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PRINCIPLES FOR MODELLING THE SPATIAL AND TECHNOLOGICAL STRUCTURE OF FLOW CONSTRUCTION PROCESSES

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ABSTRACT

This article is devoted to the influence of features of the production processes of construction products in the preparation of the calendar plan. The proposed methods of some scientists are described by definition with an accuracy of the planned duration of construction.

Construction and installation work (CEW) has the following technical, economic and organisational features:

1) Lack of stationarity in construction processes.

– Construction products have a special character: they are stationary and fixed to the ground.

– The movement of tools and manpower along the work front. To assess these movements, timetables and schedules are created.

– Periodic interruptions in the production process, irregularities in the construction process over time. For example, when pouring concrete for solid concrete structures, it takes time for the setting concrete to reach the required strength properties. A well-designed timetable will use the workforce and

machinery to work on other fronts (if available) during this time, otherwise there will be downtime for workforce and machinery.

– For the construction and installation work, it is first necessary to set up building facilities: auxiliary and amenity rooms, storage areas, coff...

Building access roads for crane and other machinery, etc. For which purpose a construction master plan is developed. All of this adds to the cost of the construction product. The cost is also affected by the time spent on delivery of construction materials and the time required to move construction equipment, materials and resources.

Factor in the length of time it takes to produce the final product.

This factor gives rise to the following features in construction financing. For example, organisations carrying out the initial work would like to be paid for the work as soon as it is completed rather than waiting until the building is ready for use. Therefore, in addition to setting the price for the construction of the whole building, prices are also set for individual components and parts of the building. During construction it is often necessary to review the design decisions made. For example, during construction of the second stage of the Mariinsky Theatre in St Petersburg, subsidence and partial flooding were detected in the basement. As a result, reinforcement was made and completely different solutions were adopted for the underground part of the building, which increased the initial estimated cost by eight times and increased the construction period by two years. The duration of the construction and the different types of works are related to the involvement of a number of contractors, their turnover and sequence of work. The project documentation includes the regulation of these activities.

The construction process is significantly influenced by the climate and local conditions, which determine the thermal protection conditions, the design of the building's foundations, and other conditions. Construction work takes place outdoors which also affects a number of processes (e.g. concreting in winter requires special heating). External factors are not sufficiently predictable (weather conditions may change, e.g. sudden frost) which adds a degree of uncertainty and influences the planning of seasonal work.

The construction industry is very material-intensive. This makes construction and assembly work very dependent on suppliers and transport. There are often restrictions on storage space and also on time. For example, concrete mix is delivered as a liquid and can be used up to the point of setting, which limits the time and conditions for delivery.

In order to take all these factors into account, SOPs and PICs are developed.

The PIC considers options for estimating construction time and cost in terms of present value. The comparison of options is determined using the formulas:

$$Э=S_{по}\ T(i=1)\ 0{,}15(Ci”- Ci’) + (Э_н + Э_д + Э_р) - ДЭ_н=H(1-T2/T1)$$

$$Э_р=0{,}15\ Ф\ (K1T1-K2T2) Э_д=0{,}15\ Ф\ (T1-T2)$$

Sustainable

where Ci' and Ci' are the average annual value of fixed assets by year of construction

Эн - is the effect of a reduction in notional fixed HP.

Эд -is the effect of early commissioning of fixed production assets.

Эр - is the effect of a more appropriate allocation of capital investment.

Д - additional costs related to shortening the construction period.

H - notional constant HP

T_1 and T_2 - duration of construction according to the standard and the comparative variant.

Ф – CC -of main production assets.

The chapter (1Figure 1) showed the methods of searching for options to carry out an EPC according to a certain criterion, where among the criteria were such as:

the duration of construction,

The use of resources (labour, material, financial) is consistent and uninterrupted,

the cost of construction and installation,

the productivity of the workers involved in the construction of the project and others.

It is known that construction times have an indirect impact on costs, especially when building.

In the case of investment projects, the investor is interested in the earliest possible return of the invested funds. Delayed construction and untimely completion of works in this case may lead to bankruptcy of the company. Therefore, optimisation of construction and erection works should be carried out according to the total optimisation criterion - time/cost of construction, taking into account the risks of untimely completion of works. Decisions made in this case take the form of scheduling.

The methodology for evaluating the efficiency of technological solutions consists of assessing the time taken and finding the optimum technological process that makes efficient use of materials, machinery and human resources to reduce construction time. To identify the optimum solution in terms of these indicators, the following are drawn up:

Timetable

Timetable (line chart for different indicators)

Different degrees of enlargement of schedules are used. The degrees of enlargement depend on the norms and tasks (degree of estimation).

The methods of work are justified in the construction project on the basis of the capabilities of the construction company and the specifics of the construction site, and a decision is made on the method of work.

A rough selection of the scope of work is made, the scope of work is calculated, and the process flow diagram is adopted. On this basis, a network schedule and a work and resource definition map of the network schedule are prepared. A peak of material and labour is determined by the construction diagram, the number of temporary warehouses and temporary service buildings is calculated, and flow charts are drawn up. The organization-technology diagrams (as part of the process map) show particular and specialised solutions for individual types of work and the use of machines and mechanisms.

