electrical installation works

Each stage contains various works that are performed on the site to implement the construction process. At the same time, various additional (preparatory) works are required to perform certain types of work, without which the implementation of the main front of work will be impossible. Some similar works are taken into account as part of the formation of the estimate documentation. They are attributed to the percentage of overhead costs, on the basis of which the final estimated cost of the construction of a real estate object is formed. Standards for the performance of certain works are reflected in the estimate in accordance with the" State Element Estimate Standards " (SES). They reflect potential standards for the execution of project work according to the estimate, but these standards are not applicable for the formation of internal standards, since they do not take into account all factors that affect the speed of work execution. Overhead costs included in project documents reflected in the estimates usually include:

1. Labor costs for administrative and business personnel;
2. Social contributions (mandatory contributions to the State Social Insurance Fund);
3. Depreciation charges (rent) on fixed assets;
4. Expenses for carrying out all types of repairs (deductions to the repair fund or reserve for repairs) of fixed assets, etc.

At the same time, overhead costs are paid directly by the customer (at the time of forming and signing the cost of work), but some of the preparatory work required for the construction of the object cannot be attributed to overhead costs.

These works are not paid for by the customer and cannot be included in various supplementary agreements. These works belong to the class of indirect (related) works. The organization and execution of these works is organized and carried out by the contract or himself, who carries out construction work directly on the site. Since these works are not additionally paid for by the customer, contractors in the process of carrying out these activities necessary for the implementation of the main production front must control the cost of human resources for related work. Lack of control over this process can lead to a decrease in the planned profit and reduce the financial efficiency of the object on which the organization performs work. To control and plan financial and human resource requirements, it is necessary to develop standards that allow you to calculate in advance the necessary costs for their implementation. This article discusses the list of these activities within each stage of construction and suggests a system for rationing the potential costs of carrying out these works.

2 MAIN PART

2.1 Materials and methods

To form a system for rationing indirect works, the main stages of production that are included in the construction work process were considered. Factors influencing the inclusion of additional features in the financial planning process in the construction of objects that have certain features (climatic, territorial, organizational, architectural, etc.) are formed and evaluated.

2.2 Research results

As part of the analysis, the main works that are carried out at this or that stage of construction were identified (Table 2).

Most of the works contain more than four necessary related works, each of which must include a certain percentage of financial costs and expenses of financial expenses. At the same time, the actual amount contained in a particular work may vary due to the special features of each construction object and the area of the object being built. Because of these differences, each project requires additional consideration of factors that affect the process of performing the construction process itself and performing related works. Such factors can be divided into several main categories, which include architectural features of the object, climatic conditions of the object, and geographical conditions. As part of the analysis, three main factors a were identified that affect the process of performing basic work and related work.

2.2.1 Climatic coefficient of reduction in output

This coefficient is due to extreme or complicated weather conditions. There is a difference between this coefficient and the coefficient of winter price appreciation, which is reflected in the estimate. The winter price increase coefficient reflects the indexation of labor remuneration (without taking into account the decrease in output). This coefficient takes into account the speed of performing certain works due to changes in weather conditions that do not allow you to perform work at the desired pace. This coefficient can be applied to regions where high or low temperatures persist over a longer period of the year.

2.2.2 Loading and unloading operations with complicated conditions

Loading and unloading of material from the warehouse is an integral part of the work process, but in the case of transferring materials and lifting manually in difficult conditions (terrain, erected title objects, etc.), an additional coefficient is required, due to the slowingм down of the work process).

2.2.3 Repair work that occurs during the work process

This coefficient applies to objects that may have difficulties in the construction process due to architectural solutions of the real estate object. This may lead to reworking the built elements, for example, leveling strong deviations in the walls after finishing work.

Due to the fact that each of the related works is not paid for by the customer, a unified system of rationing and accounting for these works is required. The unified accounting system allows you to calculate each work included in the estimate and form an effective system for managing finances and organizingю construction, regardless of the site's specifics, which allows you to make comprehensive calculations that reflect the overall indicator for the entire object.

