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DIGITAL TRANSFORMATION OF RESOURCE LOGISTICS AND ORGANIZATIONAL AND STRUCTURAL SUPPORT OF CONSTRUCTION

Introduction. *Compliance of timing of construction works and supply of resources to the site with the works program is an urgent need, because any failure to supply or mismatch of schedules of works and the movement of materials and technical resources may have serious negative consequences for the construction process.*

Problem Statement. *It is necessary to minimize deviations of actual construction terms from those specified in the design documents by creating tools for managing the organization of the construction process based on operational data, their mathematical processing, identification of trends and remedy of deviations based on current information on the course of construction.*

Purpose. *To improve tools and means of the resource logistics and organizational and structural support of construction in order to minimize deviations of the actual terms of the supply of resources to the site from those specified in the design documents at the stage of design works and preparation of CSOS (construction site organization scheme) and SWEP (site work execution program) with seasonal factors taken into consideration.*

Materials and Methods. *The research uses methods of expert estimations, seasonal decomposition of time series, and comparative analysis.*

Results. *The analysis of modern software for the construction of construction, the scheme of organization of the construction project has been established, it is proved that seasonality is a factor that performs moderate influence on the terms of construction and supply of resources, created models of forecasting deviations of the course of the building process taking into account seasonality.*

Conclusions. *The existing methods for forecasting deviations, which are used in the Microsoft Project, OpenPlan, Spider Project, SureTrek Project Manager, Primavera Project Planner, and other software should be added with models designed to predict realistic timelines with seasonal factors taken into consideration.*

Keywords: construction, seasonal fluctuations, construction organization, and term of works.

In the present-day economic conditions, the problem of compliance of the actual terms of construction works and the time of delivery of resources to construction sites with the scheduled ones is particularly urgent, as either the lack of any of the materials or their surplus, or interruption in deliveries, mismatch of works program and supplies of resources can have serious negative consequences for the construction process.

In view of this, one of the main tasks of resource, logistical, organizational, and structural support of construction works is the implementation of tools that help minimize deviations from the planned indicators and can be the basis for the formation, development, and effective use of resources. This problem can be solved at a new quality level through replacing the conventional processes of interaction between the parties involved in the realization of construction works contract by digital ones, using the state-of-the-art information technologies.

Soon, all significant construction projects in Ukraine will be created using Building Information Modeling (BIM) technology at every stage of the construction life cycle, in particular, at the stage of survey and operation, which is one of the main trends in the development of domestic construction. industry. The use of information models for optimization of resource, logistical, organizational, and structural support of construction works requires digital transformation of business processes of the parties involved in the realization of construction works contracts, abandonment of outdated technologies, and changes in the organizational and technological structure of the project, which now has to be oriented towards speeding up the processes that provide information exchange within the information model of the project. Therefore, it is necessary to comprehensively study the processes of resource, logistical, organizational, and structural support of construction, given their transformation.

Among those who have been studying the problems related to minimization of construction time, increase in the efficiency of organization of construction processes, economic justification of solutions for their optimization there are I.V. Bagrova, V. Bansal, J. Bellman, M.S. Budnikov, A.F. Goiko, A. Ebner, A.D. Esipenko, K.V. Izmailova, V. Cook, O.M. Livinsky, V.O. Pokolenko, A.V. Radkevich, V.I .Sadovsky, V.I. Torkatyuk, O.A. Tugay, R.B. Tian, S.A. Ushatskiy, O.V. Fedosova, V.K. Chernenko, F. Holt, and others. They have laid foundations for further research in the field of construction organization and created the preconditions for identifying the main factors and reasons for deviations of actual terms from those of works program and the theoretical basis for developing a mechanism to minimize these deviations and for creating appropriate tools for digital transformation of construction processes.

Digital transformation of construction is, above all, a process that requires fundamental changes in technology, organizational decisions and engineering solutions and principles of construction works, which minimize deviations of the actual terms from the scheduled ones by means of creating tools for managing the processes of construction works organization, monitoring the supply of resources, analyzing the existing deficiencies and divergences of the construction process, managing construction resources based on the available data and their mathematical processing, identifying trends and removing deviations based on real-time information on the progress of construction works rather than a mere integration of digital technologies in all aspects of the activity of construction corporations or introduction of information modeling technology in the design of construction projects.

In order to maximize the efficient use of new technologies and their rapid implementation in all activities, the corporations need to change processes and models of their operation. Digital transformation is the framework for new qualitative transformations of the construction processes. However, it requires developing a methodological framework for the economic aspects and the organization of construction works, revision and optimization of the existing tools. As a result, the creation of new management principles, models, and methods, taking into consideration the digital transformation of construction processes is an important problem to be urgently addressed.

The purpose of this research is to improve tools and means of the resource logistics and organizational and structural support of construction works for contractors (at the level of contractor corporations, project managers, construction processes, construction site, section, etc.) in order to minimize deviations of the actual terms of the supply of resources to the site from those specified in the design documents at the stage of design works and preparation of CSOS (construction site organization scheme) and SWEP (site work execution program), using modern information technologies.

