The Role and Importance of Scheduling Construction Production in Modern Conditions

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ABSTRACT

Modern construction is a very complex dynamic probabilistic system. The complexity of such a system is determined by the interaction of a number of construction, installation, design, research and supply organizations, as well as manufacturing enterprises that employ thousands of people and hundreds of machines and mechanisms. The main purpose of the articles is the creation and scientific substantiation of modern methods, models and mechanisms for scheduling construction production, as a means of improving management and accelerating its intensification and efficiency. The developed models, methods and algorithms make it possible to obtain optimal (or close to optimal) schedules for the implementation of construction projects under various implementation conditions. The resulting economic effect indicates the possibility of introducing these software products in the construction industry to improve management efficiency. Using the methodological foundations developed in the dissertation information technology for modelling and evaluating schedules, creating and using an automated control system allows you to repeatedly apply developments, replicate them and carry out their mass implementation with a significant reduction in labour costs and funds. The results of the research are intended to radically improve the organization and technology of engineering training, planning and management of construction production, accelerating the intensification and increasing its efficiency.

Keywords: scheduling, building production, modelling technology, evaluation of calendar plans, creation and application of an automated control system.

Introduction

Currently, builders are facing complex tasks, the implementation of which requires the search and implementation of scientifically based, organizational, technological, managerial and technical solutions that comprehensively link the preparation, organization and planning of construction products and, as a result, increase labour productivity and the efficiency of the construction system as a whole.

Effective management of construction production in modern conditions is possible only based on modelling the production activities of a construction organization. Such a model is the calendar plan for the production of construction works. Calendar planning of construction products is one of the primary, most complex, labour-intensive and responsible complexes of management tasks in construction [1-4].

The quality of calendar plans directly affects the most important indicators and performance results of a construction organization. This determines the high requirements for models and methods of scheduling and the central place of the complex of such tasks in the automated control system created for the construction organization. The calendar plan is a document that determines the order, timing and intensity of resource consumption at construction sites [5-9]. The calendar plan is the central link in a single chain of tasks for calculating resources and costs, forming an organizational and technological model for the construction of facilities, and annual and operational planning. The variety of different situations, restrictions and criteria inherent in the construction industry predetermines many particular tasks of scheduling. The high degree of complexity and laboriousness in compiling calendar plans for the implementation of a large number of works by many participants in modern construction using a huge range of various resources, high requirements for the quality of plans, the need for their systematic compilation and adjustments, as well as the rapid development of economic and mathematical methods and CT, stimulated an intensive search for effective methods for solving this complex class of problems [10-14].

Materials and methods

When developing a calendar plan for production activities, a construction organization takes into account and increases among themselves a variety of conditions and requirements: the timing of putting objects into operation, restrictions on the capacities of organizations involved in construction, funding volumes, organizational and technological conditions for the production of work, resource restrictions, technical and economic indicators [15-19]. Each of these conditions and requirements relates to various participants in a single construction process, production and supply areas. Their weight and evaluation are ambiguous. Understanding this allows the system and a set of task scheduling. The importance of scheduling the construction of facilities is achieved by balancing the work plans of a construction organization, which is ensured through the interaction of various systems and the interconnection of the results of their functioning. In practice, the construction organization deals mainly with three systems that determine the need and role of scheduling [20-24]. This is the construction organization itself (its structure and system of activities), logistics and management decisions of policymakers. However, the most balanced operation of all these systems does not give any guarantee that at the right time all the necessary types of resources and in the required quantity will be available at the construction site since the balance of functioning of the systems providing construction in time and space has not been achieved, i.e. there is no calendar interaction. Interaction and coordination in time are carried out using the organizational and technological model of scheduling. The scheduling mechanism is a complex system consisting of elements of a different nature, which can be combined into two large subsystems - functional and providing [25-27].

Functional includes construction management in the form of decision-making by planning, economic, production, technical and other services of all participants in the construction industry. The supporting subsystem includes elements of an informational, mathematical, technical, organizational, economic, legal, etc. nature, i.e. a set of tools that ensure the solution of all tasks of scheduling following their specifics. The scheduling system in a construction organization operates in various time modes - long-term, current and operational [28-31]. The general system (Fig. 1) scheduling construction production in time can be designated as a set of four elements, each of which is a complex system [32-37]. Efficiency in building production management is achieved by interacting the performance of each system on others through the scheduling system in the construction organization.