Formula for determining the cost of related (indirect) works for the entire estimate:

$$Ssn = (((1 + (K_{ch.v} + K_n + \ldots + K_{nn})) * (\%\,PRR + \%TRASH + \%ATT + \%ORG + \%PFP)) + 100\%) * CHTS_{cf.} \quad (1)$$

Where:
$Ssop$ – Cost of related work;
$K_{Kn.v}$- Climatic coefficient of production reduction;
K_n – Other coefficients that complicate the work;
%PRR – The percentage laid down for loading and unloading operations (over a short distance);
% COP – The percentage used for sorting the material;
%ATT – The percentage allocated for training/ certification of workers;
% ORG – The percentage used to prepare for work;
% PRM – The percentage allocated for job preparation (provision of connection points);
$CHTS_{wed}$ – Average hourly rate.

Formula for calculating the total cost of work performed (planned):

$$C_{is\ full.} = Ssmet + Ssop \quad (2)$$

Where:
$Ssmet$-Estimated cost.

Within the framework of the presented formula, all factors included in the performance of a particular work are taken into account and distributed among the work items, which makes it possible to determine the financial costs of performing related work.

Table 2: Related work that can be carried out at each stage of construction.

Name of the stage	Of work with the object,	Related works carried out at the stage
Investment stage	No work is carried	-
Designing	stage No work is carried	out at this stage
Land work	Development	Certification and training of specialists Organizational time Certification and training of specialists Organizational time Preparation of the site for work
	Ground movement	
	Ground movement Compaction of the ground	
	Artificial soil consolidation	Certification and training of specialists Organizational time Preparation of the site for carrying out operations Loading and unloading operations (for short distances) Preparation and sorting of the material that came from the warehouse
	Arrangement of drainage structures	
	Planning of foundation foundations	
	Backfilling	-
Foundation work	Pouring concrete or laying slabs	1. Certification and training of specialists 2. Organizational time 3. Preparation of the site for work 4. Loading and unloading operations (for short distances) 5. Preparation and sorting of materials that came from the warehouse
	Waterproofing	
Installation of load-bearing and enclosing structures	Slinging of mounted elements	1. Certification and training of specialists 2. Organizational time 3. Preparation of the site for work 4. Loading and unloading operations (for short distances) 5. Preparation and sorting of the material that came from the warehouse
	Installation of structures in the design position	
	Ensuring the stability and immutability of the position of structures	
	Ensuring the accuracy of the position of structures (Geodesy)	
	Control of connections during installation	Repair work
Installation of the roof and internal partition	laying of roofing material	1. Certification and training of specialists 2. Organizational time 3. Preparation of the site for work 4. Loading and unloading operations (for short distances) 5. Preparation and sorting of materials that came from the warehouse
	installation of roofing elements	
	installation of vapor barrier and waterproofing	
	installation of drainage systems	
	Construction of frame partitions with plasterboard	
	covering installation of partitions made of glass blocks, bricks,	
	sound insulation of walls and partitions	
ST works	Introduction of pipelines into the building	

	Wiring of pipelines inside the structure Construction and installation of assembly units and connections Installation of plumbing equipment	1. Certification and training of specialists 2. Organizational time 3. Preparation of the site for work 4. Loading and unloading operations (for short distances) 5. Preparation and sorting of the material that came from the warehouse
	Commissioning	Repair work Testing
of ET works	installation of junction boxes laying of cables and wires inside and outside premises installation of additional supports installation of earthing	1. Certification and training of specialists 2. Organizational time 3. Preparation of the site for work 4. Loading and unloading operations (for short distances) 5. Preparation and sorting of materials that came from the warehouse 6. Repair work 7. Tests
Finishing works	putty and plaster works leveling floors with screed plasterboard work painting, painting walls and ceilings	1. Certification and training of specialists 2. Organizational time 3. Preparation of the site for work 4. Loading and unloading operations (for short distances) 5. Preparation and sorting of materials that came from the warehouse 6. Repair work
	electrical work	1. Certification and training of specialists 2. Organizational time 3. Preparation of the site for work 4. Loading and unloading operations (for short distances) 5. Preparation and sorting of materials that came from the warehouse 6. Repair work 7. Trials

