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The basis of reliability of calendar plan modeling: evidence of project solution expertise

Lobar Yusupova[1] , Makhamadjan Mirakhmedov[2], Makhamadaziz Rasulmukhamedov [3],

[1] Tashkent Institute of Architecture and Civil Engineering (Uzbekistan)

[2,3] Tashkent State Transport University (Uzbekistan)

Abstract: In order to improve the project management system in the construction of complex residential buildings, to regulate the construction documents, to bring the documents for the delivery of completed buildings and structures into a single national order, a graphic-analytical model of the created calendar plan is proposed. The developed calendar plan can serve as a basis for determining the schedule of contracts and financing between construction participants, the timing of the start and completion of stages, the supply of material and technical resources to the construction site.

Keywords: construction, complex, graphanalytic model, mathematics, software, technology.

1. Introduction

The construction reforms carried out in Uzbekistan in recent years, including the construction of low-rise housing for the poor, the lack of clear documentation for quality and control of construction, will lead to serious construction errors in the future. The need to establish order in such construction is stated in the Decree of the President of the Republic of Uzbekistan PF-6119 dated 27.02.2020 "On approval of the Strategy of modernization, accelerated and innovative development of the construction industry of the Republic of Uzbekistan for 2021-2025" from March 1, 2021:

a) ..., including the construction and reconstruction of individual housing without a mandatory examination of the project documentation of the object and without the establishment of state construction control by territorial inspections in the field of construction under the Ministry of Construction ... "- emphasized. [1]

2. Methods of research

2.1. Graphanalytic model of construction as a basis for calendar planning

Among the project solutions that will be submitted for examination in order to solve the task set by the President, the creation of a calendar plan, which in many respects is not clear today, remains abstract. First of all, the product of the calendar planning process, then calendar planning is a design process based on a document that defines the scope of future construction, usually called a title list, in which the title is the distribution of capital construction and construction costs over time. is understood [2].

Table 1. The main part of the construction organization project form of design documentation

№	The name of a particular building, structure or type of work (separating start-up or urban complexes)	Estimated cost, thousand soums		Volume of construction and installation works and distribution of capital investments by construction periods (quarters, years) thousand soums
		Total	Volume of construction and installation works	
A	B	1	2	3-14

According to the general concept, the calendar planning process has its own internal structure and logic. At present, the form of the calendar plan, which is a product of this process, is clear, but its creation, distribution of capital funds and construction and installation work (implementation algorithm) remains a mystery. Therefore, there is a need to clarify these features. [3]

Since the calendar plan is a product of the calendar planning process, its structure must be reflected in the cross section of time and space, that is, it must be reflected in its logically complete and algorithmically complete model. Then the calendar plan becomes a reliable document with proof for examination, the basis of which can always be found in the archives of project documents.

The graphanalytic model of building organization is aimed at overcoming this shortcoming.

2.2. Theoretical and normative bases of the model

Theoretical and organizational-technological bases of the model: organization of construction in the flow method - a factor in improving the quality of construction and productivity.

It is known that if an executor does the same job for a long time, labor productivity increases dramatically. The increase in efficiency is due to the acquisition and improvement of labor skills, the use of special devices, equipment and tools, the reduction of time spent on moving from one workplace to another. Specialization involves the maximum division of any work into separate technological parts (works, processes, operations) and the transfer of each such part to a separate executor - the relevant work team (joint, brigade, etc.).

Organizational factors such as the adequacy of production and the uniformity of the work, the distribution of machines, the presence of idols are also of great importance for the work to be productive. [4]

Organizing construction in the flow method leads to the consistent use of all resources during the construction period. If such an arrangement is put in place, it will lead to a limitation of visible deficiencies in quality, control and other factors in future construction work.

The practice is that without the allocation of capital investments, the subsequent development of project documentation, it is impossible to carry out construction work as required by the norms of construction organization and the literature related to this science. Finally, the calendar plan for the construction of an affordable housing complex is not currently available as a basis for establishing relationships between project participants in the form of a diagram, but as an evidence base in the archives of design documents accounted for. Norms and textbooks recognize the importance of a calendar plan in the system of organizational and technological preparation for project implementation without specifying how to develop a calendar plan [5,9,10]. In this regard, a method that recognizes the place and role of the calendar plan in the system of organizational and technological preparation of construction (TPC) should be developed as part of the working documents (WH).