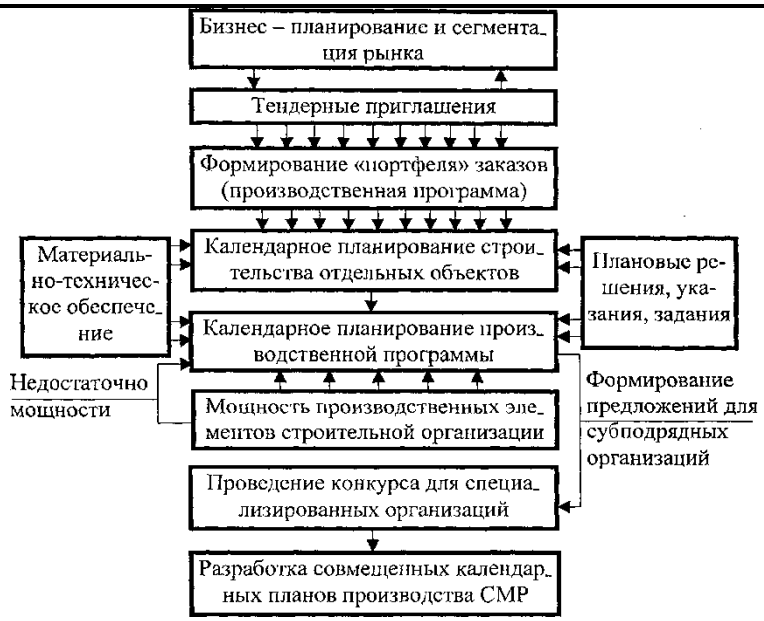

Figure 1. An enlarged scheme for the formation of calendar plans in a construction organization

The scheduling system in a construction organization plays a dual role. Initially, in the process of developing a calendar plan, it acts as a tool by which all elements of scheduling are interconnected. This is the distribution of object volumes of work by planning periods, which is carried out taking into account the capabilities of construction departments and logistics in the performance of these works while checking the reality of planned decisions .

to these capabilities. It should be noted here that the current schemes and technologies for scheduling differ significantly: a) in terms of directive planning targets; b) in a market economy.

The scheme for the development of work schedules for a construction organization, taking into account the latter condition, is shown in fig. 2

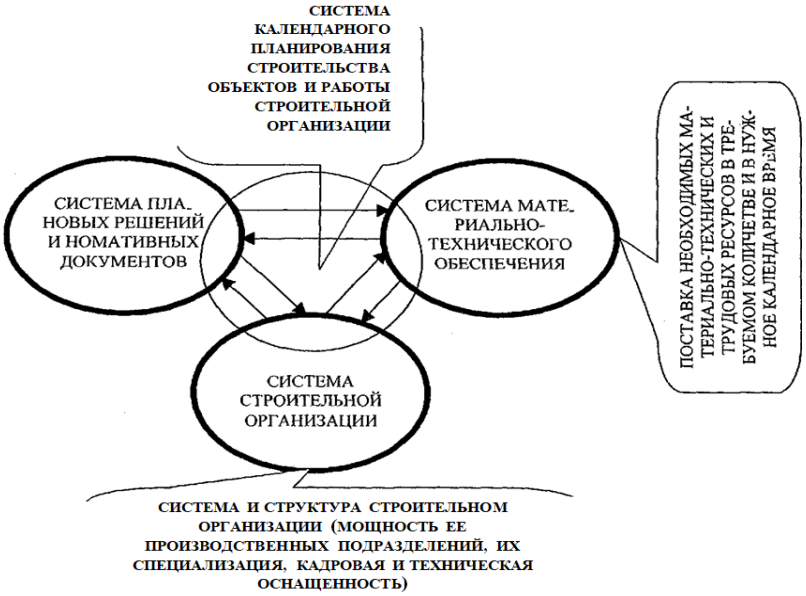

Figure 2. The relationship of the elements of the scheduling system in a construction organization.

