Торайғыров университетінің
ҒЫЛЫМИ ЖУРНАЛЫ

НАУЧНЫЙ ЖУРНАЛ
Торайгыров университа

ТОРАЙҒЫРОВ УНИВЕРСИТЕТІНІҢ ХАБАРШЫСЫ

Экономикалық сериясы

1997 жылдан бастап шығады

TORAIGHYROV UNIVERSITY

ВЕСТНИК ТОРАЙГЫРОВ УНИВЕРСИТЕТА

Экономическая серия

Издается с 1997 года

ISSN 2710-3552

№ 2 (2022)

Павлодар

НАУЧНЫЙ ЖУРНАЛ
Торайгыров университета

Экономическая серия
выходит 4 раза в год

СВИДЕТЕЛЬСТВО
о постановке на переучет периодического печатного издания,
информационного агентства и сетевого издания
№ KZ93VPY00029686

выдано
Министерством информации и коммуникаций
Республики Казахстан

Тематическая направленность
публикация материалов в области экономики, управления,
финансов, бухгалтерского учета и аудита

Подписной индекс – 76133

https://doi.org/10.48081/CFIK7953

SRSTI 06.71.05

https://doi.org/10.48081/DLJR6812

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CLASSIFICATION OF NETWORK SCHEDULES AS PART OF CONSTRUCTION ORGANIZATION PROJECTS AND WORKS PRODUCTION PROJECTS

The article considers the basics of rational scheduling using modern organizational and technological models. The advantages and areas of the most effective use of network modeling are characterized. The requirements for the rational organization of network planning and management systems in the construction industry are stated. The classification of network diagrams in the composition of projects for the organization of construction and projects for the production of works is given. Relevant recommendations on the most rational use of their specific varieties are given. On the example of scheduling the construction of a town-planning complex, the optimal sequence for the development of a comprehensive integrated network schedule is recommended. The structure and interrelation of various elements of network modeling is detailed. Proposals and a list of related activities are presented that allow optimizing network schedules in time. It is noted that the optimization of the network schedule can be achieved in two main ways: by reducing the duration of individual critical works, i.e. transferring them to the forced mode of operation of teams and by restructuring the network topology, i.e. changes in the structure, technological sequence and interconnections of individual works. At the end of the article, a classification of network models is given according to the organizational structure of management, the characteristics of the models used, the features of the tasks being solved and the functioning in time, and the means of information processing.

Keywords: network modeling, network chart, network planning and management, construction duration, rational use of resources, time optimization.

Introduction

The basis for drawing up rational calendar plans (CP) for construction should be based on a normalized organization and technology for the construction of buildings and structures. It, as a rule, is reflected in the organizational and technological models (OTM) of the construction of facilities. The main task of scheduling is to draw up such work schedules that satisfy all the restrictions that reflect in the OTM of the construction of objects the interconnection of the timing and intensity of work, as well as the rational use of resources [1].

Solving the tasks of scheduling based on OTM, taking into account the need for work in specific resources, at the same time allows the most efficient distribution of these resources for individual facilities, as well as for a construction organization or a corporate association as a whole. The effectiveness of the KP largely depends on how the OTM of the erection of buildings and structures, which they are based on, meets certain requirements. The most important of them is the adequacy of the model to a real object [2].

The model should display the object in all aspects that are essential for solving the problems of scheduling and regulating production and economic activities, and the information about the object contained in the model must be complete enough to solve these problems on its basis.

Other requirements for the model are ease of perception and ease of analysis. In addition, when modern technical means are used for modeling, the economic characteristics of the model are also important - the costs of its development and operation.

Regardless of the type of OTM used for construction management, it should reflect the full list of works, the order of their implementation and the nature of the relationship between them.

Various types of OTM for the construction of buildings and structures are known: line graphs, cyclograms, network models, etc. At the same time, their characteristic features should be taken into account to determine the most rational areas of application [3].