2.3. Organizational and technological parameters of the graphenalytic model.

The model should sufficiently rely on the organizational and technological schemes and methods used in the organization of construction. Given the level of sophistication of construction flow organization, it can be assumed that complex flow cyclograms can be used to create a model of construction flow organization with a logical and time-dependent structure formed on the basis of organizational and technological schemes of construction. formation of flows in accordance with the purpose. For example, buildings that correspond to the normal operation of the main building and structures, the objectives of the relevant project, ancillary buildings and utility units.

The norm of organization of construction production states that "... the delivery of material resources on the basis of a calendar plan and work schedule, taking into account the building, structure, network, section, department, floor" and "documents determining the construction period" [2].

Given the degree of introduction of the flow method in the organization of construction, it can be observed that on the basis of organizational-technological schemes it is possible to form complex flow cyclograms. In this case, the set of buildings and structures under construction can be divided into local (spatially limited) and elongated (length is much larger than other dimensions) types of flow development. In turn, buildings can be grouped into primary and secondary according to their purpose. Given the limited construction time, it is possible to parallelize the time of construction of groups in relation to the main buildings, as the location of the groups is different.

Evidence for this can be found in the sources [5,6]. It is emphasized that ancillary buildings, structures and communications should be ready for operation until the main structures are ready. In accordance with this principle, before the acceptance of ancillary buildings (pumping stations, transformer substations, warehouses, administrative buildings (AB) and other facilities) communications (water supply, sewerage, heating, electricity and other elongated facilities) are commissioned. had to be ready because they could not be sure that the auxiliary buildings were ready until they were ready. A minimum of 1-2 weeks must be set for the commissioning of the ancillary buildings to ensure that the facilities are commissioned by the working commission (customer-contractor) [6].

The main flow parameters accepted from the norm are the duration of construction, including the period of preparation and the utilization of capital and construction works (zadel) [7].

The prices of the objects included in the complex are calculated according to the standards [8] or determined on the basis of execution estimates of similar and recently constructed similar (analog) objects, then the prices of each stream are summed and the final cost of the objects included in the stream is determined. These prices do not change during the design and approval of the calendar plan. The intensity of capital investment in the construction process is determined by dividing the flow cost by the period of development of the finished product, ie equal to the abscissa projection of the second horizontal line of each flow in the cyclogram. At the same flows and intensities are determined for the complex, the ratio of the value of the amount determined for the construction period to the current price represents the percentage of zadel, and it should be equal to zadel.

The distribution of funds in the calendar plan according to the zadel is determined by gradually changing the parameters of auxiliary and communication flows.

It should be noted that the formation of the model depends on the organizational and technological schemes and methods of construction organization, so the model is based on the complex of buildings and structures planned for construction. The proposed method is proposed taking advantage of the fact that the construction is organized in series and in parallel.

Calendar development is a sufficiently algorithmic additive process that allows you to create construction schedules, automate optimization in the development of a capital allocation plan. The proposed method is aimed at creating an automated workplace in the development of a construction organization project.

Complex-type construction flows are organized on two criteria: the specific nature and purpose of the flow development in space. That is, buildings that are built in a confined space and develop vertically, and horizontally developing elongated structures (communications). The buildings are divided into main and auxiliary, respectively. Thus, the construction of a set of buildings and structures is formed as a complex cyclogram reflecting the flow of at least three objects, and the graphenalytic model of the organization of the complex construction is accepted as a scheme for calculating its parameters.

The interdependence of the calculated parameters is represented by formulas (1-4) and a corresponding cyclogram is constructed. Therefore, such a model can rightly be called graphenalytic.

The reserve ratio is determined by the following formula: [7]

$$\delta_n = \frac{T_н}{T_р} \cdot n \qquad (1)$$

here: $T_н$ - construction period of the enterprise according to the norm;

$T_р$ - the period calculated taking into account the dependence of the object on certain conditions;

n - the serial number of the quarter when constructing the facility.

The capital reserve for the estimated duration of construction is determined by the following formula:

$$K'_n = K_{n_n} + \frac{(K_{n_{n+1}} - K_{n_n}) \cdot \alpha_n^3}{m}, \qquad (2)$$

here: $K_{n_{n+1}}$; K_{n_n} - Indicators of capital investments (construction and installation works) during the construction period are normally accepted (Table 1), denoted by the number n of the quarter, at the end of the quarter α_n corresponds to an integer in the coefficient;

α_n - coefficient d_n coefficient equal; m - i+*1*-m the number of months in the quarter.