To address this problem, it is necessary to solve many interrelated problems, in particular: to describe the organization of the processes of construction of a particular object; to identify the causes of disruption of the construction progress and the supply of materials and technical resources to the construction site; to outlook advanced software for making decisions on construction works organization; to identify the seasonal effects on the deviation of the actual terms of works from the planned ones, and to create appropriate models that may be used as methodological framework for digital transformation of construction.

Pursuant to the Law of Ukraine on Innovation Activity [3], innovation is newly created (applied) and/or modernized competitive technology, product or service, and/or organizational and engineering solution of production, administrative, commercial or other nature, which significantly improve the structure and quality of production and (or) social sphere.

Improvement of organizational and engineering solutions which can significantly improve the structure and quality of construction works and to reduce deviations from the schedule of resource supply depends on the quality of information exchange between all parts to the construction process, the organizational structure of construction works, accurate prediction of divergence of the actual terms of resources supply from the scheduled ones and adequate measures for prevention such divergences. Therefore, the system of resource and logistic support of construction projects shall be improved in two interrelated directions: improvement of information exchange within the organizational and structural support of the project and more accurate prediction of divergences of the actual terms of delivery from the scheduled ones, based on the resource and logistic system of the project.

According to the Government Construction Standards (DBN) *Organization of Construction Production* [4], the processes of construction works organization shall be planned at the stage of developing the design documentation that includes construction site organization scheme, CSOS, (works schedule and bill of quantities for plants, materials, and machinery linked to the construction phases) and site works execution program, SWEP, (works program that establishes the sequence and timing of works with the maximum possible combination of them, schedules of delivery of plants, materials and machinery/equipment to the site, completing units details, chart of workmanship and machinery flows on the site), which further is as a basis for organizing construction works on the site and for monitoring the progress of the construction process.

The main purpose of the system for resource logistics and organizational and structural support of construction projects is to fulfill the conditions for performing construction works of a required quality, within the project budget and terms. Building an effective formalization of the construction organization processes results in the formation of relationships between the necessary structural parties, in particular: the contracting organization (the client), the general contractor, the subcontractors, the general designer and other design organizations involved in the construction and engineering works.

The process of creating an effective system of resource logistics and organizational-structural support for the construction of facilities is quite complicated, involves changes in the quality of the resource provision of individual construction participants, is subject to many external and internal factors, contains certain organizational and management measures that are carried out sequentially or at the same time (Fig. 1).

The actual construction conditions (delays and interruptions in supply of materials, malfunction of equipment, unfavorable weather and climatic conditions, etc.) lead to the need for adjusting and revising the construction works and the re-

