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Software Project March Objective Real-time Monitor Mechanism Design

Yunna Wu Heyun Dong and Heping Wang
North China Electric Power University, Beijing, China

Abstract: Software project often faces the problem that projects out of control and deviating from the anticipated objective. This study proposes an innovative objective monitor method that can provide software project managers with real-time monitor of March objective (the quantity of objective consumed gradually with the project going) and research personnel activities. To obtain real-time and comprehensive state of software project March objective, grid management is used to divide the project monitor grid in three dimensions: level, milestone and objective. Then, a detailed supervision mechanism is designed to analysis objective deviation level through buffer analysis. A real software project is selected as an example to illustrate the grid structure design process and the buffer analysis method used to measure the deviation level.

Key words: Software project management, grid management, buffer analyses, real-time monitor

INTRODUCTION

Nowadays, as the widespread use of software and the higher and higher requirement for the software quality and reliability, a lot of software companies have concerned more about how to improve the maturity of software projects management. The task of managing a software project can be an extremely complex one, the complex, dynamic and continually changing nature of software research and development (R and D) process has been recognized as an important contributor to the high rates of deviation in the software project, such as project delay, cost overrun and the increase numbers of quality deficiencies. So how to make the project keep in step with the expected plan is an important problem that lots of scholars and project manager concerned with (Gu and Cai, 2008). So far, software project management has developed and already formed some mature theory frame, such as PMPBOK, Prince2, etc. Based on these theory frames, the general management level of software project has changed a lot. In spite of this, the software project management theory at present didn't pay enough attention to timeliness. as the increase complexity of the software project, the vulnerability that lack of timely monitoring lead to the defect of the project cannot be found in time, small defect cannot timely corrected and gradually expand to big accident. In this study, we design a software project real-time monitor mechanism base on the two innovative methods: Grid Management (GM) and objective buffer analysis. This mechanism is aimed at real-time monitoring march objective (cost, schedule, workload, etc.) of a software project R and D process. When objective deviation appears in the R and D process, timely hierarchical warning will raised by the mechanism according to the severity of the deviation. The structure and content of real-time monitor mechanism will be described in detail hereinafter.

REAL-TIME MONITOR MECHANISM GRID STRUCTURE DESIGN

Literature review of GM: GM is an innovative management concept based on grid technology (Chervenak *et al*., 2000), which divides the manage object into grid cells according to a certain standard (Jagatheesan, 2005). By using the computer information technology and the grid cell coordination mechanism, the manage object could do efficient information communication, share the resources of the organization transparently and finally achieve integration organization resources, improve the efficiency of management (Zheng *et al*., 2005). Current researches in GM have gradually permeated the fields of information management, business management, market management, urban management and administrative management.

Indian scholars Gor, K. extended the grid structure from the computer components and operating system to the institution, decision-making and the influence of the environment. Then put forward a GM system based on the enterprise workflow: Unified Grid Management and Data Architecture (UGanDA) (Gor *et al*., 2005). In the market management field, Intel Corporation puts forward to divide market into grid in early 2005, which can provide rapid customer response, better customer service and optimized local market activity (Lv, 2010). In the urban management field, in 2004, Beijing Dong Cheng district

Corresponding Author: Heyun Dong, North China Electric Power University, Beijing, China

government began to implement the "urban grid management", established the "100 meter x 100 meter grid management method" (Chen, 2006). This innovative management method has now popularized in many provinces of China.

GM in real-time warning grid structure: Software Project monitoring is the gathering of information to determine the current state and progress of the project in relation to its expected state and progress (Han and Huang, 2007). As indicated above, GM has the character of real-time, data sharing, rapid positioning, eliminate blind area, which can meet the requirement of software project real-time monitoring. So we innovatively apply GM in real-time warning model structure design. Though GM has been successfully used in many areas, further research is necessary to transplant this technology into the software project monitoring. Referencing the principles of GM, the study area is divided into grids with a specific size. Grids do not overlap and the blind area of administration is eliminated (Liao *et al*., 2011). According to GM regulation and model demand, we construct the real-time warning grid structure in three dimensions: level, milestone and objective.

