Algorithmization of the optimization apparatus in the organization of the current planning at the companies of the building complex

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Abstract. The issue of optimizing the decisions of the planning system at various levels and stages of construction production is one of the most important aspects of managerial and engineering activities at the construction enterprise. Such optimization is a complex multifactorial task, the solutions of which are reflected in the established documents based on the results of planning. The main document in this respect is the production and economic program (plan) developed by the planning and economic department of the corresponding construction enterprise, depending on the existing destabilizing factors and constraints established by the results of the integrated planning procedure (annual and strategic). The article discusses the concept of the annual production program of a construction company and a new approach to optimize the algorithm for distributing the resource potential between objects of the annual program.

1 Introduction

The concept of the annual production and economic plan (program) for the Russian-Soviet building complex emerged in the 1920s in the development of future so-called "five-year plans" aimed at an effective and dynamic breakthrough in the country's economic development (including the USSR) (see Tables 1, 2) through the development and production implementation of target indicators of socio-economic development in the programs of companies. Such planned economy with rigidly fixed performance indicators of programs formed the prerequisites for the development of the annual (or as it is called in the technical literature - current) planning of the construction enterprise activity, which could include in its integrated solution system the most optimal ways to implement the established plan for the facilities in the required time frame and with the lowest possible cost of all types of resources. So, you can refer to developments in the field of methodological support of planning activities of the production system (program) of a construction enterprise, which, for example, in the USSR was carried out by the Research Institute of Construction Economics (RICE). This organization in 1982 published the next edition of the “Methodological recommendations on the preparation of the production and economic plan (production and estimation plan) of construction organizations”, which describes in detail the methodology for the preparation of this current planning document.

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Table 1. The history of the application of the experience of five years of planning in the production and economic models of various countries.

No.	Some countries of the socialist bloc	Some countries of the non-socialist bloc	Apply five year planning now
1.	Union of Soviet Socialist Republics (USSR) (from 1928 to 1991)	Argentina (1947–1955)	Belarus (since 1996)
2.	Albania (since 1951)	Afghanistan (since 1957)	Vietnam (since 1958)
3.	Bulgaria (since 1948)	Egypt (since 1960)	India (since April 1, 1951)
4.	Hungary (since 1950)	Indonesia (since 1956)	People's Republic of China (since 1953)
5.	Poland	Iraq (since 1970)	Malaysia (since 1966)
6.	Romania (from 1951 to 1989)	Iran (since 1948)	Bhutan (since 1961)
7.	Czechoslovakia (since 1949)	Morocco (since 1968)	-
8.	Cuba (since 1976)	Japan	-
9.	Mongolia (since 1945)	Turkey	-
10.	-	South Korea	-

Table 2. Five-year plans for the development of the national economy of the USSR.

No.	Period	Name of the approving document	Note
1	1928-1932	Directives on the compilation of a five-year national economic development plan	I five year plan
2	1933-1937	Resolution "On the second five-year plan for the development of the national economy of the USSR"	II five year plan
3	1938–1942	Resolution XVIII Congress of the CPSU (b) on the report of Comrade. Molotov	III five-year plan - thwarted by the beginning of the Great Patriotic War
4	1946-1950	Law on the Five-Year Plan for the Restoration and Development of the National Economy (for 1946-1950)	IV five year plan
5	1951-1955	Directives on the five-year plan for the development of the national economy of the USSR	V five year plan
6	1956-1960	Directives on the five-year plan for the development of the national economy of the USSR	VI five-year plan - was not completed, the Seven-Year Plan was adopted for the period from 1959 to 1965
7	1959-1965	Directives on the seven-year plan for the development of the national economy of the USSR	Seven year plan
8	1966-1970	Directives on the five-year plan for the development of the national economy of the USSR	VIII five year plan
9	1971-1975	Directives on the five-year plan for the development of the national economy of the USSR	IX five year plan
10	1976-1980	The main directions of development of the national economy of the USSR for 1976-1980.	X five year plan
11	1981-1985	The main directions of economic and social development of the USSR for 1981-1985. and for the period until 1990	XI Five Year Plan
12	1986–1990	The main directions of economic and social development of the USSR for 1986-1990 and for the future up to the year 2000	XII five year plan
13	1991–1995	Adopted at the First Congress of People's Deputies of the USSR in June 1989. It was not implemented due to the collapse of the USSR	XIII five year plan