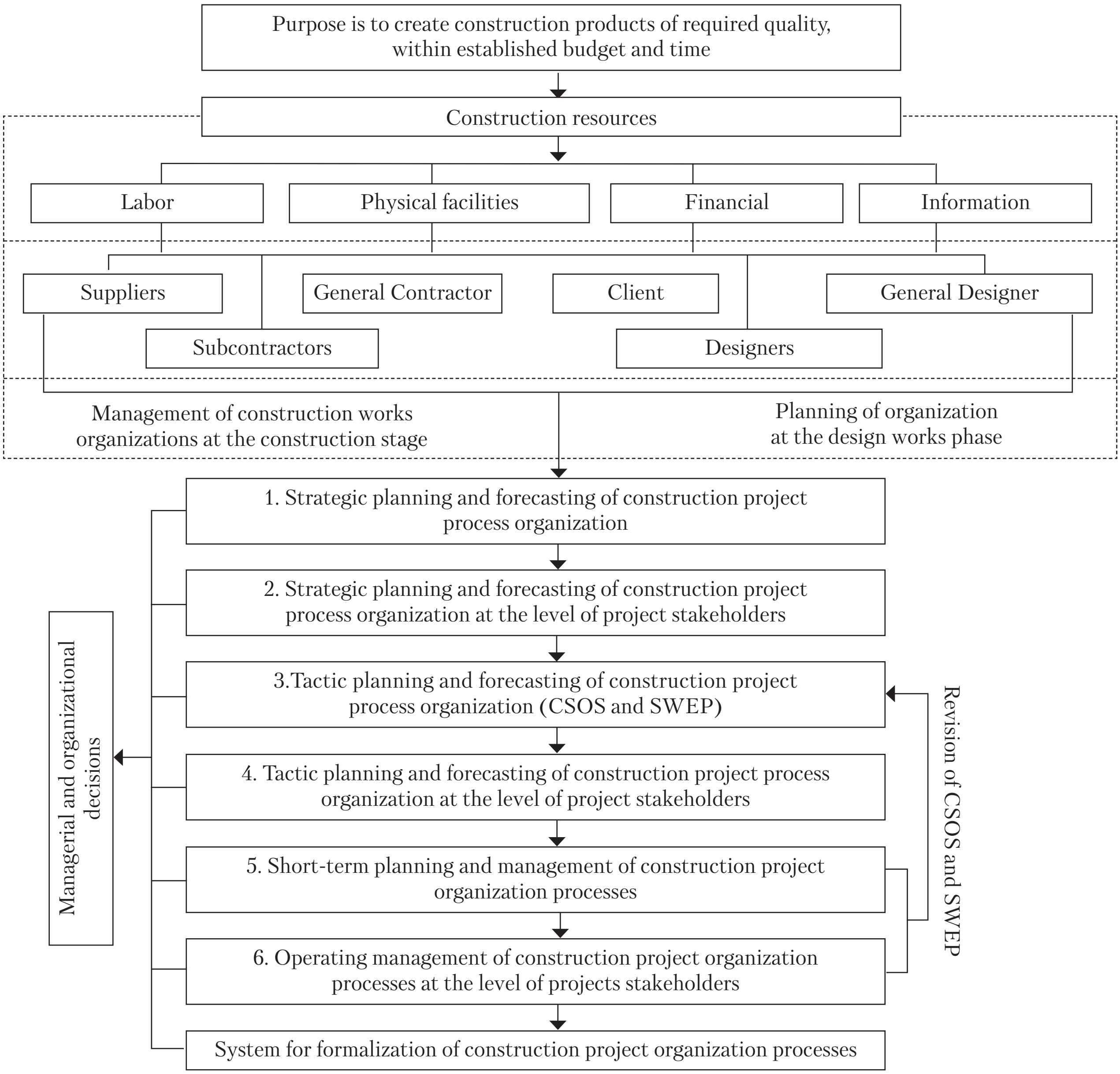

Fig. 1. Flowchart of construction project organization

sources supply schedules. The frequency of revision of the planned indicators depends on the period of construction and on how significant the divergences are, as well as on the possibility of online adjustments (for minor divergences).

Today, effective decision-making on the construction organization and management cannot be realized without the use of special software, because software is the only means that enables to take into account the stochasticity of construction processes with proper accuracy and to process significant amounts of information on deviations in the terms of execution of works and supply of resources during the project construction phase.

The construction organization and management software is based on calendar (grid or linear) models enabling to calculate the timing of individual works or the entire project by the critical path method.

Among the software used to organize the construction of various types of objects, the most widespread are *Microsoft Project*, *OpenPlan*, *Spider Project*, *SureTrek Project Manager*, and *Primavera Project Planner*, *Megaplane* [5—9], and so on. All of them are based on organizational and technological model of construction. Each program enables to create and to adjust construction works schedules and resource management models and has a set of templates for creating an organizational model of resource logistics.

Microsoft Project [5] enables to plan and to control the resources and timing of works, the activities of contractors, to promptly respond to changes in the works or the resources supply schedule. Its disadvantage is the lack of means for management and control of resources.

Spider Project [6] is designed to build construction works schedules. The program can determine the duration of a particular process depending on the quantities of works and available resources. Its advantage is the possibility to create structures that do not cover all works, or even structures that do not relate to work at all (for example, to create a model of resource support). The risks are assessed by analyzing the productivity of labor resources, machines, and mechanisms, with a conclusion on possible divergences from deadlines formulated. The disadvantage is that the *Spider Project* does not enable to simultaneously work with data for several users, so changes are usually made by project manager, which often delay decision-making. Other users have a limited access right (to view or to do a limited range of operations).

Primavera Project Planner [7] is used to manage medium and large construction projects and other projects. The program contains a standard list of works. *Primavera Project Planner* enables to revise work schedules when specifying the earliest possible end date, or the latest commencement date. The program provides a limited number of tools for organizing the resource management.

OpenPlan [8] is characterized by powerful resource and budget planning tools. It is based on a grid model. The program not only selects the degree of detail in the planning and analysis of the resource, but also manages the changes in the cost of resources, taking into account their limitations, as well as regulates the load of the resource indicating an increase in intensity at the beginning, in the middle or at the end of works. Also, the software package enables to compare the availability of resources with the plan for need in them. The risks of failure to comply with the terms of the works or of the entire project in the program assessed based on optimistic and pessimistic estimates of the project works or the Monte Carlo method used for estimating the divergence of the works completion date from the scheduled one, budget overruns, and other consequences.

Megaplane [9] is a program for construction and related projects. Information on the progress of works, terms of completion, available resources, etc. can be accessed online from any workplace. The functions of the program, in addition to scheduling, are project administration, making of contracts, appointment of meetings, preparation of reports, timing control, etc.