Materials and methods

Network models make it possible to better display the order of construction of complex objects or their complexes, to carry out scientifically based scheduling of construction, to identify and resolve many problem situations that arise in the production process.

The use of a network planning and management system (SPM) ensures a reduction in construction time, rational use of resources, growth in labor productivity and a reduction in the cost of work. All this is achieved as a result of the use of network models that make it possible to formalize the construction

processes and thereby significantly improve planning, accounting and control over the progress of work.

A network model with the required detail displays the relationship of individual works on the construction of an object (complex) and allows for mathematical analysis that contributes to rational scheduling, predicting its future state, as well as an objective assessment of the effectiveness of decisions made [4].

A rationally organized SPM system should be an effective and permanent mechanism that combines automated accounting and control, development and implementation of management decisions that provide rational modes of activity. Such a mechanism usually functions in a closed control loop, starting with the preparation of construction production and ending with the complete completion of the construction of individual facilities or their complexes.

The main objectives of using network planning and production management systems are to develop an optimal version of the construction plan that provides rational coordination in time and space of the work performed and the best use of resources, as well as effective management of the process of implementing this plan.

The most widely used method for solving planning and management tasks in a network modeling system is the so-called SPM method. STC method, i.e. the apparatus for constructing, calculating, analyzing and optimizing network models is recommended for solving problems related to construction planning (for example, forecasting construction dates, rational allocation of resources, etc.). This system can also use other economic and mathematical methods for solving individual problems (linear and dynamic programming, queuing, etc.) [5].

Results and discussion

As part of modern construction management projects (POS) and work production projects (PPR), the following classification of network schedules is adopted.

Depending on the number of independent targets, networks can have one or more end events. Networks with one end event are called single-ended, and networks with multiple end events are called multi-ended.

According to the degree of coverage of the construction program, it is advisable to subdivide the networks into local, complex and integrated enlarged ones [6].

Local network diagrams are recommended to be developed for certain types of work and performers. Integrated network schedules (CSG) are, as a rule, made up for individual objects and complexes (they should be part of the PPR). It is advisable to draw up complex enlarged network diagrams (CUSG) for separate large objects and complexes (they should be part of the PIC).

Summary network diagrams can be developed for the entire program of a construction organization or for the construction of several homogeneous large complexes [7].

Local schedules are recommended to be considered as single-purpose. KSG and KUSG can be both single-purpose and multi-purpose. Pivot network diagrams are usually developed for multi-purpose purposes. Разработку КУСГ (on the example of a town-planning complex) should be carried out in a certain sequence:

– to collect and study the initial data necessary for the construction of the CUSG, to develop an enlarged structural model of the work package. Combine specialized construction flows (sanitary, electrical, finishing works, installation of elevators (equipment)) into an enlarged KUSG element called «internal work»;

– clarify the range of works to be included in the CUSG;

– develop private (local) network models for object flows;

– to perform «stitching» of local networks (taking into account the work performed outside the flow) into a common network at reference points in accordance with the cyclogram of the complex flow (linear graph) and the enlarged structural model of the work package. The reference points for the «linking» of local networks should be their initial and final events, as well as the initial and final events of work performed outside the thread;

– to check the correctness of the «stitching» of works and their technological sequence, to encode events. The code of work in the network schedule should be determined by two digits indicating the numbers of its initial and final events;

– Simultaneously with the development of the KUGS, fill in the identification card of the works placed in ascending order of the numbers of their initial events. In the column «name of the work», in addition to its short name in brackets, indicate the number of the grip on which it is performed;

– determine the cost, labor costs, number of workers, shifts, duration and intensity of each work recorded in the identification card. Work performed using construction machines and mechanisms is recommended to be carried out in three shifts. The intensity of the work to be determined by dividing the cost of construction and installation work by the duration of their implementation and the number of shifts accepted;

– to calculate the time parameters of the CUSG (directly on the network model or by the tabular method);

– to carry out the analysis of CUSG and, if necessary, optimize it in time [8].