In accordance with the realities of a planned economy, annual planning was carried out more systematically than in the conditions of today's construction complex and the market as a whole. Naturally, this is due to the constant values of the initial (input) data in the planning system and clear indicators that should be reflected in the plan (see Table 3).

Table 3. Input data in the system of annual planning for the formation of the construction and financial plan of a building enterprise, association or trust.

No.	Name of input parameter (indicator)
1.	Terms of commissioning production facilities and facilities, including the increase in capacity due to technical re-equipment and reconstruction of existing enterprises
2.	The volume of marketable products
3.	Labor productivity growth
4.	The limit of the number of workers and employees
5.	Payroll fund
6.	Profit
7.	Payments to the budget and budget allocations
8.	The task of the introduction of new technology (scientific organization of labor and production)
9.	Volume of supplies of materials, machinery, mechanisms and other material and technical resources
10.	Other indicators set by the company, association or trust

Based on the above data, the positions of the indicators are generated, which are given in the construction and financial plan. From here, its terminal structure is formed with all internal interconnected subsections of the annual planning system (see Table 4, 5).

Table 4. Indicators of construction and financial (estimation) plan of a construction enterprise, association or trust (in the conditions of the state's planned economy).

No.	Initial indicators of the annual plan of the construction company, reflected in the relevant sections of the construction and financial plan
1.	Volumetric statement of construction products
2.	Volume list of contract work
3.	Statement of calculation of physical volumes of work
4.	Technical development plan (economic efficiency of the enterprise)
5.	Labor plan
6.	Logistics plan
7.	Plan your own capital investments
8.	Profit plan
9.	Plan to reduce the cost of construction and installation works
10.	Estimated use of funds for economic incentives
11.	Financial plan

Table 5. Structure of construction and financial (estimation) plan of a building enterprise, association or trust.

No.	The structure of the annual plan of the construction company (15 sections)
1.	Production Efficiency Plan
2.	Construction plan for the year (program of the construction company) – Annual program
3.	Technical development plan
4.	Mechanization plan
5.	Labor plan
6.	Subsidiary production plan
7.	Logistics and Equipment Plan
8.	Plan your own capital investments
9.	Profit plan and cost reduction of construction and installation works
10.	Plan for the formation and use of economic incentive funds

No.	The structure of the annual plan of the construction company (15 sections)
11.	Financial plan (balance of income and expenses)
12.	Plan for the development and use of production capacity
13.	Social development plan
14.	Plan for conservation and rational use of natural resources
15.	Calculation of the consolidated plan for all enterprises and organizations of the association (trust)

In this form, as of today, production and estimation plan (annual building production and economic plan) does not exist in the planning system of companies (even the largest representatives of the building complex segment), which is primarily due to the innovative mechanisms of the modern market economy, which contribute a large number of destabilizing factors in the planning of construction production for the annual program. At the same time, it is clear, that modern annual production and economic models of an enterprise include in their own structure elements of a production and estimation plan (the concept of a state model with a planned economic system), such as the production program - one of the main elements of a production and estimation plan - remains unchanged. Moreover, the issues of optimization of the production program decisions (including the optimal methodologies for the formation of calendar schedules for program objects) are an extremely relevant area of knowledge and further scientific research.

2 Materials and Methods

If we describe the mechanism for the formation of the annual plan of a construction enterprise in a planned economy (within the framework of the implementation of the construction production and estimation plan), we obtain the following scheme.