Each analyzed software complex allows users to compose, to match up in terms of different contractors and suppliers, as well as to adjust the schedule of works, to meet the project terms of works, to specify quantities, terms of delivery of resources, their optimal distribution according to the project (CSOS and SWEP). Based on the actual data on the execution of the construction project and the allocation of resources during the construction works, project organizational and technological measures are taken to neutralize the effects of adverse factors, to take into account and to enhance the favorable effects.

In order to identify the reasons for divergence of the actual terms of construction works from the scheduled ones, scholarly research works on the subject of research has been reviewed and based on their analysis a list of factors has been determined and a questionnaire has been prepared for the survey of construction corporations regarding the reasons for deviations from the planned terms of works.

One of the significant factors influencing the timing and cost of construction works is the lack of rapid information exchange between the different levels of management. Yu.V. Isayenko [1] states, "... existing developments do not fully address the need of construction corporations in constant improvement of their competitiveness by implementing organizational approaches aiming at identifying and utilizing the potential and resources of production systems, since organizational and technological solutions are developed, implemented and rationalized at different independent organizational levels, which slows down information exchange between them...". The reasons for this are both the remoteness of the line staff from the top management and the disruption of information exchange between them.

Yu.T. Borovik [2] distinguishes the following factors that might result in unpredictable failure of construction production: the climatic (snowfall, ice, wind over six balls, rain, frost below –25 °C), the financial and economic (inflation, sharp decline in investment, rise in prices for materials, structures, parts, machines, mechanisms, fuel, electricity), the social (strikes, absenteeism or delay in attendance, non-performance of job instructions, low skills of the contractor, deliberate damage or theft of materials, tools, equipment), the organizational (untimely provision of design and cost estimate documentation, breach of the agreed terms of works, lack of materials, products, semi-finished products, equipment, lack of workmanship having required skills, experience, and qualification, drawbacks of operational planning and management, lack or failure of communication facilities, breach of the terms of preparation of the construction site, change in plans for commissioning of the object), the technological (remedy of defects, remedy of consequences of poor quality works, change in the planned sequence of works, breach of the rules of labor protection and safety, unforeseen works, drawbacks of the design or const-

Table 1

Weights of Influence of Various Factors on the Construction Process

Factors	Average score (0–100)
Climatic (snowfall, ice, rainstorm, frost or extremely hot weather)	22
Financial and economic:	
inflation;	31
sharp decline in investment;	53
rise in prices for materials, worsening of quality of resources;	52
breach of the terms of payment for works	73
Social:	
strikes;	15
absenteeism or delay in attendance;	11
non-performance of job instructions;	10
deliberate damage or theft of materials, tools, equipment	18
The organizational :	
untimely provision of design and cost estimate documentation;	15
breach of the agreed terms of works;	21
breach of the terms of works by subcontractors;	34
untimely handover of site for construction works ;	36
lack of materials, products, semi-finished products, equipment, lack of workmanship having required skills, experience, and qualification;	29
breach of the terms of preparation of the construction site;	28
drawbacks of operational planning and management, lack or failure of communication facilities;	16
poor quality of software	6
Technological:	
remedy of defects, remedy of consequences of poor quality work;	21
change in the planned sequence of works;	11
drawbacks of the design or construction	3
technology;	14
unforeseen works	
Technical:	
malfunction of machines, mechanisms, vehicles;	21
poor quality of materials, parts, structures, equipment;	62
failure of energy and water supply, access roads;	30
changes in the design solutions in the course of the construction works	15
Force majeure (natural disasters, hostilities, etc.	6

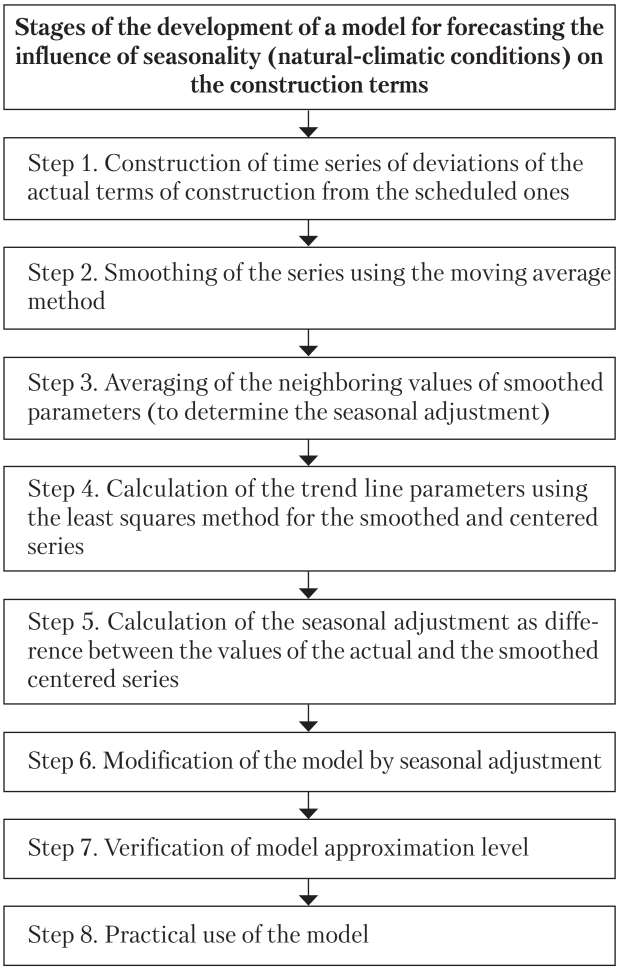

Fig. 2. Sequence of determination of influence of seasonal factors on the construction terms

