Associated Control Research for Software Project Schedule and Budget Based on Function Point Method

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ABSTRACT

Associated control of schedule and budget is the important means to improve the success rate of software project. In this paper, aim at associated control of schedule and budget based on function point method for software project, put forward completed software effort calculation method based on function point analytical method, then apply Earned Value theory to calculate Earned Value variables and carry on Earned Value analysis, thus to evaluate schedule and budget.

INTRODUCTION

Compared with the rapid development of software industry, failure rate of software project remains high all along. Much has been done in academe and practice to find the causes of high failure rate of software project. Succeed of software project depends not only on technique, estimation difficulty caused by ambiguity goal and changeable requirement, and many other causations are all in the domain of project management. So, when technical effort can not gain prospected effects, people have to appeal to management technology. Statistical date from international software corporations shows, after continuous improvement on software project management, project fulfill schedule can be
shorten above 40%, cost can be retrenched more than 50%, and rate of bug 75%, at the same time, improvement cost just account for 2% of the overall cost.

Earned Value Management (EVM) [1,5], very important projects supervise method in modern project management domain, can insure project manager to adopt effective correct measure as soon as possible when warp appeared via analyzing synthetically schedule and budget. EVM is method analyzing the difference between expectative goal and actual implementation, its basic principle is to introduce a medial variable - Earned Value for project’s alternation analysis of investment and schedules based on variance analysis, then identify and analyze the variance when they appeared, forecast their development in the future moreover.

Earned Value is a specialized variable to measure and compare the work performed and the work planed; measurement veracity and analysis reliability depend on creditable measurement for work performed. Generally, we use accumulative workload to describe software project’s progress, but estimation of accumulative workload is very hard because software outcome is invisible. In this paper, improved function point method is adopted to count accumulative work performed, then Earned Value Method is applied to supervise schedule and cost synthetically.

EARNED VALUE VARIABLES CALCULATION FOR SOFTWARE PROJECT BASED ON FUNCTION POINT

Applying Earned Value method to software project, the emphasis is to calculate three key Earned Value variables - Budgeted Cost of Work Scheduled, Budgeted Cost of Work Performed and Actual Cost of Work Performed. They are all relative with measurement of software work performed. That is to say, the focus mission of Earned Value method is to compare work performed with work planned to do. Software workload is always the function of software size. There are many techniques to measure software size in software engineering domain, but they are all aimed at program constitution at software initial stage. Theoretical research for software work performed is rare, and there is no mature and exact measure technique or method also.

Work Performed for Software Project

Software size estimation is the base for project schedule constitution. Software size can also be used as the reference or basic data for actual work estimation, for actual work can be gotten by modifying the original software size according the actual progress and matters occurred, thus many repeated procedures can be omitted, and the result veracity is always high. In addition, comparability is rather better for the same estimation method used to count work performed and work budgeted.
Function point analysis method is the commonly used method for software size estimation [1], taking the software function validated by both sides in requirement specification as basis, analyze the function of the developing system mainly; that is to say, estimate software size according to the information characters and complexity of the software [2,3]. Function point analysis method analyzes two kinds of functionality requirement from end-user’s view of functionality requirement to the application software: one is data functionality requirement, another is business functionality requirement. Data functionality requirement includes Interior Logical File (ILF) and Exterior Interface File (EIF), and business functionality requirement can be partitioned as Exterior Input (EI), Exterior Output (EO) and Exterior Query (EQ). Function Point analysis method is related with end-user’s operation requirement, and it is independent of program language and technology.

Function point analysis method is used for software size estimation at the project’s initial stage mainly. We modify function point analysis method properly to count work performed in the project’s implementation process. Main step of the modified function point analysis method for counting work performed is as follows:

(1) Count the number of EI, EQ, EO, ILF and EIF performed
For the number of EI, EQ, EO, ILF and EIF have been counted at the software project initial stage, so the actual work performed in the prosecution process can be corrected necessarily according to the former estimation and the practical status.

(2) Determine the complexity of the above elements
Determine the complexity of EI, EQ, EO, ILF and EIF differently referencing the relationship depicted by function point analysis method. Complexity of the module performed should be corrected according to the actual status.

(3) Determine the power of function point for all the elements
Determine the power of function point for all the elements according respective complexity, thus to count the number of function points. For difficulty of work performed is very clear, evaluation in the implementation process would be more accurate relative to the initial stage.

(4) Calculate the number of unadjusted function points
Calculate the number of unadjusted function points according number of EI, EQ, EO, ILF and EIF performed and respective power.

(5) Calculate the number of adjusted function points for work performed
This step is similar with function point analysis method [1].
All the above steps are similar with function point analysis method. And the primary difference is to study more accurately about complexity and any other influence factors in the process of software implementation according to the actual status.
Calculate the Three Key Earned Value Variables

(1) Budgeted Cost of Work Scheduled, BCWS
   BCWS is the necessary budgeted cost for work scheduled when software project progress to some time point, based on the schedule and budget approved by project team. BCWS is a baseline to evaluate project schedule and cost.
   
   \[ BCWS = \text{Work Scheduled} \times \text{Budgeted Ration} \]
   
   Where Budgeted Ration is the budgeted cost for unit function point, Budget Ration=Whole budget/Sum of Function Points. BCWS reflects the work should be completed according to schedule, not the actual man-hours or cost. In general, BCWS holds a line in the project process, unless the contract changes. If modification of contract influences project schedule and cost, the baseline of BCWS will change correspondingly.

