

CONSTRUCTION WORK TASKS DURATION: NEW METHOD OF ESTIMATION AND QUALITY CONTROL

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The article considers the principles of ensuring the completion of construction projects to meet the date. The authors suggest the method of assessing the progress of the project and estimating timely completion of the project based on the application of the Schedule Timeless Index (STI) and the Schedule Progress Index (SPI). The method allows to analyze dynamically the deviation of the timing of the project for prompt adoption of effective management decisions.

Key words: Planning, Project management, Performance indices, Project performance

INTRODUCTION

The modern practice of construction project execution shows that the completion date of separate projects in principle can not be delayed and ensuring timeliness of construction is an important management task. For the projects where the failure of meeting dates leads to serious, to catastrophic consequences creation of effective system of planning and control of project dates has a great meaning.

The world conventional standards of project management pays great attention to project dates planning and control, in particular, in a Guide to the Project Management Body of Knowledge (PMBOK® Guide) [01] published by the Project Management Institute (PMI), in the International Competence Baseline (ICB) [02] published by the International Project Management Association (IPMA) and others [03]. At the same time these standards cover the processes of project planning in detail, however it doesn't sufficiently state the guidelines of ensuring achievement of planned dates of separate activities and the entire project. The methodology of project management uses the term deadline as designation of date to which activity or the complex of activities or the entire project have to be completed. Failure of the deadline can be considered as project crash [04-10].

MATERIALS AND METHODS

In case of the construction project crash we need to make a rule to name the achievement of such results of the project (on duration, cost, quality, scope and other parameters) which are beyond the established limit values and lead to basic failure of the project purposes [11]. If a construction project crash happens we should necessarily state what caused such results of the project (in terms of duration, cost, quality, scope and other criteria) having gone beyond the established limit values and led to basic failure of the project purposes.

One of the main objectives of investigation of crashes and incidents is to prevent their emergence in the future. At implementation of construction projects it is necessary to provide timely data acquisition about the potential achievement of critical values of parameters which can lead the project to a catastrophic outcome and expeditious development of the effective administrative decisions, allowing to remove project parameters for a framework of critical conditions.

For ensuring construction project to complete on time it is necessary to create the effective system of tracking and control of project dates [12, 13], one of such methods is presented below.

The revisions of the construction project can be performed with the frequency equal to one week.

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The actual project progress should be checked to the data which is called as the status date. Schedule tracking by criterion of time has to be carried out according to functionality project management software, in particular Oracle Primavera P6 [14] and Microsoft Project Professional [15]. The actual activities start and finish dates are checked daily.

The parameter of the remaining duration for all performed project activities is weekly evaluated. We suppose to take a forecast of an expected date of activity finish date as an input of this parameter.

Remaining Duration (RD) - the amount of time which needs to be spent of the status date for the activity completion. If the activity is performed according to the schedule, the Remaining Duration will be determined by a formula:

$$RD = \text{Total Duration} - \text{Actual Duration} \quad (1)$$

Otherwise it is necessary to specify the forecast finish date (FFD) of activity:

$$FFD = \text{Status Date} + \text{Remaining Duration} \quad (2)$$

Here, the Remaining Duration will be determined by an expert way or on the basis of calculation depending on the type of work and its implementation method.

Before the start of the project it is important to accept a certain forecasting period, it is necessary in order to control not only those activities which are planned to be performed within the status date, and not only behind the schedule, but also the activities scheduled to start within the forecasting period (usually from 4 to 8 weeks). Thus, for activities planned within this period it is nec-

essary to specify an expected date of their start and their expected duration.

The important problem of control consists of evaluation on the basis of collected and processed actual data about activities' performance and an assessment of the entire project condition [16, 17]. As a result of such periodical assessment it is necessary to produce a short, laconic Project Status Report which reflect a situation for the following reporting to project stakeholders [18, 19].

The project manager and project team usually are expecting to get answers to the following key questions:

- If the project completion date is going to meet the deadline?
- If the earned project value is equal to the planned project value?

The essence of an assessment of possibility of the project completion date as to the project target date is shown on curve (Figure 1). Here: T_{st} - start project date; T_{tar} - target completion project date; T_{for} - forecast completion project date, depends on the achieved progress of the project, at the project start date is equal to T_{tar} , at the project completion date is equal to T_{act} ; T_{act} - actual completion project date, when the project will be finished; $\Delta T(t) = T_{tar} - T_{for}$ - function of project dates deviation.