ruction technology, breach of works schedule by subcontractors), the technical (malfunction of machines, mechanisms, vehicles, poor quality of materials, parts, structures, equipment, failure of energy and water supply, access roads, changes in the design solutions in the course of the construction works) and force majeure (natural disasters, hostilities, etc.).

Despite a considerable progress of researchers in the field of the forecasting of divergences, the organization of supplies, the resources flows on the construction site, the formation and assessment of organizational structures in order to improve information exchange between the parties in the construction process, certain tasks related, above all, to the identification of causes of deviations in terms of the delivery of resources, the formation of methodological framework for analysis, evaluation and forecasting of construction terms at all stages of implementation of construction projects, need to be further studied.

In order to identify the factors that have the most significant impact on failure to perform and deviations from the planned resource support of construction, a survey of employees of various construction corporations involved in the construction of public, commercial, and industrial objects in Ukraine (Table 1) has been conducted. In total, 78 representatives from 53 construction companies took part in the survey aiming at assessing the influence of individual factors, based on a 100-point scale, where "100 points" is the highest degree of influence, "0 points" means no influence.

The survey results indicate a high percentage of organizational, technological, and financial-economic factors that influence the resource system of construction. The "financial" and "organizational" factors are the most often mentioned by the respondents. Therefore, eliminating the influence of these factors, including the latter, is an urgent task to solve the problem as a whole.

The purpose of the system of resource logistics and organizational and structural support for the construction projects is to quickly respond to divergences of the actual terms from the scheduled ones, to revise the works program so that to promptly remedy consequences of delays, disruptions of the construction process, and divergences.

The survey results have shown that the influence of climatic factors on the terms of the works is estimated by the construction managers at 22 points, which is characterized as an average influence. In addition, the quantities of construction works are highly dependent on weather and climatic conditions, since many construction works are carried out in open, unprotected space.

O.Yu. Bielienkova [10] proposes an approach to forecasting the need for working assets depen-

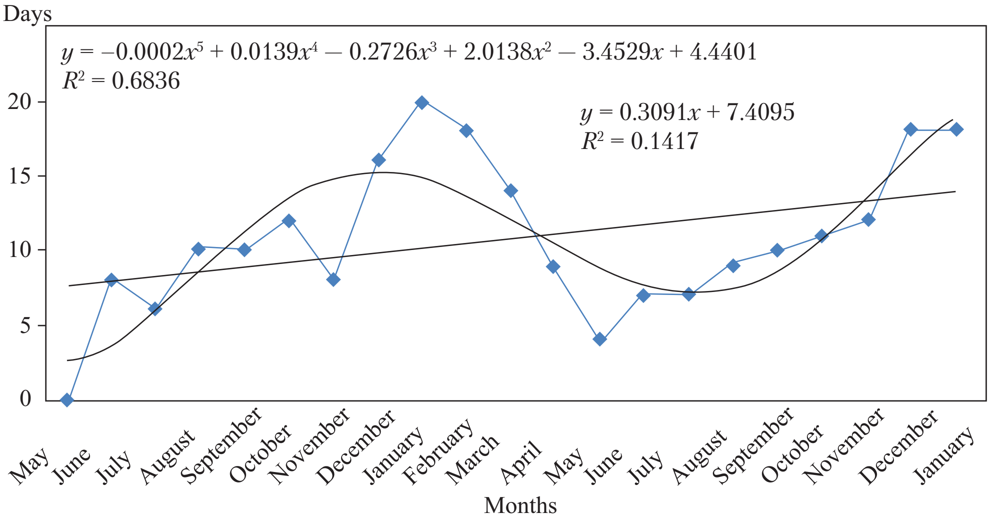

Fig. 3. Input data for analysis of influence of seasonal factor on the construction terms

ding on seasonal variations and some factors of the internal environment. I.V. Antokhonova [11] states that while forecasting the seasonal phenomena, each level of the time series can be represented as result of evolutionary, annual, seasonal, and random variables:

$$Y = f(t) + s(t) + \varepsilon t,$$

where $f(t)$ is evolutionary component (describing the trend); $s(t)$ is seasonal component; εt is random component showing the influence of unpredictable factors that are not taken into consideration explicitly while doing forecast, but may cause an error.

Taking into account the influence of the seasonal factor on the terms of construction, we consider it expedient, while planning and supervising, to use the algorithm for developing a model of economic indicators forecast, as shown in Fig. 2.