There is a clear trend in modern construction to move away from the construction of one-piece buildings towards the integrated development of large plots of land. This approach ensures the creation of a comfortable urban environment, as it allows for the planning and construction of an ergonomic infrastructure. Integrated land development is traditionally carried out using flowing construction methods. The other peculiarity is that there is a great deal of attention to the deadline for delivery of the finished projects. It is conditioned by the fact that such projects are often included in the list of socially important projects and are implemented not only with involvement of shareholders' funds, but also with partial financing from the city budget. This increases the responsibility of the construction company for failing to meet the deadline.

In most cases, deterministic estimates of duration are used in scheduling, including through precise organization methods, but there are many examples that show that people tend to overestimate the accuracy of their own projections. As noted in a paper , the duration of most project activities cannot be estimated with a margin of error of less than 20%. Moreover, additional information efforts, requiring time and resources, are needed to reduce the uncertainty. Leach, L. shows that to improve the accuracy of the forecast, the budgetary cost increases substantially, with a limit due to the inherent variability of the process in question.

E.M. Goldratt proposes that the expert duration should be reduced by a factor of 2, and that safety buffers should be introduced into the timetable to damp down any delays in completion. An alternative to expert judgment is the statistical determination of duration. To justify it, we turn to the work that defines the shape of the distribution curve and its parameterization through the use of standard statistical characteristics.

Many modern software products have a built-in random number generator. A computational tool such as MS Excel has an integrated "SLCHIS" function that produces a random, evenly distributed real number in the range of up to016 .

The transition from a uniform generator to an exponentially distributed random duration generator is made using the formula:

$$t = 0.5t [1 - Ln (Rnd)], (3)$$

where R_{nd} is a uniform random number generator in the range [0, 1].

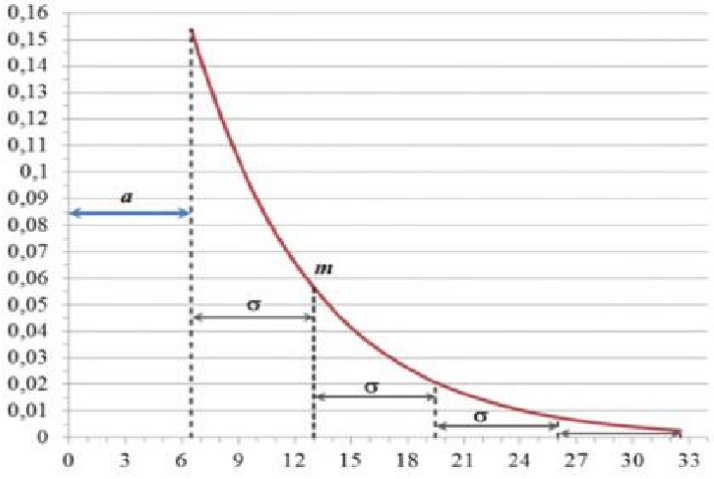

Fig. Probability density1. of exponential distribution of construction time for a 12-storey monolithic building with an area of sqm12000 and a standard construction period of one month137.

Hereinafter, we will refer to random duration generator as a function of random duration distribution used in statistical modeling of works in construction schedules. The computational experiment performed in MS Excel software has confirmed validity of this formula for generating random work durations in accordance with exponential probability distribution. The results are presented as a histogram (Figure 3).

Fig. Dynamics2. of effort as the work progresses

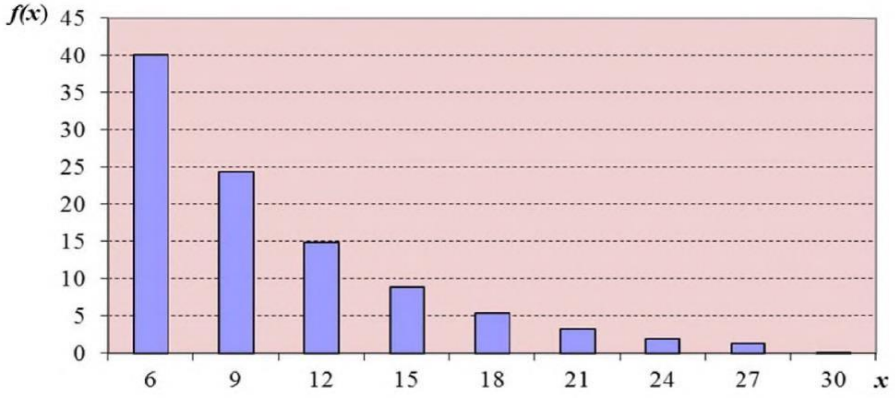

Fig. Probability density3. of an exponential distribution, based on MS Excel's built-in uniform random number generator

Leach L. [p. 109] 8 examined the dynamics of effort as the work progresses and found that effort increases as the target completion date approaches (Figure 2). It may therefore be advisable to use a "loading at the end" type of resource sheet when scheduling activities in a programme such as MS Project.

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