THE NP-HARD PROJECT MANAGEMENT PROBLEM WITH CREDITS[1]

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The project management problem with reinvestment of incomes and an opportunity to use credits is considered. There is a set of jobs $V = \{1, 2, \ldots, n\}$ and partial order of their execution E. Each job $j \in V$ is characterized by the duration p_j and the cash-flow $c_j(\tau)$, $\tau = 0, 1, \ldots, p_j$. There are financial resources $K(t)$, $t = 1, 2, \ldots, T$, where T is the planning period. The discount rate r_0 is given.

In this paper we research the model from [1], in which there is an opportunity to use credit in every moment of time. The credit rate is $r_k \geq r_0$. Let $D(t)$ be the credit size in the year t. The model with credits and reinvestment of incomes has the following form: create a schedule of jobs execution $S = (s_1, s_2, \ldots, s_n)$, where the jobs execution technological order is kept $s_i + p_i \leq s_j, \quad (i, j) \in E$, and in every moment of time $t^* = 1, 2, \ldots, T$ the positive balance of payments with credits is saved:

$$\sum_{t=1}^{t^*} \left(\frac{K(t)}{(1+r_0)^{t-1}} + \sum_{j \in N_t} \frac{c_j(t-s_j)}{(1+r_0)^{t-1}} + \frac{D(t) - (1+r)D(t-1)}{(1+r_0)^{t-1}} \right) \geq 0,$$

where $N_t = \{j \in V \mid s_j \leq t < s_j + p_j\}$ is a set of jobs which are performed in the interval $[t, t+1)$. The purpose is to maximize the net present value including credits:

$$NPV(S) = \sum_{j \in V} \sum_{\tau=0}^{p_j} \frac{c_j(\tau)}{(1+r_0)^{s_j+\tau}} + \sum_{t=1}^{T} \frac{D(t) - (1+r)D(t-1)}{(1+r_0)^{t-1}} \to \max .$$

In this paper complexity of the problem with credits was researched and the following theorem was proved.

Theorem. *The project management problem with credits is NP-hard in the strong sense.*

There is given an example that shows the necessity of credits optimization.

ЛИТЕРАТУРА

1. E.A. Martynova, V.V. Servakh *On scheduling credited problem.* — Automation and Remote Control. — 2012, Vol. 73, Is. 3, p. 508-516.

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