Multifunctional logistics complex in the village of Chaiky (16, Chaikai St.), a typical site in the region (Kyiv Oblast) is selected as proxy object. The technical and economic indicators of the object correspond to the average technical level of similar objects and have similar resource and technological models, configurational and design solutions that meet the modern design requirements, the development of the technical and technological base of construction corporations and organizations of the region; its design documentation is elaborated in accordance with applicable regulations. The mentioned object has got a favorable opinion of the government expert review, and its resource and technological model most completely meets the structural, technical, technological, and organizational decisions typical for this type of objects.

Its configuration is based on the warehouse buildings, the nine-store administrative office building and the equipment support structure with dock levelers and technical premises. The main characteristics of the complex are given in Table 2.

Table 2

The Facilities of the Studied Object and Their Parameters

Technical and economic parameters	Complex facilities		
	Warehouses	Administrative office building	Raised engineering and utility services rooms
Dimensions, m	84 × 72 + + 84 × 42/2 + + 18 × 12	52 × 16	27.3 × 11,7
Area, m²	9051	8416.6	1313
Gross building volume, m³	93526.2	29947.3	19919.4

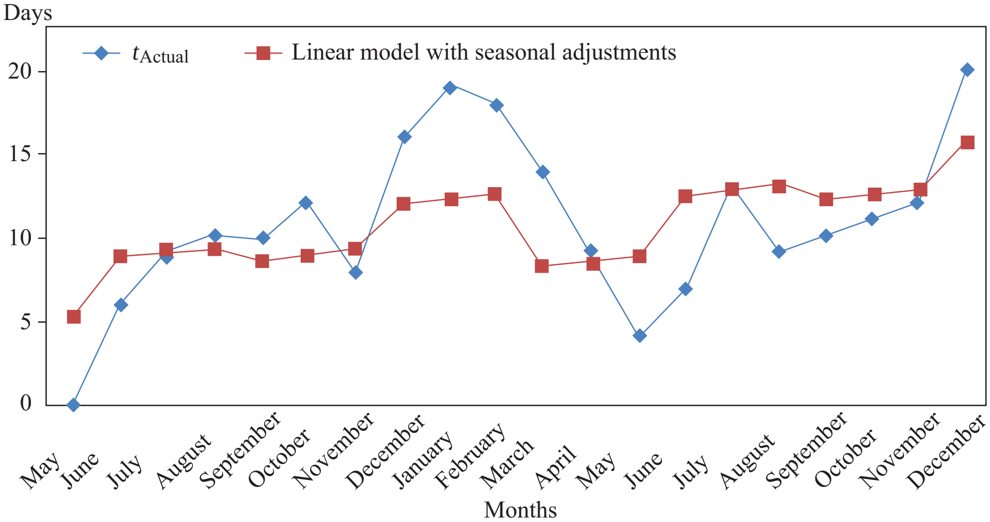

Fig. 4. Results of modeling of divergences of the actual terms of construction works from the scheduled ones, with linear trends and seasonal adjustments taken into consideration

According to DSTU B A.3.1-22: 2013 "Determination of construction duration" [62], the construction of administrative and office premises shall last 312 days, including the main period of 273 days (9.11 months); the duration of warehouse construction is 456 days, including 387 workdays (for six-day work week); the duration of the main period is 395 days. The construction of engineering and utility services premises lasts 197 days; the duration of the main period is 172.8 days.

The construction of the logistics complex is based on the general contracting system.

The effect of seasonal fluctuations on the timing of works by the example of warehouse construction (Fig. 3) was studied from May 2015 to January 2017 according to the method [12].

The initial visual analysis of the schedule (Fig. 3) makes it possible to detect periodic, with a lag of about three months, divergence of the actual terms of works from the planned ones. The approximation of the divergence dynamics using the linear trend model was unsuccessful because the solid trend line shows the general tendency towards increase in the timing of divergences that does not correspond to the actual dynamics. This means, if the construction is long-term, then the model accuracy decreases with each month, and the coefficient of approximation confidence is quite low (R^2 = 0.1417). That is, the linear trend model explains the variation in the divergence of the time of resources delivery for 14.22%. The 5th order polynomial trend (dashed line) explains the variation in cash flows much better, for 68% (R^2 = 0.6836), but the dashed line does not reproduce the peak divergences with a period of about three months. In addition, despite a relatively high level of input sampling approximation, the polynomial trend models are not acceptable even for short-term forecasting due to the systematic overestimation of results. Therefore, to improve the accuracy of forecasting and to control the divergences of the actual terms of construction works and delivery of resources from the scheduled ones, it is necessary to use models with a seasonal component.

The parameters of this model calculated using the algorithm (Fig. 2) are given in Table 3. Also, the Table contains theoretical results calculated using the linear and polynomial trend models.