It is recommended to optimize the network schedule in time in order to reduce the duration of the construction of the urban complex. This reduction can be achieved in two main ways:

1) by reducing the duration of individual critical work, i.e. transfer them to the forced mode of work of brigades. In this case, the total amount of time reduction for all activities of the critical path should not be less than the size of the total negative reserve;

2) by rebuilding the network topology, i.e. changes in the structure, technological sequence and interconnections of individual works.

In the first case, as noted above, one should try to reduce the duration of the critical path by transferring resources such as machines and teams of workers from non-critical activities, some delay and increase in the duration of which will not affect the overall duration of construction, to critical activities. If this cannot be done, for example, due to the lack of similar resources, or the lack of jobs from which to take the necessary resources, it is necessary to attract additional capacities from outside.

In the second case (in agreement with the customer and the designer), for example, some work can be withdrawn, without which the object can be put into operation, or a deeper combination of the work to be performed by dividing and paralleling them can be carried out [9].

The calculation of the optimized CUSG, as noted above, can be carried out by the tabular method or directly on the network diagram.

Fictitious works, shown by dotted arrows between individual holdings of objects, indicate organizational dependencies, reflecting the transition of teams of workers and the transfer of machines and mechanisms from one holding to another. Fictitious works linking the completion of the preparatory period with the beginning of the construction of the underground part of subsequent facilities are technological dependencies that show that the condition for the commencement of work on the construction of the underground part of the facilities is the completion of all the works of the preparatory period. Moreover, in order to reduce the time for the implementation of CUSG, it is recommended that the construction of all objects of the urban planning complex be started simultaneously.

The completion of works on the improvement of the territory of the town-planning complex is the final event of the network model. The time periods between the completion of the construction of individual objects of the urban complex and the completion of works on the improvement of its territory are organizational breaks, and the arrows corresponding to them on the network model indicate the processes of organizational expectation of a certain duration [10].

Conclusions

As a result of the research, it was found that all the main control systems that use network models for the construction of facilities can be classified as follows.

According to the organizational structure of construction management – depending on the level of management using them (construction and installation organization, corporate association).

According to the characteristics of the models used – local or multi-network; detailed or enlarged; primary, private, complex or summary; individual or

standard; alternative or deterministic (including: the simplest time, multi-purpose, nodal, generalized, models taking into account cost and resources); probabilistic (including: with an indefinite duration of work and uncertainty in the scope of work). According to the nature of the tasks to be solved, network models for the construction of facilities can be divided into resource and temporary ones.

When classifying network models and the schedules developed on their basis, according to the nature of the system's functioning in time, the absence or presence of periodically recurring construction objects or work packages should be taken into account.

According to the information processing tools used, network models for the construction of facilities can be divided into automated (based on modern digitalization and computerization) and non-automated.

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Material received on 21.06.22.

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Республика Казахстан, г. Павлодар.
Материал поступил в редакцию 21.06.22.

КЛАССИФИКАЦИЯ СЕТЕВЫХ ГРАФИКОВ В СОСТАВЕ ПРОЕКТОВ ОРГАНИЗАЦИИ СТРОИТЕЛЬСТВА И ПРОЕКТОВ ПРОИЗВОДСТВА РАБОТ

В статье рассмотрены основы рационального календарного планирования с применением современных организационно-технологических моделей. Охарактеризованы преимущества и области наиболее эффективного использования сетевого моделирования. Изложены требования к рациональной организации систем сетевого планирования и управления в строительном производстве. Приведена классификация сетевых графиков в составе проектов организации строительства и проектов производства работ. Даны соответствующие рекомендации по наиболее рациональному применению их конкретных разновидностей. На примере календарного планирования возведения градостроительного комплекса рекомендована оптимальная последовательность разработки комплексного укрупненного сетевого графика. Детализирована структура и взаимосвязь различных элементов сетевого моделирования. Представлены предложения и перечень сопутствующих мероприятий, позволяющих оптимизировать сетевые графики по времени. Отмечено,

что оптимизация сетевого графика может быть достигнута двумя основными способами: за счет сокращения длительностей отдельных критических работ, т.е. перевода их на форсированный режим работы бригад и путем перестройки топологии сети, т.е. изменения структуры, технологической последовательности и взаимосвязей отдельных работ. В заключении статьи приведена классификация сетевых моделей по организационной структуре управления, характеристикам используемых моделей, особенностям решаемых задач и функционирования во времени, средствам обработки информации.