The curve (Figure 1) shows that, despite existence of the negative forecast of project completion date deviations, these deviations don't leave out of the set limits (see the admissible value of deviation) and the project to be finished on time.

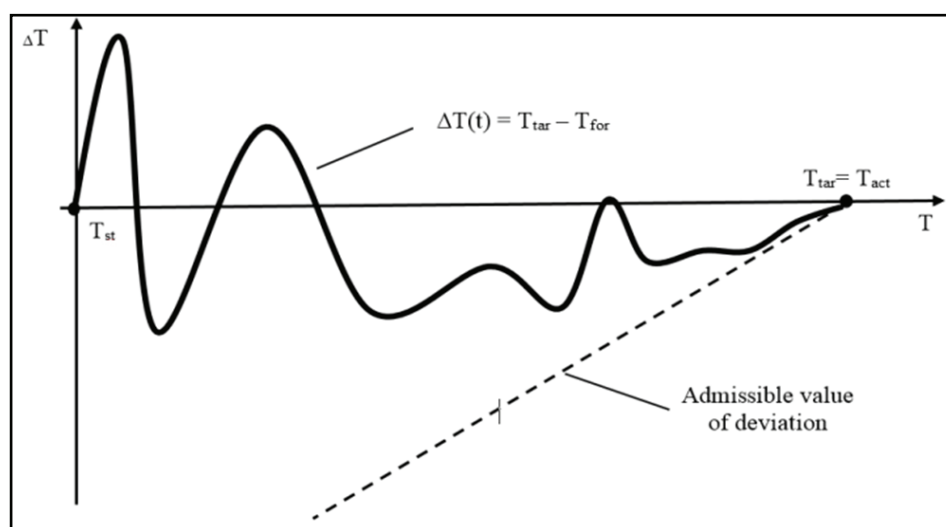


Figure 1: The curve of deviation of the forecast project completion date according to the status project date in case of completion project date is on time

The curve (Figure 2) shows that, the forecast of deviations from a target date of the project left out the set limits that led finally to failure of project deadline. The time point where the function of a deviation of the forecast project completion

date according to the status date exceeded the limit of admissible value, is “a point of no return”, i.e. it is possible to consider that further beyond this point it is impossible to bring the project back on track.

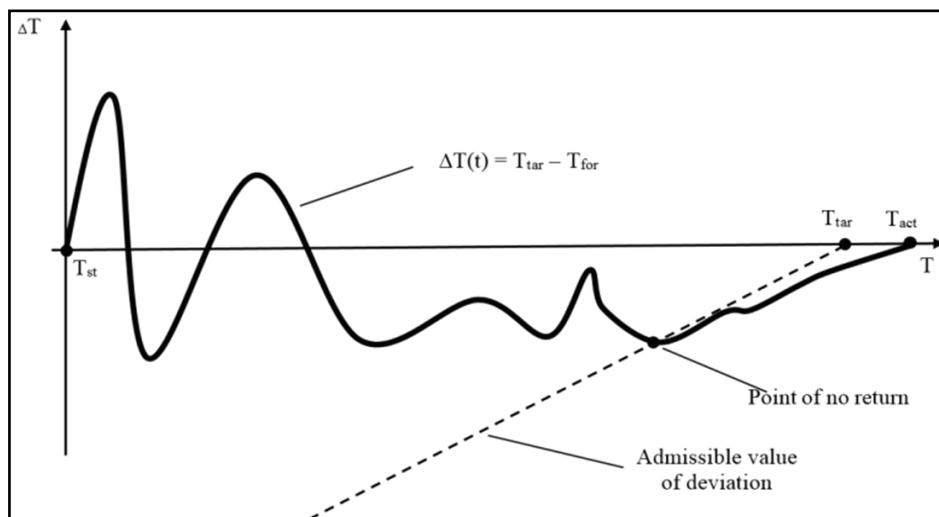


Figure 2: The curve of deviation of the forecast project completion date according the status date in case of failure of deadline of the project

RESULTS AND DISCUSSION

It is necessary to consider two main tracked features to estimate the status of the entire project: timeliness of the project completion date and extent of progress of activities performing in comparison with the schedule [11].