Based on the quarterly differences between the actual and the centered smoothed divergences of the actual construction time from the design ones, the seasonal adjustments have been calculated as follows:

December—February: $\left(\frac{2.833 + 3 + 0.667 + 3.833}{4}\right) =$ $= 2.167$ days;

March—May: $\left(\frac{-1.333 - 2.333 - 3.833}{3}\right) =$ $= -2.556$ days;

June—August: $\left(\frac{1 - 0.33 + 4.167 - 1.167}{4}\right) =$ $= 0.833$ days;

September—November:

$\left(\frac{-0.167 - 1.667 - 3 - 0.333 + 0.5 - 0.667}{6}\right) = -0.333$ days.

The indicators that do not take into consideration the seasonal factor are better approximated by the linear trend model, as evidenced by the relatively small deviations of the broken line of the actual data from the straight trend line in Fig. 4. The confidence factor of the approximation in this diagram is $R^2 = 0.797$. That is, the straight line explains the variation of indicator without the seasonal component for almost 80%; the share of unexplained variation decreases significantly due to the smoothing and centering of the dynamic series.

According to the calculations (Table 3), the following models that take into account quarterly seasonal changes have been developed:

Table 3

Effect of Seasonal Factor on the Terms of Works *

№ п/п	Period	Divergence of the actual terms of constructions works from the scheduled ones, days			Season adjustment, days	Theoretical results		
		Actual	Averaged by 3 months	Centered up to 1 month		Linear model with season adjustments	Linear model ($y = 7.4095 + 0.3091 \cdot t$)	Polynomial model ($y = -0.0002 \cdot t^5 + 0.0139 \cdot t^4 - 0.2726 \cdot t^3 + 2.0138 \cdot t^2 + 3.4529 \cdot t + 4.4401$)
1	May	0	—	—	—	5.219	7.7186	2.7421
2	June	6	—	—	—	8.944	8.0277	3.6247
3	July	9	—	—	—	9.170	8.3368	5.9227
4	August	10	8.333	9.000	1.000	9.479	8.6459	8.7565
5	September	10	9.667	10.167	–0.167	8.622	8.955	11.5081
6	October	12	10.667	10.333	1.667	9.236	9.2641	13.7971
7	November	8	10.000	11.000	–3.000	9.545	9.5732	15.4567
8	December	16	12.000	13.167	2.833	12.049	9.8823	16.5097
9	January	19	14.333	16.000	3.000	12.414	10.1914	7.1445
10	February	18	17.667	17.333	0.667	12.723	10.5005	17.6911
11	March	14	17.000	15.333	–1.333	8.254	10.8096	18.5971
12	April	9	13.667	11.333	–2.333	8.563	11.1187	20.4037
13	May	4	9.000	7.833	–3.833	8.872	11.4278	20.7217
14	June	7	6.667	7.333	–0.333	12.570	11.7369	9.2075
15	July	13	8.000	8.833	4.167	12.879	12.046	7.5391
16	August	9	9.667	10.167	–1.167	13.188	12.3551	9.3921
17	September	10	10.667	10.333	–0.333	12.636	12.6642	6.4157
18	October	11	10.000	10.500	0.500	12.946	12.9733	8.2087
19	November	12	11.000	12.667	–0.667	13.255	13.2824	11.2955
20	December	20	14.333	16.167	3.833	15.814	13.5915	14.1021
21	January	18	18.000	—	—	—	13.9006	18.9321
Approximation coefficients						0.031	0.195	4.15

* Developed by the authors.

December—February: $y = 9.5764 + 0.3091 \cdot t$; (1)

March—May: $y = 4.8535 + 0.3091 \cdot t$; (2)

June—August: $y = 8.2425 + 0.3091 \cdot t$; (3)

September—November: $y = 7.0765 + 0.3091 \cdot t$. (4)

The analysis of deviations is important for assessing the plan realization and the production dynamics, determining the impact of factors on the change in the indicators and, accordingly, developing measures to improve the organization and management of construction works.

Thus, the given results expand the scholarly research base of construction organization by creating tools for resource logistics and organizational and structural support of construction projects, organization of information space for contractors by combining widespread and proven methods for estimating deviations of the time parameters of construction projects with elements of operational management.

The practical value of the research is that the results are recommended to be used by general contractors and contracting organizations for creating a system of organization of the construction project, which enables estimating and minimizing divergences of the actual indicators from the scheduled ones.

The climatic conditions have been proved to have a moderate influence on the construction time as seasonal fluctuations in the divergences of the actual construction process or the supply of resources from the planned ones. Models that take into consideration the seasonal component have been developed.