In level dimension, the whole working process of software developing is broken down into hierarchical activities based on analysis of the project Work Breakdown Structure (WBS). WBS is a deliverable-oriented grouping of project elements, which organises and de?nes the structure of the entire project. Each descending level represents an increasingly detailed de?nition of a project component (Jung and Woo, 2004). In a software project, it is very important to accurately determine the project scope and work procedures workload. As a special product, the software project development process consisted of many activities and each activity has its own objectives such as cost, time limit. Therefore, in order to do objective control, software project WBS is need to build first, break the entire project into hierarchical work packages or activities and then control the objectives of individual activity, finally integrate into the overall objective control system. In addition, the software WBS can also avoid the chaotic relationship of activities and project organization structure, which will cause some uncared-for work. Take a highway passenger transport management system project in China as an example, this system is composed by 5 subsystems. Content of the project is shown in Fig. 1.

According to the content of the project and the situation of software company, the whole R and D process is decomposed into three levels, WBS structure of this software project shown in Fig. 2 (complex process of the project will be further decomposed in the actual development process, due to space limitations, here only lists the main work content).

Milestone can be defined as the completion of an important activity (Bergner and Friedrich, 2010). In the software project, the end of each important R and D activity is considered a milestone. In this study, we divided the overall process of software R and D into several milestones according to the distribution of activities order and the need for real-time monitoring, as the detailed inspection and monitor point. The milestone