The maximum value of production intensity is determined by formula (3):

$$(I_j) = {P_j}/{T_{\text{пр}_j}}, \qquad (3)$$

here: P_j - the cost of the objects included in the given j stream, mln. sum;

$T_{\text{пр}_j}$ - construction product production period, year / quarter / month.

The production period of a construction product is conditionally calculated as the time from the time the last batch enters the flow until the workload is fully completed, and is calculated by the following formula (4).

$$T_{\text{пр}_j} = T_{\text{о}} - \left(T_{\text{п}_j} + \tau_j\right), \qquad (4)$$

The duration of construction is determined by the directive organization directly or in accordance with SNiP 1.03.04-85 *, which is equal to the maximum allowable time of planned new construction, which is set for the expansion of existing production and non-production facilities in all sectors of the economy. This principle summarizes the optimal distribution of capital and construction volumes over time during this period and is used in the development of projects for the organization of capital construction ([7]).

Results

In the construction of large enterprises and construction of facilities of the construction industry, the duration of construction is extended in accordance with the norm, but not more than 30%, taking into account the process of construction of the main structure and ancillary facilities not included in the number of buildings and structures of the enterprise under construction (paragraph 10). In mountainous conditions with a height of more than 1500 m and in desert areas with less than 300 mm of rainfall, a coefficient of 1.3 is applied for the duration of construction; 1.05, for the construction of housing and civil facilities in the deserts - a coefficient of 1.1 is applied (paragraph 10). Reduction coefficients are used in the construction of light structures (0.75), large blocks (0.5) and the organization of construction and installation work performed by construction machinery in two shifts, the rest in 1.5 shifts or in the organization of all work. In 2 shifts - 0.9 or in 3 shifts - 0.8 (items 13-15), if there are several conditions, only one coefficient is applied (item 16).

Based on the organizational and technological schemes and local conditions of the method of construction organization, a generalized model is developed in accordance with time and monetary parameters [11], flow financing schedules are constructed, and the optimal option is determined on the basis of a special program [10]. This creates a source that is stored in the project archive and confirms the calculations of the calendar plan as a project document. They serve as a means of proving the calendar plan during the project examination.

