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Xin Wang, Aihua Ren, and Xiangshang Liu

Researching on Quantitative Project Management Plan and Implementation Method

Xin Wang[a)], Aihua Ren[b)] and Xiangshang Liu[c)]

Computer Science & Engineering Beihang University, Beijing 100083, China.

[a)]Corresponding author:781594958@qq.com
[b)]renah@buaa.edu.cn
[c)]13251044@bjtu.edu.cn

Abstract. With the practice of high maturity process improvement, more and more attention has been paid to CMMI and other process improvement frameworks. The key to improve the process of high maturity is to quantify the process. At present, the method of improving the software process of high maturity is lack of specific introduction to the corresponding improvement link or process implementation. In this paper, based on the current improvement in the quantitative management of the framework and statistical analysis technical of the high maturity recommended for the enterprise to improve the process of planning and implementation methods. These methods provide quantitative process management for the enterprise, as well as quantitative management of the project to provide a systematic process, and finally evaluate the effectiveness of quantitative management projects. Finally, this method is used to verify the effectiveness of the framework in guiding the enterprise to improve the process of high maturity.

INTRODUCTION

Since 1820s, the manufacturing industry has begun to use quantitative management techniques to understand the diversity of processes, as well as to improve the performance of the process [1]. In the field of software engineering, the well-known models such as CMMI and ISO/IEC 15504 and other process improvement model is also consider the process of quantitative management as an important process in high maturity improvement. In CMMI, quantitative management is the key to the maturity of low maturity enterprises change to high Maturity. It requires enterprises based on customers, the needs of the organization, the establishment of quantitative management objectives for the project and organization, namely the quality and process performance objectives (Quality and Process Performance Objectives, QPPO) as the criterion of project management. To achieve this goal, the selected sub-process metrics should be statistically and analyzed, and the process performance baselines (Process Performance Baseline, PPB) should be established to understand the process capability. Analysis of the effects of selected stator processes on the objectives of achieving quality and process performance. Establish process performance model (Process Performance Model, PPM) to understand the quantitative relationship between quality and process performance objectives [2]. How to use these models and baselines to optimize the combination to achieve the purpose of quantitative management is worthy of the enterprise who is planning to manage their projects Quantitative.

In recent years, quantitative management from the manufacturing industry to the software industry has been a lot of successful practice. The regression analysis technique has been successfully used to establish the multiple linear regression equation of QPPO and related sub-processes. The function of the equation to predict the quality and performance of the product has been verified [3]. The effectiveness of using simulation technology in the process improvement of high maturity has been proved by theory and practice [4]. Reference to the statistical process control technology in software industry there is less data from the traditional manufacturing process is not stable and difficult, and some measures to improve project management personnel the statistical process control has been implemented effectively in [5] software enterprise. It is feasible to evaluate the effect of process improvement by statistical techniques [6].

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In this paper, based on the above technical practice, through the square and practice of high maturity enterprises, a framework for quantitative management of high maturity enterprises is summarized. This framework sets the quality and process performance objectives for the enterprise, establishes and maintains process performance models and process performance baselines. Forecast quality and process performance objectives. A combination of process optimization and evaluation of the effectiveness of a series of CMMI best practices.

QUANTITATIVE PROJECT MANAGEMENT PLAN

Quantitative project management planning stage is composed of establishment process of the establishment of QPPO and PPB, PPM, the three processes are interactive in the course of operation, they are parallel in time, but they are all dependent on historical data of organization. The specific process is shown in FIGURE 1.