The Schedule Timeless Index (STI) can be calculated by the following formula:

$$STI = \frac{T_{tag} - T_{for}}{T_{tag} - SD} \quad (3)$$

where T_{tag} - target completion date of the project is defined during the approval of the baseline; T_{for} - expected completion date of the project, i.e. date of approach of a finishing milestone of the project, determined by the current schedule for status date; SD - status date.

The value of the STI depends on amount of time which remains before finish of the project, i.e. to be able to make management decisions.

The actual project progress can be measured as the ratio of activities which are actually completed as per the status date to amount of activities which has to be completed according to the baseline schedule. In this case the completion of activities is considered both the numerator, and the denominator i.e. if an activity is being performed now it is considered incomplete that creates a certain reserve. If project activities are

equal in terms of importance, it is possible to reduce calculation of this index to a quantitative assessment: $N_{compl} / N_{planned}$, where N_{compl} - the amount of activities, which are actually completed as of the status date; $N_{planned}$ - the amount of activities which have to be completed as of status date according to the baseline. This index will correspond to the Schedule Performance Index (SPI) from the Earned Value Management [20- 22].

However it is necessary to consider the time which remains before the completion of the project, and also to carry out an assessment of value of a deviation of the actual parameters from planned, instead simply define a ratio of the performed and planned activities. Taking into account these factors, a relative indicator — the Schedule Progress Index (SPI) - will be calculated by a formula:

$$SPI = \left(\frac{\frac{N_{compl}}{N_{planned}} - 1}{T_{tar} - SD} \right) \quad (4)$$

The STI can be considered as the basic, and the SPI - as an additional. Values of these indexes aren't interconnected therefore change of one index will directly not influence the value of other. It is necessary to estimate the limit of these indexes to define in what “zones” the projects are in terms of time [11].

Table 1: The example of successful implementation of the project

Status Date	Time to Completion	Plan Amount of activities	Actual Amount of activities	Project Duration Variance	STI	STI Zone	SPI	SPI Zone
0	210	0	0	0				
7	203	25	35	4	0,020	Dark green	0,414	Dark green
14	196	75	90	7	0,036	Dark green	0,214	Dark green
21	189	125	150	10	0,053	Dark green	0,222	Dark green
28	182	165	210	6	0,033	Dark green	0,315	Dark green
35	175	210	280	2	0,011	Dark green	0,400	Dark green
42	168	260	350	0	0,000	Dark green	0,433	Dark green
49	161	330	400	-3	-0,019	Light green	0,277	Dark green
56	154	400	460	-5	-0,032	Light green	0,205	Dark green
63	147	470	530	-4	-0,027	Light green	0,182	Dark green
70	140	540	600	-2	-0,167	Light green	0,167	Dark green
77	133	610	650	-8	-0,104	Light green	0,104	Dark green
84	126	720	700	-10	-0,069	Light green	0,069	Dark green
91	119	830	820	-7	-0,059	Light green	-0,021	Dark green
98	112	930	950	-8	-0,071	Light green	0,040	Dark green
105	105	1020	1040	-10	-0,095	Light green	0,039	Dark green
112	98	1090	1110	-12	-0,052	Light green	0,040	Dark green
119	91	1160	1180	-6	-0,066	Light green	0,61	Light green
126	84	1230	1260	-8	-0,095	Light green	0,021	Light green
133	77	1300	1310	-4	-0,052	Light green	-0,086	Light green
140	70	1390	1350	-9	-0,129	Light green	-0,086	Light green
147	63	1500	1450	-11	-0,175	Yellow	-0,111	Yellow
154	56	1620	1500	-8	-0,143	Light green	-0,278	Yellow
161	49	1690	1590	-6	-0,122	Light green	-0,254	Yellow
168	42	1760	1670	-6	-0,143	Light green	-0,256	Light green
175	35	1820	1790	-4	-0,114	Light green	-0,099	Light green
182	28	1880	1870	-3	-0,107	Light green	-0,040	Light green
189	21	1930	1915	-2	-0,095	Light green	-0,078	Light green
196	14	1960	1955	-2	-0,143	Light green	-0,038	Light green
203	7	1980	1975	-1	-0,143	Light green	-0,076	Light green
210	0	2000	2000	0	Success			

If the $STI > 0$ or the $SPI > 0$ - project implementation is in a dark green zone.