As for the USSR (until 1991), the state was conditionally divided into areas dominated by certain ministries specializing in a specific industry. For example, in the Ural part of the USSR, the ministry “Mintyazhstroy” had priority, in the European part - the Ministry of Industry and Construction, and so on.

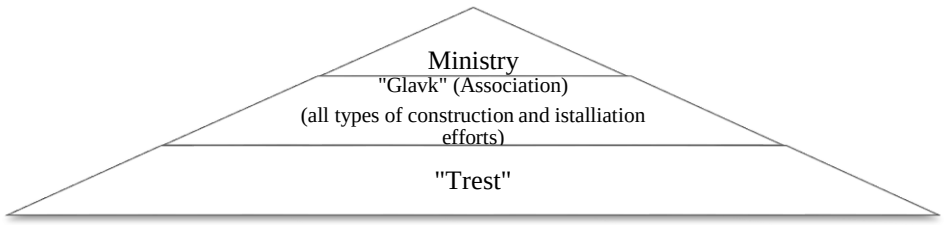

Fig. 1. Hierarchical structure of construction management in a planned economy.

According to the results of the next congress of the CPSU (once every 5 years), a directive on the directions of the country's development was approved (published in the state newspaper “Pravda”). This directive was worked out by the State Planning Committee according to two fundamental schemes - sectoral and territorial, the plan was approved at the level of the State Planning Committee of the region. Further, the Ministry transferred (lowered) the planned scope of work to the level below - subordinate to “Glavk” and “Trusts”, according to the results of which the Title lists were formed, which regulate the plan for putting the program objects into operation by year. Thus, usually by the 1st March of each year, the Trust had information about its stable annual planned scope of work for the implementation of a corresponding number of objects that requires a constant distribution of a resource after planning (a static resource management system).

However, before the period of the so-called "Perestroika" ("Conversion"), the originally approved plan for the introduction of production and residential capacities could be disrupted due to the impact of destabilizing factors on the building production system. These failures of the previously static and stable system of the planned production cycle began to violate the pre-existing balance in the industry, the planned pace of production of finished construction products was disrupted. Under these conditions, the CPSU adopted an unscheduled decision on additional volumes of construction products and sent it to the State Planning Committee and the relevant ministries. The system of resource regulation in the "Trusts" began to acquire the features of a dynamic system, changing under the influence of the external environment.

$$R + \Delta R \rightarrow P, \text{ where} \quad (1)$$

P – the final finished product (for example, steel) of the industry (construction, engineering, etc.) that requires a certain resource availability;
R – initial raw material resource;
ΔR – additional resource requirements resulting from import deliveries (if foreign currency is available) or as a result of the construction of new compensating plants.

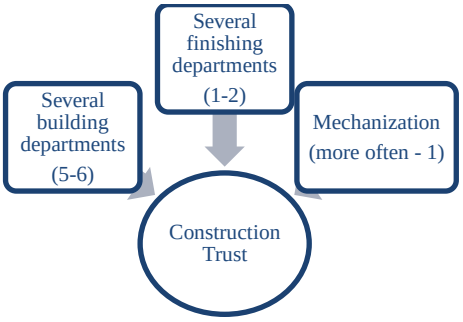

Fig. 2. Typical the structure of a large construction organization in a planned economy (Trust or "Trest") based on an analysis of the activities of existing facilities – representatives.

In the conditions of modern economy, the balance by branches is broken even more significantly, the entropy nature of changes and additions to the program with new objects (of a different order of criticality) is widespread. It becomes obvious that optimization processes are becoming a tool to reduce risks and material costs in the process of implementing the projects of the construction company's production programs. Along with the existing developments in the field of optimization of scheduling and resource allocation planning [1-13], the authors propose a more extensive optimization algorithm for managers during the formation of production programs.