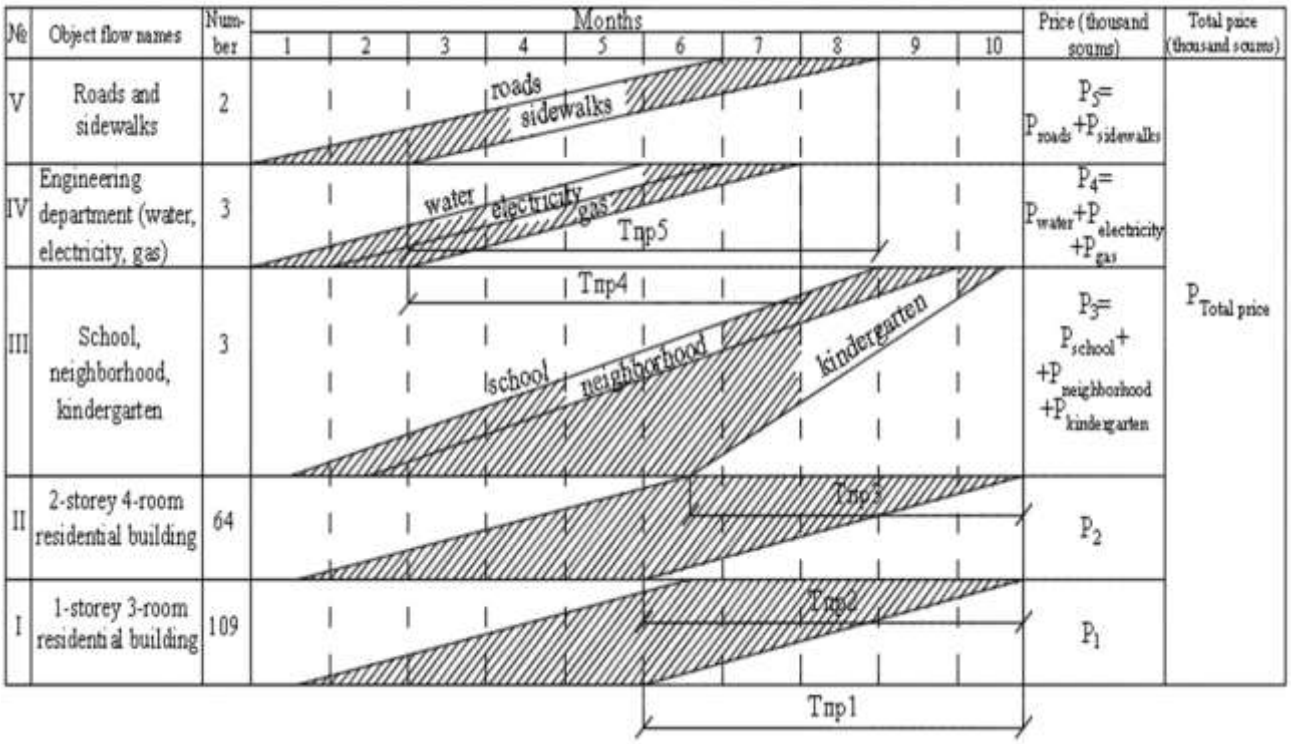

Figure 1. Complex cyclogram of low-rise housing

I, II, III, IV, V - object flow; duration of complex construction is 10 months; the duration of the preparation period is 0.6 months; tI is the duration of the current distribution period; the duration of the production period is 5 months (1 brigade completes 1 house in 5 months).

Parameters of the complex cyclogram:

P_1 – Total amount of money spent on construction of one-storey 3-room main building (billion soums); (P_1 =25.9840914 billion soums)

P_2 – the total amount of money spent on the construction of a two-storey 4-room main building (billion soums)); (P_2 = 20.9203052 billion soums)

P_3 - the total amount of money spent on ancillary buildings (billion soums)); ($P_3 = P_{max}+P_{loc}+P_{garden}$= 20.2733016 billion soums)

P_4 – Total amount of money spent on construction of engineering networks (billion soums); ($P_4 = P_{water}+P_{elec}+P_{gas}$=29.0911931 million soums)

P_5 – Total amount of money spent on roads and sidewalks (billion soums); ($P_5 = P_{road}+P_{sidewalk}$=11.62994297 billion soums)

ΣP – the total amount of money spent on construction;

(ΣP = 107.898834 billion sum).

An object-oriented programming language in the Visual Studio environment is a flow calculation program for the construction of individual low-rise housing using C #.

If we create a model of these parameters using a programming language, it will look like this.