The results enable to formulate directions of further research, in particular: the development of an integrated scheme for controlling divergences of the construction process, which combines the tools of resource logistics and organizational and structural support of construction project, the system for cost management and quality of construction works, and the development of relevant software. The currently available methods for estimating resources supply risks [15, 16] provided by *Microsoft Project*, *OpenPlan*, *Spider Project*, *SureTrek Project Manager*, *Primavera Project Planner* and others shall be complemented by the models designed to forecast the actual terms of works and resources supply to the construction site, their deviations from the scheduled ones, to minimize such deviations, etc. Unlike the standard methods used in the abovementioned software for risk assessment, the appropriate models shall not only consider the stochasticity of the construction process, but also be able to choose the optimal method depending on the nature of deviations and the behavior of the time series.

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ЦИФРОВА ТРАНСФОРМАЦІЯ ПРОЦЕСІВ РЕСУРСНО-ЛОГІСТИЧНОГО ТА ОРГАНІЗАЦІЙНО-СТРУКТУРНОГО ЗАБЕЗПЕЧЕННЯ БУДІВНИЦТВА

Вступ. Відповідність термінів виконання будівельних робіт і постачання ресурсів на об'єктах будівництва плановим показникам є нагальною потребою, адже порушення ритмічності надходження матеріалів, невідповідність графіків виконання робіт та руху матеріально-технічних ресурсів можуть спричинити серйозні негативні наслідки для всього процесу будівництва.

Проблематика. Існує потреба в мінімізації відхилень реальних термінів будівництва від проектних шляхом створення інструментів управління процесами організації будівництва об'єкту на основі оперативних даних, їх математичної обробки, виявлення тенденцій та корегування відхилень на основі поточної інформації щодо ходу будівництва.

Мета. Удосконалення інструментарію ресурсно-логістичного та організаційно-структурного забезпечення об'єктів будівництва, спрямованого на мінімізацію відхилень реальних термінів постачання ресурсів на об'єкт від проектованих, які визначено на етапі (стадії) розробки проектно-технологічної документації (проекту організації будівництва (ПОБ), проекту виконання робіт (ПВР)), з урахуванням сезонної складової.

Матеріали й методи. Застосовано методи експертних оцінок, сезонної декомпозиції часових рядів, порівняльного аналізу.

Результати. Проведено аналіз сучасного програмного забезпечення організації будівництва, створено схему організації процесів будівництва об'єкту, доведено, що сезонність є фактором, який чинить на терміни будівництва і постачання ресурсів помірний вплив, створено моделі прогнозування відхилень ходу будівельного процесу з урахуванням сезонності.

Висновки. Наявні на сьогодні методи прогнозування відхилень, що використовують в програмних комплексах *Microsoft Project*, *OpenPlan*, *Spider Project*, *SureTrek Project Manager* і *Primavera Project Planner* та інших, доцільно було б доповнити моделями, що призначені для прогнозування реальних термінів виконання робіт з урахуванням сезонної компоненти.

Ключові слова: будівництво, сезонні коливання, організація будівництва, терміни виконання робіт.

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ЦИФРОВАЯ ТРАНСФОРМАЦИЯ ПРОЦЕССОВ РЕСУРСНО-ЛОГИСТИЧЕСКОГО И ОРГАНИЗАЦИОННО-СТРУКТУРНОГО ОБЕСПЕЧЕНИЯ СТРОИТЕЛЬСТВА

Введение. Соответствие сроков выполнения строительных работ и поставки ресурсов на объектах строительства плановым показателям является насущной необходимостью, ведь нарушения ритмичности поставок материалов, несоответствие графиков выполнения работ и движения материально-технических ресурсов могут иметь для строительного процесса серьезные негативные последствия.

Проблематика. Существует потребность в минимизации отклонений реальных сроков строительства от проектных путем создания инструментов управления процессами организации строительства объекта на основе оперативных данных, их математической обработки, выявления тенденций и корректировки отклонений на основе текущей информации о ходе строительства.

Цель. Совершенствование инструментария ресурсно-логистического и организационно-структурного обеспечения строительства объектов строительства, направленного на минимизацию отклонений реальных сроков поставки ресурсов на объект от проектных, определенных на этапе (стадии) разработки проектно-технологической документации (проекта организации строительства (ПОС), проекта производства работ (ППР)), с учетом сезонной составляющей.

Материалы и методы. Использованы методы экспертных оценок, сезонной декомпозиции временных рядов, сравнительного анализа.

Результаты. Проведен анализ современного программного обеспечения по организации строительства, создана схема организации процессов строительства объекта. Доказано, что сезонность является фактором, который оказывает на сроки строительства и поставки ресурсов умеренное влияние, созданы модели прогнозирования отклонений хода строительного процесса с учетом сезонности.

Выводы. Существующие в настоящее время методы прогнозирования отклонений, используемые в программных комплексах *Microsoft Project*, *OpenPlan*, *Spider Project*, *SureTrek Project Manager* и *Primavera Project Planner* и других, целесообразно было бы дополнить моделями, предназначенными для прогнозирования реальных сроков выполнения работ с учетом сезонной компоненты.

Ключевые слова: строительство, сезонные колебания, организация строительства, сроки выполнения работ.