Ключевые слова: сетевое моделирование, сетевой график, сетевое планирование и управление, продолжительность строительства, рациональное использование ресурсов, оптимизация по времени.

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Материал 21.06.22 баспаға түсті.

ҚҰРЫЛЫС ҰЙЫМДАУ ЖОБАЛАРЫ ЖӘНЕ ЖҰМЫС ӨНДІРУ ЖОБАЛАРЫ ҚҰРАМЫНДАҒЫ ЖЕЛІЛІК КЕСТЕЛЕРДІҢ ЖІКТЕЛУІ

Мақалада заманауи ұйымдастырушы – технологиялық модельдерді қолдану арқылы, рационалды күнтізбелік жоспарлау негіздері қарастырылған. Желілік модельдеуді тиімді қолданудың артықшылықтары мен бағыттары сипатталады. Құрылыс өндірісіндегі желілік жоспарлау мен басқару жүйелерін ұтымды ұйымдастыруға қойылатын талаптар баяндалды. Құрылысты ұйымдастыру жобалары мен өндірістік өндірістік жобалар бөлігі ретінде желілік сызбалардың жіктелуі келтірілген. Олардың нақты сорттарын ұтымды пайдалану бойынша тиісті ұсыныстар берілген. Қала құрылысы кешені құрылысын жоспарлау мысалын қолдана отырып, кеңейтілген желілік кестені құрудың оңтайлы дәйектілігі ұсынылады. Желілік модельдеудің әртүрлі элементтерінің құрылымы мен өзара байланысы егжей-тегжейлі көрсетілген. Желілік кестелерді уақытында оңтайландыру үшін ұсыныстар мен байланысты іс-шаралар тізімі ұсынылған. Желілік кестені оңтайландыруға екі негізгі жолмен қол жеткізуге

болатыны атап өтіледі: жеке сыни жұмыстардың ұзақтығын қысқарту арқылы, т.б. оларды бригадалардың мәжбүрлі жұмысына көшіру және желі топологиясын қайта құру арқылы, т.б. жеке жұмыстардың құрылымындағы, технологиялық бірізділігі мен қарым-қатынасындағы өзгерістер. Мақаланың қорытындысында желілік модельдердің жіктелуі басқарудың ұйымдастырушылық құрылымына, қолданылатын модельдердің сипаттамаларына, уақытында шешілетін және жұмыс істейтін міндеттердің ерекшеліктеріне, ақпаратты өңдеу құралдарына сәйкес келтірілген.

Кілтті сөздер: желілік модельдеу, желінің кестесі, желілік жоспарлау және басқару, құрылыстың ұзақтығы, ресурстарды ұтымды пайдалану, уақытты оңтайландыр.

Теруге 21.06.2022 ж. жіберілді. Басуға 30.06.2022 ж. қол қойылды.
Электронды баспа
1,14 Mb RAM
Шартты баспа табағы 7,25
Таралымы 300 дана. Бағасы келісім бойынша.
Компьютерде беттеген З. С. Искакова
Корректор: А. Р. Омарова
Тапсырыс № 3942

Сдано в набор 21.06.2022 г. Подписано в печать 30.06.2022 г.
Электронное издание
1,14 Mb RAM
Усл.п.л. 7,25. Тираж 300 экз. Цена договорная.
Компьютерная верстка З. С. Искакова
Корректор: А. Р. Омарова
Заказ № 3942

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