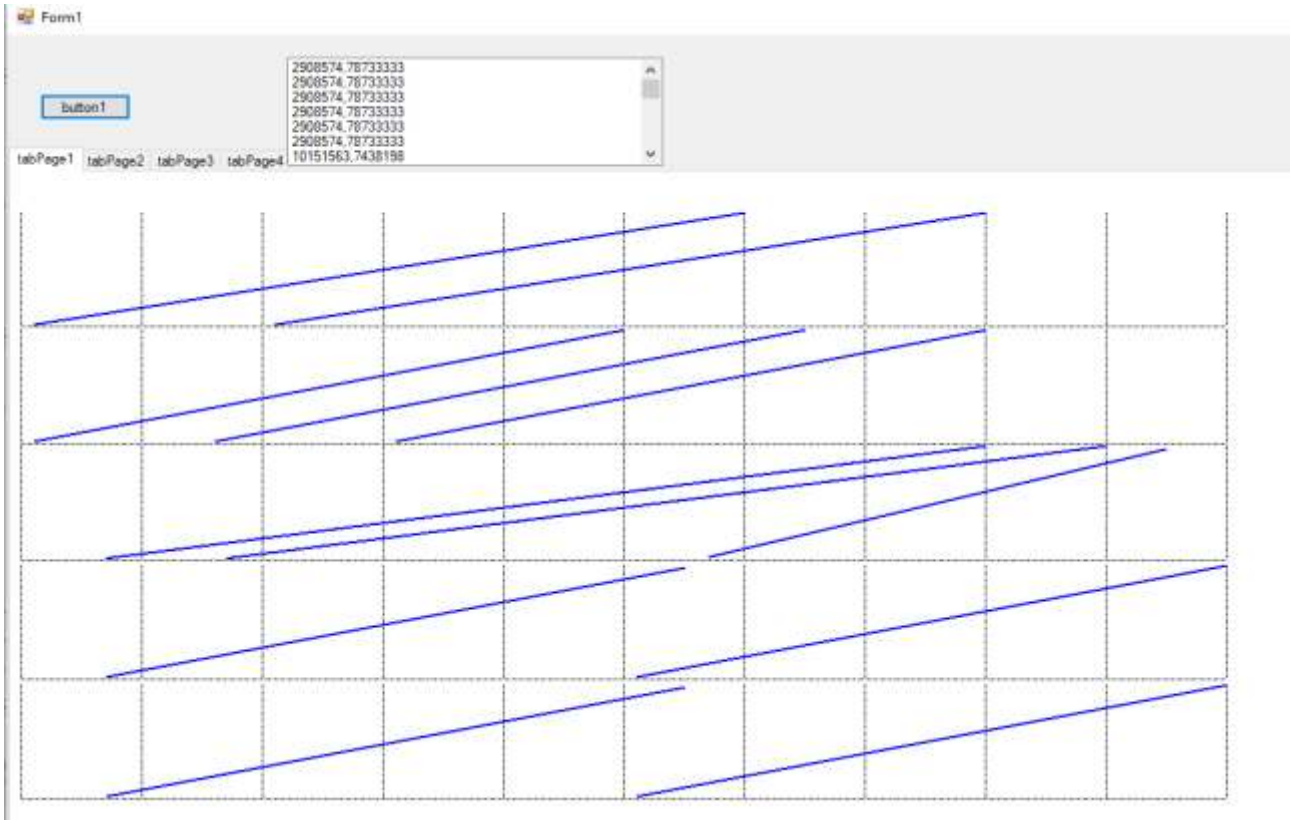

Figure 2. View of the complex cyclogram calculation of the organization of construction in the flow method

The rate of disbursement of capital allocated for construction is determined by the value of funds allocated to it for each facility flow and the period of production corresponding to this flow:

$$J_i = \frac{P_i}{T_{np_i}} \text{ mln. sum.}$$

Here, P_i - is the amount of money spent on main and auxiliary buildings, the number of which is determined depending on the type of main and auxiliary buildings.

T_{npi} – is the duration of construction time, which is determined by the cross section of months (weeks).

($T_{пр1}$ =5 month, $T_{пр2}$ =5 month, $T_{пр3}$ =4 month, $T_{пр4}$ =5 month, $T_{пр5}$ =6month,)

$T_{пi}$ – construction is the initial preparatory period, which is determined by the interval of days. ($T_{п1}$ =15 days, $T_{п2}$ =15 days, $T_{п3}$ =15 days)

If the above values are more than one, the amount of money spent on construction, the duration of the construction time, and the initial preparation period are also reflected in several calculations.

Conclusion

1. Development of a calendar plan is a sufficiently algorithmically additive process that allows you to build construction schedules, optimize the distribution of capital in accordance with the requirements of the norm, automate the calculation.

2. The proposed method is aimed at creating an automated workplace in the development of the project of construction organization.

3. In the context of the achievements and prospects of the housing construction program in Uzbekistan, there are a number of shortcomings related to the organization of construction. Thus, to ensure the continuity of QTL and IBL, the calendar plan and calendar schedules must be interconnected, which cannot be achieved without the method of calendar plans. In addition, the calendar plan should also be examined, which means that there is an evidence base of decisions made in the archive. The

absence of this method does not allow to confirm the reliability of the calendar plan provided in the project, which is one of the main documents of the project and should serve as a basis for contractual agreements, so it is required in construction.

4. A method of developing a calendar plan for the construction of affordable housing complexes based on the organization of reasonable work, taking into account the requirements of duration and delay in construction is proposed, for which a graphoanalytic model of work in the form of a complex flow cyclogram consisting of three object flows (complex residential buildings) is given; social infrastructure buildings; structural structures). The calculated parameters of the cyclogram are determined depending on the technical part of the design documentation of residential buildings, social infrastructure and facilities, their quantity, nomenclature and scope of work. The construction period and a number of other conditions are given in the explanatory notes. The model takes into account the requirements of the norms of organization and acceptance of completed facilities in construction.

5. The calendar plan developed by the presented method can be used to determine the relevant parameters of the contractual arrangements, such as funding schedule, start and completion of works, stages, objects.

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