If the $-0,15 < STI < 0$ or the $-0,5 < SPI < 0$ - project implementation is in a light green zone.

If the $-0,3 < STI < -0,15$ or the $-0,3 < SPI < -0,15$ - project implementation is in a yellow zone.

If the $STI < -0,3$ or the $SPI < -0,3$ - project implementation is in a red zone.

When the value of two indicators is in a dark green zone – the project implementation goes better than planned.

When the value of at least one of two indicators exceeds the dark green zone into the light green, it indicates that it is close to its negative deviations from the schedule, but these deviations are insignificant and they can be neglected.

When the value of at least one of two indicators exceeds the light green zone into the yellow one – the schedule of the project demands recalculation. In this case it is necessary to find opportunities for acceleration of the remained activities or if it is impossible or it is inefficient, to negotiate

agreement of moved project deadline [23-25].

In case when the value of at least one of two indexes exceeds the yellow zone into the red one - the project can be considered as failed on dates in spite of the fact that there is still time before project completion. It should be noted that the extreme value of these indexes directly depend on amount of the reserve put at the schedule evaluation.

If the project is carried out according to rather intense schedule which isn't providing considerable internal reserves, extreme values of indexes have to be minimum, and vice versa. Anyway, it is necessary to approach determination of the extreme values of indexes responsibly. The example of successful implementation of the project is presented in Table 1.

Table 2: The example of failure implementation of the project

Status Date	Time to Completion	Plan Amount of activities	Actual Amount of activities	Project Duration Variance	STI	STI Zone	SPI	SPI Zone
0	210	0	0	0				
7	203	25	35	4	0,020	Dark green	0,414	Dark green
14	196	75	90	7	0,036	Dark green	0,214	Dark green
21	189	125	150	10	0,053	Dark green	0,222	Dark green
28	182	165	210	6	0,033	Dark green	0,315	Dark green
35	175	210	280	2	0,011	Dark green	0,400	Dark green
42	168	260	350	0	0,000	Dark green	0,433	Dark green
49	161	330	400	-3	-0,019	Light green	0,277	Dark green
56	154	400	460	-5	-0,032	Light green	0,205	Dark green
63	147	470	530	-4	-0,027	Light green	0,182	Dark green
70	140	540	600	-2	-0,014	Light green	0,167	Dark green
77	133	610	650	-8	-0,060	Light green	0,104	Dark green
84	126	720	750	-10	-0,079	Light green	0,069	Dark green
91	119	830	820	-7	-0,059	Light green	-0,021	Dark green
98	112	930	950	-8	-0,071	Light green	0,040	Dark green
105	105	1020	1040	-10	-0,095	Light green	0,039	Light green
112	98	1090	1110	-12	-0,122	Light green	0,039	Light green
119	91	1160	1180	-6	-0,066	Light green	0,040	Yellow
126	84	1230	1260	-8	-0,095	Light green	0,061	Red
133	77	1300	1310	-4	-0,052	Light green	0,021	Red
140	70	1390	1350	-9	-0,129	Light green	-0,086	Red
147	63	1500	1450	-11	-0,175	Yellow	-0,111	Red
154	56	1620	1500	-15	-0,268	Yellow	-0,278	Red
161	49	1690	1560	-20	-0,408	Red	-0,330	Red
168	42	1760	1630	-20	-0,476	Red	-0,369	Red
175	35	1820	1680	-20	-0,571	Red	-0,462	Red
182	28	1880	1730	-18	-0,643	Red	-0,598	Red
189	21	1930	1770	-15	-0,714	Red	-0,829	Red
196	14	1960	1800	-13	-0,929	Red	-1,224	Red
203	7	1980	1840	-12	-1,714	Red	-2,121	Red
210	0	2000	1880	-10	Failure			

CONCLUSION

Herein we state a system of project parameters indication that allows to track effectively the condition of activities (a complex of activities) in particular and the entire project, as well as to provide timely information on approach of critical parameters which can lead to substantial, catastrophic effects. This method allows to make an assessment of the project progress in order to make the effective management decisions, allowing to remove project parameters from the framework of critical conditions. The proposed method can be used in the construction project management. This method can be used to ensure completion of the project or the key milestones on time.

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- Paper sent to revision: 07.02.2016.*
- Paper ready for publication: 10.03.2016.*