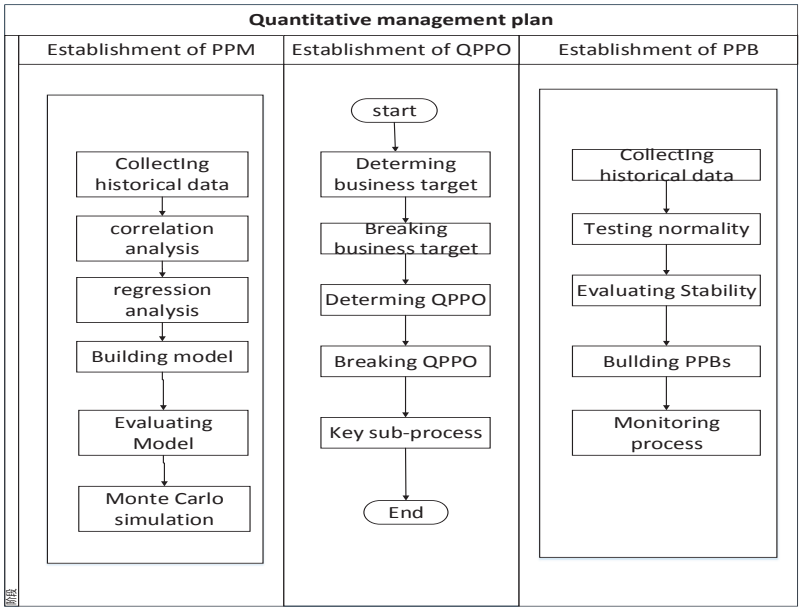

FIGURE 1. Quantitative project management

In the early days of quantitative management, business objectives have been established on the basis of establishing business objectives. There is a corresponding relationship between the business objectives and the QPPO to be established, through the regulation of QPPO can indirectly affect the business objectives. The company organized experienced staff to discuss the factors that affect the business objectives, the process of discussion and analysis is reflected in a causal diagram that can reflect the primary and secondary factors that influence the business objectives. These factors as input of the establishment of PPM. PPM can be established under the historical data and influencing factors using correlation analysis technique for relatively strong correlation. The definition of strong correlation is based on the company of quantitative management requirements and the organization, is a mathematical model based on historical data. A strong correlation is the process of setting the QPPO. At the same time, the PPB can be established for the QPPO process. The main step of the PPB is to establish the data base and the baseline. The baseline is based on statistical process control. At this point, we can establish the PPM of the business objectives and the QPPO process by regression analysis, which is a regression equation, or other forms such as Bayesian network model. The quantitative relationship between business objectives and multiple QPPO processes. After the inspection became a PPM. There is a quantitative relationship between business objectives and the QPPO process, and the history of the QPPO process PPB. Monte Carlo simulation can be performed using existing baseline data [7]. The result of the simulation is the probability distribution of a business objective, through which we can get the probability that the business target falls on an interval. The value of QPPO can be set to the value of PPB if the probability of reaching the goal of the business is up to 80%. Otherwise, it is necessary to make the appropriate adjustments to the value of PPB, and then go to the simulation, until the probability of business objectives meet the requirements of the organization. Finally, the distribution of the predicted variables corresponding to the Monte Carlo simulation is the set value of QPPO. Since QPPO is not directly controllable, it is necessary to further decompose the QPPO into a key

sub-process that can be controlled. This process is similar to the decomposition of business objectives. However, the process of determining the key sub-process not only to meet the requirements of the QPPO to achieve the organization's requirements, but also requires more than 25% sensitivity in the simulation process. Because the total of influence factor sensitivity is 100%, this setting can make a number of key sub-process selected is less than or equal to 4, which can control the process of the most important alternative when more, can also indirectly reduce the cost of enterprise management. With the preparation of these quantitative management, you can choose the pilot project to implement the quantitative project management plan.

QUANTITATIVE PROJECT IMPLEMENTATION

When the quantitative management plan is established for the quantitative management of organization. It can be applied in the practice of quantitative management by the use of PPB and PPM, such as probability at the beginning of the project can reach the target with PPM and PPB to predict the organization, can also have different process when using the optimal combination analysis to select the optimal combination of process the in the process, and after the completion of the project inspection related to whether the process is significantly improved, operation process is shown in FIGURE 2