(2) Budgeted Cost of Work Performed, BCWP
   BCWP is the necessary cost for actual work performed at some time point based on the schedule and budget approved by project team. BCWP is named as Earned Value also:
   
   \[ BCWP = \text{Function Points Performed} \times \text{Budgeted Ration} \]
   
   BCWP is the cost calculated by actual work performed and budgeted ration at some stage of software project process. BCWP reflects the project’s actual schedule which satisfy quality standard and denotes acquired schedule by currency.

(3) Actual Cost of Work Performed, ACWP
   ACWP is the actual cost of work performed at some time point. ACWP is the actual expenditure index reflecting project implementation.

ASSOCIATED CONTROL FOR SOFTWARE SCHEDULE AND BUDGET BASED ON EARNED VALUE THEORY

Variance Analysis

Carry through schedule-budget variance analysis using the three basic variables introduced in 2.2. There are four evaluation indexes [4].

(1) Schedule Variance, SV
   \[ SV = \text{BCWP} - \text{BCWS} \]
   
   If SV is negative, then software project actual schedule drops behind the original plan; if SV is positive, then software project actual schedule exceeds the original plan; is SV=0, then actual schedule is consistent with the original.

(2) Cost Variance, CV
   \[ CV = \text{BCWP} - \text{ACWP} \]
Similarly, if CV is negative, then software project actual cost drop behind the original plan; if CV is positive, then software project actual cost exceeds the original one; is SV=0, then actual cost is consistent with the original.

Besides SV and CV, we can also calculate efficiency of work performed.

(3) Schedule Performed Index, SPI
SPI is the ration of project Earned Value and BCWS:
SPI=BCWP / BCWS
If SPI>1, then actual schedule is faster than the planed; if SPI<1, then actual schedule is slower than the planed; if SPI=1, then the software project is ongoing according to the original schedule.

(4) Cost Performed Index, CPI
CPI is the ration of budgeted cost and actual cost:
CPI=BCWP / ACWP
If CPI>1, then actual cost is under the budgeted; if CPI<1, then actual cost oversteps the budgeted; if CPI=1, then the software project is ongoing according to the budget.

Overall Cost Estimation

We can analyze the overall cost estimation according to actual schedule and cost of work performed. There are two functions for this forecast and diagnose: firstly, it can provide information for the cost of remain work of the software project; secondly, it can provide evidence for raising money the software project required in the future.

We can estimate the overall cost according to actual efficiency or stated efficiency: if estimate according to actual efficiency, then the overall cost equals to the quotient of budgeted cost and CPI; if estimate according to stated efficiency, then the overall cost equals to actual cost plus to cost estimation of the remaining work.

Overall Schedule Estimation

We can analyze the overall schedule estimation according to actual schedule and cost of work performed [6]. There are two functions for this forecast and diagnose: firstly, it can provide information for schedule management of remain work of the software project; secondly, it can provide evidence for adjusting schedule the software project required in the future.

We can estimate the overall schedule according to actual efficiency or stated efficiency: if estimate according to actual efficiency, then the overall schedule equals to the quotient of budgeted schedule and SPI; if estimate according to
stated efficiency, then the overall schedule equals to actual schedule plus schedule estimation of remaining work.

APPLICATION EXAMPLES

The budget of a software project is 2,400,000 Yuan, overall schedule is 12 months, and software size is 2400 function points at project’s initial stage. After 7 months, the project’s actual cost is 1,800,000 Yuan, and work performed is 1600 function points.

First, calculate the three key Earned Value variables:
\[
BCWP = \frac{1600}{2400} \times 2,400,000 = 1,600,000 \\
ACWP = 1,800,000 \\
BCWS = \frac{7}{12} \times 2,400,000 = 1,400,000
\]

Further:
\[
CV = 1600 - 1800 = -20 < 0; \\
SV = 140 - 1600 = -20 < 0; \\
CPI = \frac{140}{160} = 0.875 < 1; \\
SPI = \frac{160}{180} = 0.889 < 1.
\]

Estimate the overall cost according actual efficiency: Overall Cost = 2,400,000/CPI = 2,740,000;
Estimate the overall schedule according actual efficiency: Over Schedule = 12/SPI = 13.5.

So, after the project progressed 7 months, the actual schedule lagged behind the original schedule, and actual cost was higher than budgeted cost. According to the present efficiency, when the project complete, overall schedule will defer 1.5 months, and overall cost will overspend 340,000 Yuan.

CONCLUSION

In this paper, we introduce function point method to calculate software project’s work performed, taking Earned Value as a ligament, combining cost control and schedule control, provide project manager an effective tool for cost-schedule variance analysis and work estimation.

REFERENCE


5. Li Ming. Apply Earned Value to quantify project schedule management. Project Management Technology, 2017.09.