3 Results and Discussion

The basic principle of construction of the developed algorithm is that the costs (volume) of the amount of labor resources for all objects of the production program in a specific cross-section of the resource schedule should be minimal (formula 2).

$$\Delta \sum_1^n (R_1 + R_2 + \cdots + R_n) \rightarrow min, \text{ where} \quad (2)$$

R_1 – Resource consumption for object number 1 of the production program of the construction program;

R_2 – Resource consumption for object number 2 of the production program of the construction program;

R_n – Resource consumption for object number N of the production program of the construction program;

n – the number of objects of the production program in the range $n \in [1; n]$.

Table 6. Features of static and dynamic resource allocation systems.

No.	Features of the static resource allocation system in a planned economy	Features of the dynamic resource allocation system in a modern market economy
1	Trusts have a clear sectoral and technological specialization, in accordance with which the production plan and programs were created.	Modern construction companies "adapt" to orders on the market
2		Reducing the level of mechanization and automation of construction due to the impossibility of the preventive formation of such a diverse fleet of construction machines and sets of mechanisms and tools
3		Reducing the skill level of workers in the construction industry (with the potential for hiring additional personnel in the labor market, it is not possible to form a trained and qualified team in practice in such a short time)
4		Lack of material incentives
5	Constant resource consumption in accordance with the approved plan and programs (the approved plan was rarely violated)	Intuitive dynamic distribution of resources in time over objects in the absence of an approved algorithm
6		Emergency attraction of a resource from the outside when adding a new object to the established production program
7		The national problem in the construction industry, associated with the use of a large proportion of foreign personnel due to the uncompetitiveness of the domestic labor market and the operational need to increase the overall intensity of resource consumption when adding a new object to the established production program
8	Uniformly loaded front of work during construction	Due to the chaotic transfer of labor on the objects of the critical path of the production program, the fronts of work are loaded unevenly

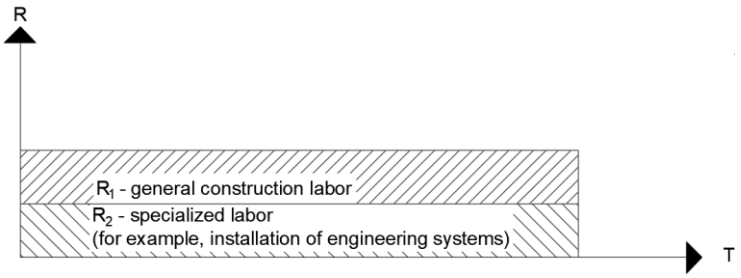

Fig. 3. Typical scheme of resource allocation of a large (by capacity) construction enterprise at the end of the year.

In this case, the costs (volumes) mean the difference between the planned (see Fig. 4) and actual resource consumption (formula 3).