It is known that before the adoption of the law on the enterprise, planning was carried out from previously achieved results by the construction organization according to directive instructions from above. The task of the construction organization in this case was to justify the reduction of these tasks since the economic aspects of planning did not matter. Thus, the development of calendar plans in a construction organization was carried out based on a whole system of directive planning targets in the absence of a methodology by which the objectivity and reliability of the decisions made would not be questioned by higher levels of management. Therefore, the developed plan almost always differed from the approved one, since it was formed with a certain amount of subjective moments and without taking into account the interests of the construction organization. In this case, the scheduling system was focused on performing only one function - to link the construction organization system and the logistics system. Under the conditions of such planning, the possibility (necessity) of verifying the reliability (justification) of plan targets was completely ignored [38-41]. This is explained by the fact that, on the one hand, the higher authorities were not interested in obtaining the necessary (optimal) calculations, on the other hand, there was no specific methodology or mathematical apparatus for obtaining strictly objective and reliable results. Since such planning is characterized by the fact that tasks are first issued (plans are sent down), and then all this is formalized in the form of an agreement with all the ensuing consequences, the question is quite appropriate: what should be formed first - an agreement or a work plan? Differently, scheduling should take place in the new conditions of a market economy. The services of the construction organization already independently need to form an economic policy.

First, it is necessary to determine the amount of profit and the level of profitability at which a construction organization can not only exist but also develop. This involves several tasks that affect both of the above indicators, such as labour productivity, cost, number, duration, etc., that is, the formation of a system of planning decisions, which in turn is impossible without scheduling.

Secondly, independently form 1111 (order book). This circumstance is the main distinguishing feature from the system of directives discussed above. The right to independently form your production program puts the solution of scheduling tasks on a fundamentally new basis, which consists in the continuity of the process of developing calendar plans, which allows you to include objects in the production plan at any time if:

- there are free or vacant capacities;
- the order (tender invitation) is economically advantageous;
- there are free material and technical and labour resources.

We especially note that the task of forming a portfolio of orders cannot be solved in isolation from scheduling, since the scheduling plan dictates the appropriate set of objects (work packages). And the system of solved tasks (scheduling) checks the developed planning solutions and the objects proposed for inclusion in the plan with a balanced distribution of the amount of work in time, taking into account the capabilities of the construction organization and the logistics system. It should be noted that the available methods of scheduling do not always, quickly enough and objectively allow you to obtain optimal calculations, and in a construction organization between its various services, there is often a lack of confidence in the received schedules, the reasons for which will be revealed below.

Being a tool for interconnecting all systems and analysing the possibilities of implementing planning decisions with the available capacity of a construction organization and providing material and technical resources, the results of solving scheduling tasks must be stable, reliable and sustainable, since all this determines the continuity of the construction process, the constant loading of resources and their uniform use, maximum use of the capacity

of all participants in the construction. However, the elements of the scheduling system have a certain dynamism, and in some cases, the functioning of these elements is more or less probabilistic. This was noted in several works [44, 53, 83, 137, 154, 185]. At the same time, the construction organization system inherently cannot be static either. Its dynamism is primarily due to the characteristic features of the construction industry itself. Diverse type of construction products, immobility of products and mobility of resources, variety of resources consumed, different duration of construction of individual buildings and structures, lack of wide typification of the technology of work and technology of erection of objects, the large number of participants in the creation of finished products, the multivariance of methods of organizing production, the interchangeability of consumed resources, the impact of production and natural and climatic factors - all this determines the main characteristics of construction as a complex probabilistic system. Probabilistic is not only the factors affecting the entire system as a whole but also the behaviour of each element of this system [179].

A construction organization as a social and economic system is a collection of groups of people, means of labour, and objects of labour. The probabilistic nature of the behaviour of groups of people is a generally recognized concept. The multivariance of technological and organizational solutions and their use, depending on the place and conditions of the construction process, determines the probabilistic nature of the means of production. And as noted in [188], one cannot but agree that the third element - the objects of labour - also have a probabilistic character.

Construction production as a component of the system The construction organization is a dynamic, non-rhythmic, often stochastic process, which is understood as a set of the interaction of resources [100, 125, 160, 196].

These interactions lead to changes in the quantitative and qualitative characteristics of resources in time and space. The highest speed (shortest duration) of modern construction of facilities is determined by the maximum possible technological intensity of work. The uneven intensity of technological processes is characterized by uneven use of labour, means and objects of labour.

Conclusion

In some parts, the probabilistic nature is also inherent in the system of planned decisions. This is due to changes in construction technology, which, in turn, are caused by changes in design or architectural and planning solutions. As noted above, the scheduling system plays the role of a tool by which the three elements of the overall system are interconnected (Fig. 2). The results of solving the interconnection of these complex systems, although determined, are probabilistic. Therefore, in the course of construction products, as a rule, deviations of various natures occur, associated with the influence of those factors that could not be taken into account due to certain circumstances. These deviations that occur in various elements of the systems affect primarily the results of the functioning of the scheduling system, that is, ultimately, the developed work schedule of the construction organization.

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