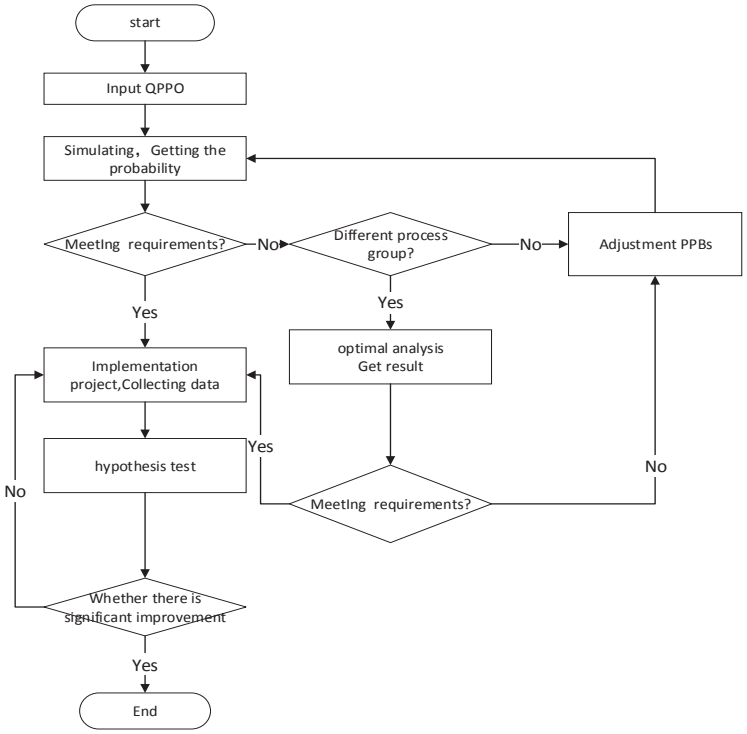

FIGURE 2. Manage quantifiable projects

QUANTITATIVE PROJECT MANAGEMENT

Define project execution objectives

In going to the quantitative management of a project, it is necessary to determine a project quantitative management objectives, such as make quantitative objectives in the cost and time of the predetermined condition, to make the function point implemented reached 63. According to the experience of the decomposition of the enterprise, the customer demand can be divided down. This is the process of selecting PPM.

In order to set the key sub-process goals and to verify the probability of achieving the objectives of the project, according to the baseline of the selected process performance model, we can find the process performance baseline.

To determine the baseline process performance model and the corresponding process performance, we can carry out Monte Carlo simulation with crystal ball tool, QPPO to achieve the goals of probability to achieve organizational requirements, then the baseline value is the value of QPPO, or after adjustment for baseline again. That meets the requirements of reach probability. This modified baseline is the value of QPPO.

Optimize the process performance.

If there are many choices for each sub-process in the process definition of the project group, the process performance baselines of these candidate sub-processes can be simulated by Monte Carlo simulation to select the optimal sub structure. At this time, we need to identify the discrete decision variables by Monte Carlo simulation according to the different decision variables. If a company has 3 options for requirements analysis, each method has a corresponding process performance baseline. And there are 2 ways to review the requirements.

At this point, if the requirements for the shortest period of time, then when the project team in the definition of the requirements engineering process, the process definition contains 6 combinations. Which combination can make the shortest period of time, you can choose by Monte Carlo simulation. At first, the model is constructed according to the requirement of setting the scene, and it is assumed that the quality goal of the project is the minimum of the defect density. For example, the cost management is the key part of software project management, in the implementation process of quantitative project, in order to control the cost in the expected range, the optimization process in combination as a budget, and in the early stage of project cost of consumption is too large, as well as the project late offer an alternative role in reducing costs. For example, the cost of the company can be summed up by the cost of the sub-processes. One project of company consist of requirements development, requirements review, design, coding, code review, internal testing department testing and integration of the cost of the test phase added. The organization's history PPB can be obtained by the following stages of the cost baseline.

TABLE 1. The selected PPM

periods	PPB name	Mark	Mean	Standard Deviation
Requirement development	RD cost	F11	36514	4874
	Demand review cost (prototype)	F12	22462	1826
	Demand review cost (interview)	F13	18933	1726
Design	Design cost	F21	25023	2717
	Design review cost	F22	14954	1823
Coding	Coding development cost	F31	62678	9273
	Code review cost (Conference)	F32	21748	2577
	Code review cost (review)	F33	26411	1824
Test	Internal test cost	F41	55845	6112
	Integrated test cost	F42	30950	3006

$$\text{Total Cost}=F11+Fx\ (\text{if } P1=1, F12; F12)+F21+F22+F31+Fy\ (\text{If } P2=1, F32:F33) \quad (1)$$

As can be seen from the table above, there are two different baselines for the requirements review, and the code review is also divided into the meeting and the survey of the two different baselines. P1=1 is used to express the requirements review of the prototype method, and p1=2 is an interview method. P2=1 means to select the code review of the conference method, and P2=2 means the code review of the selection method. Then the optimal analysis of the crystal ball plug. The optimal combination is set at 0 of the cost to 290 thousand yuan on the maximum probability interval, simulation software based on the P1, all possible combinations of P2 traversal, the total cost of the selected value portfolio, the largest of 290 thousand yuan and below the probability of P1, is the combination of P2. The results of the simulation, as shown in Figure 3, the horizontal axis of the table is possible, the vertical axis of each case corresponds to the decision value, according to the decision value to determine what kind of choice.