$$\sum_1^n (R_{theor} - R_{fact}) \rightarrow min, \text{ where} \quad (3)$$

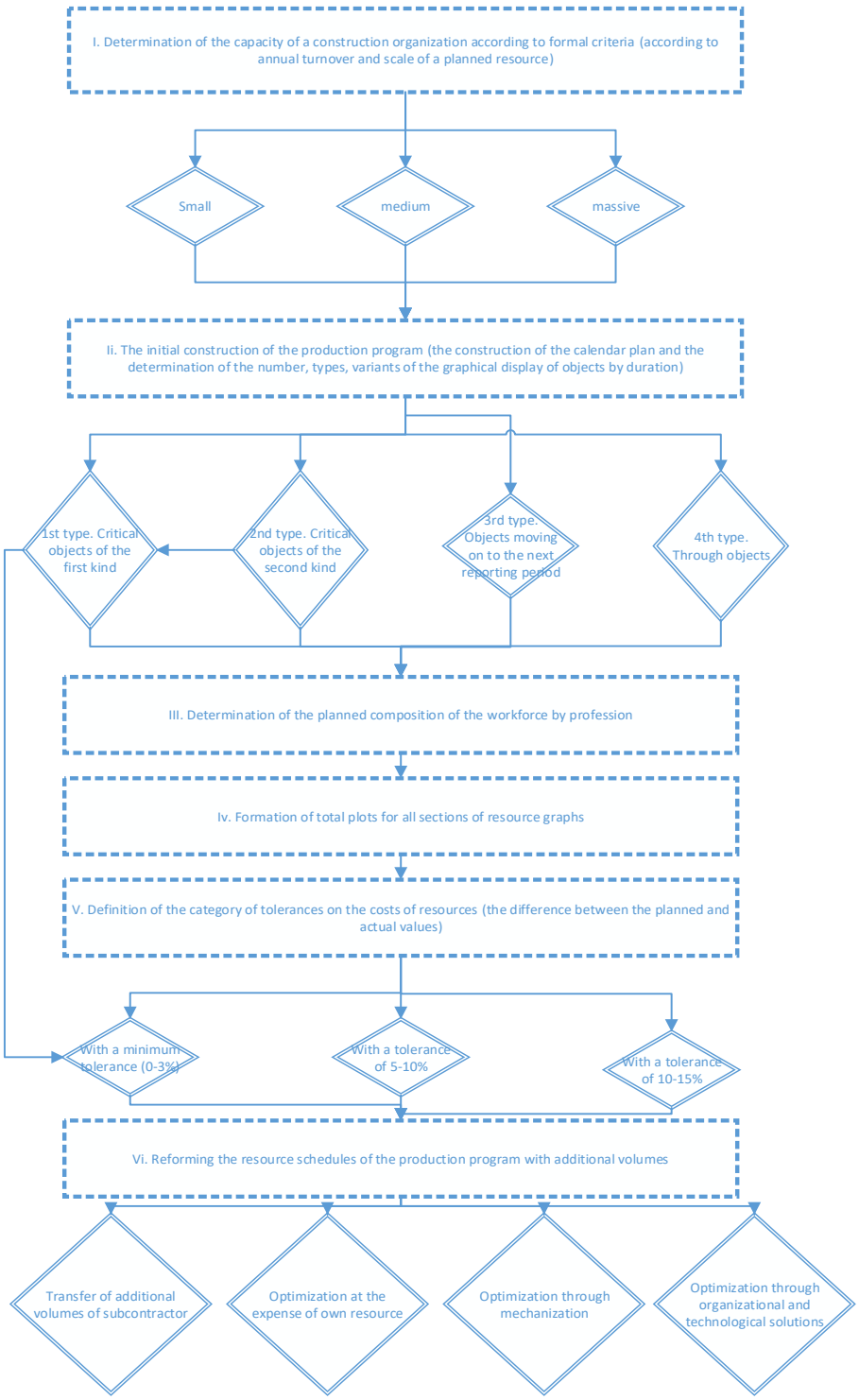

Fig. 4. Truncated optimization algorithm for the formation of the production program of a construction enterprise by resource.

R_{theor} – theoretical resource consumption by program objects, equal to the constant planned value;

R_{fact} – actual resource consumption by program objects;

n – the number of objects of the production program in the range $n \in [1; n]$.

As a limitation of the optimization algorithm, the following condition applies (formula 4):

$$T \leq T_{dir}, \text{ where} \quad (4)$$

T – total actual time of work at the facility approved by the production program;

T_{dir} – the directive deadline for performing work at the facility in accordance with the construction contract.

A truncated algorithmic approach to the process of planning and allocating resources will be represented by the following block scheme (see Fig. 4).

4 Conclusions

The purpose of modern business to enter the small business segment becomes unwarranted - such small enterprises in an unstable economy and in the absence of a standardized algorithm for current planning (in close connection with the strategic), unable to cover different types of objects offered in the market of construction and engineering services, simply become uncompetitive. The significant difference between the planned and actual indicators of resources in case of adding a new object at the stage of formation of the production program often does not allow for a smooth redistribution of resources between new and existing volumes of construction and installation works. Algorithmization of the process of such planning would allow small and medium-sized organizations to function on a par with large holdings, since the mechanism for distributing the resource field in this case takes a clear mathematical and technological look, justifying the enterprise's managers the current planning solution — to include a new object in the production program, or this step will bring significant risks.

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