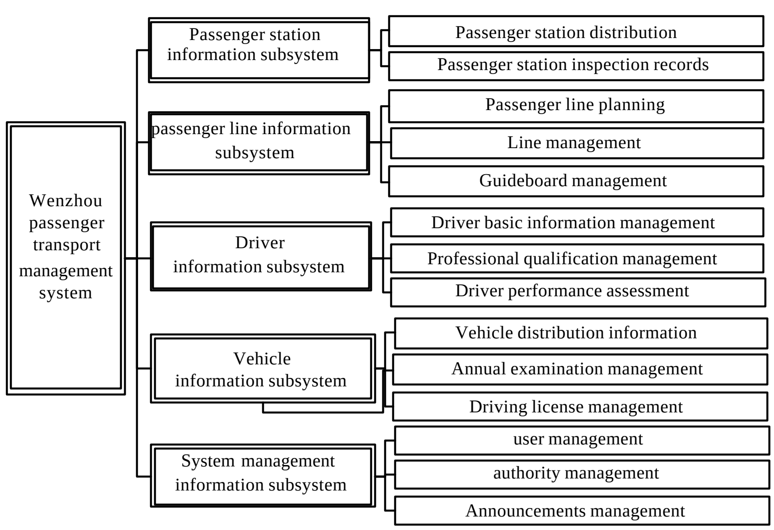

Fig. 1: Content of Wenzhou passenger transport management system

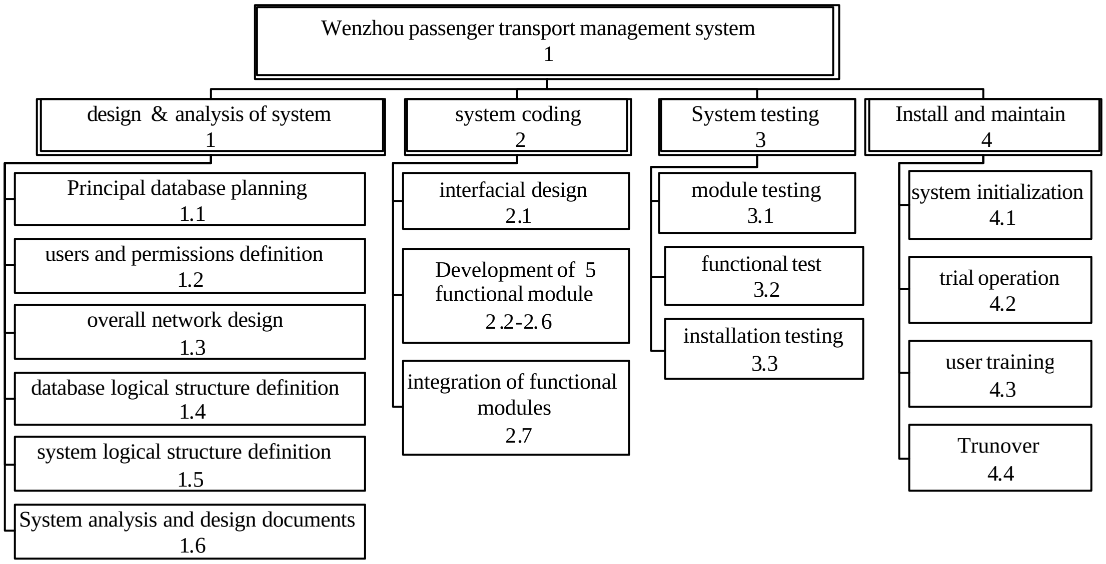

Fig. 2: WBS of Wenzhou passenger transport management system

Table 1: Progress plan of wenzhou passenger transport management system

Activity	Period (workday)	Start time	Completion time	Front closely activity
1.1	15	6.20	7.10	
1.2	5	7.11	7.17	1.1
1.3	7	7.11	7.19	1.1
1.4	8	7.18	7.27	1.2
1.5	23	7.20	8.21	1.3
1.6	2	8.24	8.28	1.4, 1.5
2.1	7	8.29	9.60	1.6
2.2	9	9.70	9.19	2.1
2.3	11	9.70	9.21	2.1
2.4	18	9.24	10.17	2.2, 2.3
2.5	23	9.24	10.24	2.3
2.6	15	10.18	11.70	2.4
2.7	15	11.80	11.28	2.5, 2.6
3.1	18	11.29	12.24	2.7
3.2	12	12.25	1.90	3.1
3.3	12	1.10	1.25	3.2
4.1	10	1.28	2.80	3.3
4.2	20	2.11	3.80	4.1
4.3	5	3.11	3.15	4.2
4.4	8	3.18	3.27	4.3

management mode is typically a result-oriented management mode, judging whether a bit of project process is reasonable through the objective situation of the milestone (Malinen, 1984). In this study, to better align with the purpose of software project real-time monitor, based on WBS structure and the organization plan of the software project, we arranged activities in every levels in accordance with the work orders and the distribution of schedule and then marked the monitoring milestones. As the smallest time unit of project monitoring, milestone monitoring simulates real-time monitoring with intensive time node, it not only can meet the timeliness requirements of the project monitoring, but also improve the feasibility and save the management resources. According to the progress plan of Wenzhou passenger transport management system (Table 1), the improved WBS structure and corresponding milestone show in Fig. 3.

Objective refers to the main element need to be managed during the project process (Hwang and Lim, 2013). Management by objectives (MBO), which put forwarded by American management guru Drucker (1954), is a method that improves the productivity and efficiency of an organization based on formulated objectives. In this case, each project must commit to productivity objectives and self-efficacy in improving the productivity and