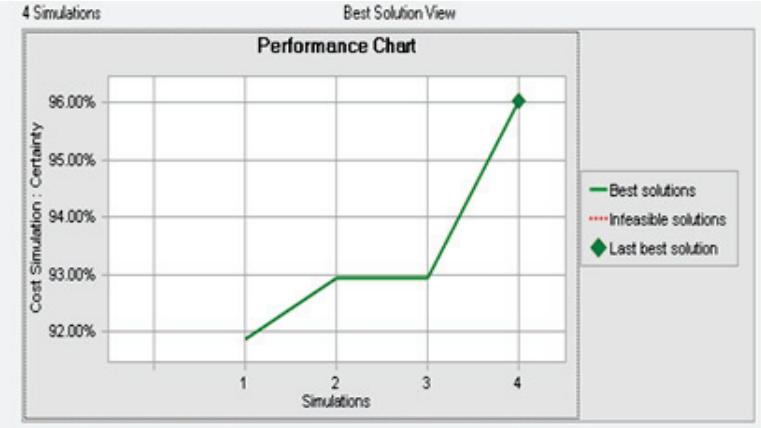

FIGURE 3. Optimal analysis distribution map

From the simulation results we can know, in the third simulation results, the total cost of 290 thousand yuan and below the maximum probability of 0.960 at this time, the optimal selection method for the analysis of interview needs assessment, select the meeting method for code review. This combination can make the total cost within the specified range of maximum probability.

Evaluate process improvement

After the implementation of quantitative project management, it will choose some items to check whether the improvement effect is significant. Hypothesis testing is an important statistical inference method. Hypothesis testing is based on the assumption of the overall parameters, and then use the sample information to test whether the hypothesis is established, to determine whether the sample information is in the range of the interval, so as to reject or accept the conclusion of the hypothesis. In the process of verification of the hypothesis, there may be such a situation: the original hypothesis is correct, but the probability of false rejection, the alpha said, called alpha error: original hypothesis error, the error will be accepted, the probability of error by beta said, called beta error. In the process of hypothesis testing, the judgment may be right or wrong.

Project data before and after process improvement is shown below

TABLE 2. historical data

project	Delay rate	periods	project	Delay rate	periods
P1	1.083	before	P16	1.088	before
P2	1.057		P17	1.003	after
P3	1.111		P18	1.011	
P4	1.018		P19	1.001	
P5	1.105		P20	0.912	
P7	1.094		P21	1.105	
P6	1.036		P22	1.001	
P8	1.062		P23	1.002	
P9	1.101		P24	1.004	
P10	1.099		P25	1.017	
P11	1.032				
P12	0.934				
P13	1.009				
P14	1.075				
P15	1.033				

We do the hypothesis test for the improved and improved data, and get the following results

```
Two-sample T for delay-rate1 vs delay-rate2

              N    Mean   StDev  SE Mean
delay-rate1  16  1.0598  0.0464    0.012
delay-rate2   9  1.0062  0.0486    0.016


Difference = μ (delay-rate1) - μ (delay-rate2)
Estimate for difference:  0.0536
95% lower bound for difference:  0.0188
T-Test of difference = 0 (vs >): T-Value = 2.69  P-Value = 0.008  DF = 16
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FIGURE 4. Results of hypothesis testing

It can be seen from the results of the hypothesis test that the demand delay rate is significantly reduced, indicating that the quantitative management plan is beneficial.

ACKNOWLEDGMENTS

This paper first introduces the concept of quantitative project management based on CMMI. Then it introduces some key techniques of quantitative project management in recent year's domestic and foreign scholars in quantitative project management in practice, these techniques in practice in theory and use has been a large number of verification. In this paper, the framework of quantitative project management is introduced to combine the above processes to quantify the management project, and to provide a systematic implementation plan. For example, by regression analysis to determine the quality and process performance objectives, using Monte Carlo simulation to verify whether the QPPO is reasonable, with the optimal analysis of the process portfolio optimization. In the latter part of this paper, the framework of this framework is described in the practice of a CMMI 5 level maturity enterprise. It is proved that this framework can play an important role in the process of establishing quantitative project management.

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