Based on a similar formula, it is possible to determine the basic standards for performinge a particular job, which allows you to calculate the cost of human resources

Formula for the rate of human resource expenditure for carrying out works (related):

$$Nsn = (((1 + (K_{ch.v} + K_n + \ldots + K_{nn})) * (\%\ PRR + \%TRASH + \%ATT + \%ORG + \%PFP)) * (Z_{per\ unit} * V) \quad (3)$$

Where:
$Nsop$-standard for performing related work;
$Z_{per\ unit}$ – the cost of people/hour to sell a unit of volume;
V-volume.

The formula for forming fullx norms of human resource expenditures for work:

$$N_{is\ full.} = N_{project.} + N_{sop.} \quad (4)$$

Where
$N_{is\ full.}$ - Full rate;
$N_{project.}$ - Standard for project work;
$N_{sop.}$ - Norm for related work.

The amount of hours spent on the project and related work process allows you to track the actual hours required to complete the work front and the required amount of human resources.

For the effective formation of norms, it is necessary to lay down a more likely percentage for a particular job. To do this, you need to perform timekeeping for the performance of a particular work, but keep in mind that not all works fall under the timekeeping formation, so you need to take into account that the amount of interest charged for additional work should vary in the range from 30% - 40% for objects that do not contain special conditions and 45%-65% for items that contain special conditions. This will allow you to maintain an optimal balance of costs for related work relative to the potential estimated profit and generate higher efficiency in the construction process of the property.

3 CONCLUSIONS

On the basis of the conducted research, the main related works that may arise in the course of various design works in construction were identified. A system of rationing and control of these works has been developed, which allows contractors to more efficiently generate and allocate funds and human resources for project work. This makes it possible to more realistically assess the potential costs both for the full list of works reflected in the estimate documentation, and to assess the standards for carrying out specific works within the project documentation.

REFERENCES

Sinelyubov, M.A., 2023. Analysis and comparison of methods of fastening metal structures, *Tula State University News. Technical sciences*., №5.

Kosarev, L.V., Kostyukova, Y.S., 2022. Installation of metal structures in the conditions of the Far North, *INNOVATION AND INVESTMENT*, №12.

Ulshin, A.N., 2015. Experimental substantiation of the method for increasing the integrated manufacturability of a steel rod structure, *Engineering and construction journal*, №2.

Sidorenko, P.V., Savchik, E.N., 2022. Application of quality management methods to analyze the process of installation of metal structures, *Current issues in aviation and astronautics*, vol.2.

Narkevich, L.V., Kazanskiy, A.V., 2020. A systematic Approach to Evaluating the Effectiveness of an investment Project, *Economic journal.*

Ulshin, A.N., 2015. Methodology for determining the generalized indicator of manufacturability of design, manufacture, transportation and installation of a steel rod structure, *International scientific-research journal*.

Mukhametzyanov, Z.R., Razyapov, R.V., Mogucheva, T. A., Batyrova, D.R., 2021. Optimization of technology and organization of installation of isothermal tank as a component of the industry complex, *Construction Economics*, №6.

Pleshko, M.S., Nasonov, A.A., Yagodkin, F.I., Privalov, A.A., 2017. Some issues of increasing the efficiency of design, construction and reconstruction of vertical shafts, *Mining information and analytical bulletin*, №8.

Topchiy, D.V., 2023. Managerial and engineering solutions made to ensure the quality of construction and installation work at various stages of the life cycle of a constraction facility, *MGSU Bulletin*.

Moshkalev, D.S., 2022. Practical tools for an integrated construction cost management system, *MGSU Bulletin.*