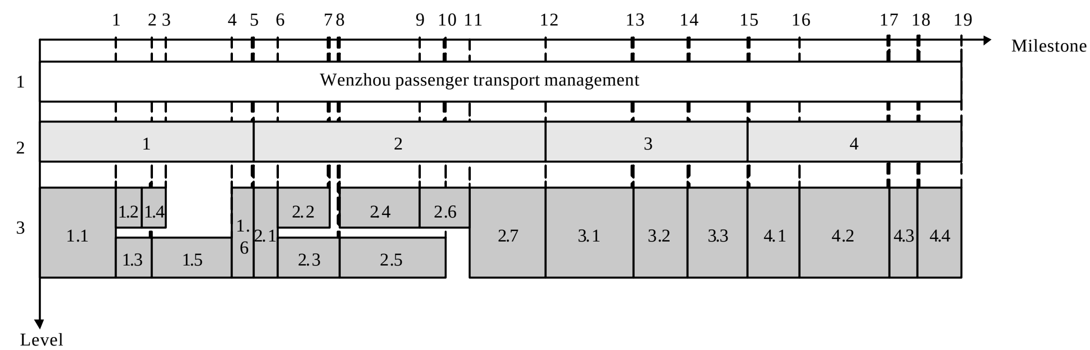

Fig. 3: Level and milestone dimension of grid structure

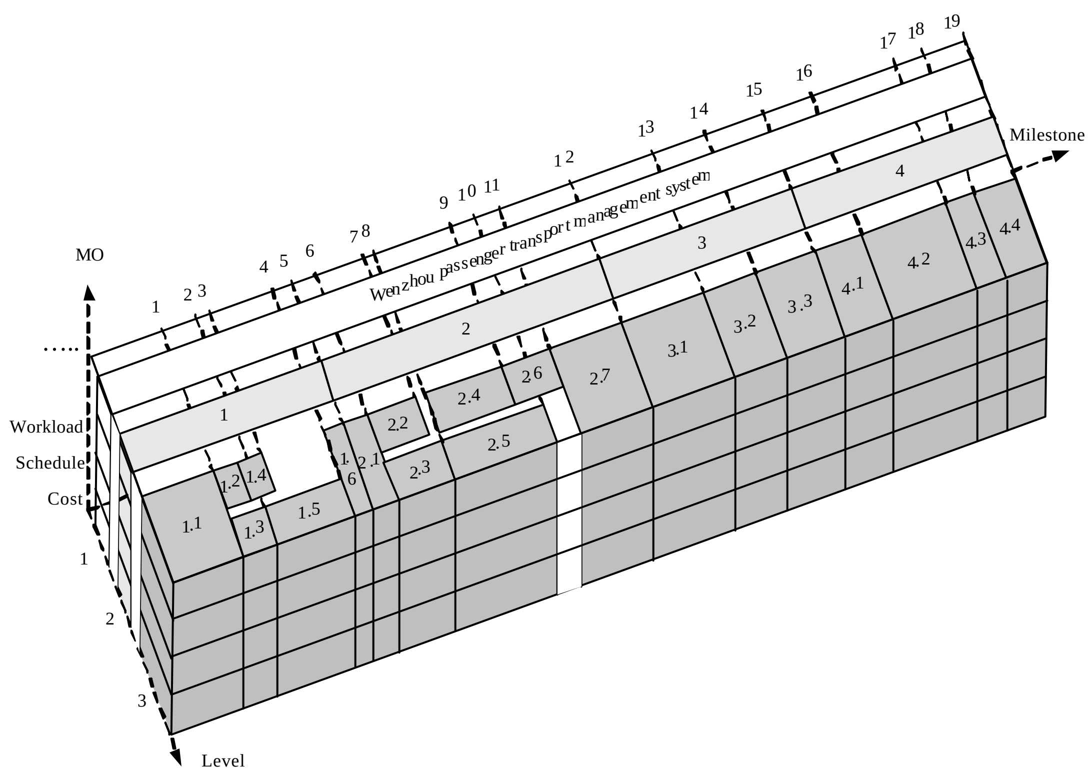

Fig. 4: Completed real-time monitor grid structure

improve the work during the process of achieving objectives. At present, objective control has become a main focus of software project management (McBride, 2008), through intensive study, we found that for some kinds of objectives such as cost objective, schedule objective, workload objective and so on, they have a common feature that the total quantity of objective clearly defined in the project plan and is consumed gradually with the project going. We named them March Objective (MO). this study is focus on the real-time monitor of MO, other objectives like quality, safety, due to its manage standard is fixed according to limitation of contract provision and relevant industry standards, their objective monitoring procedures have big difference between MO, so is beyond the scope of this study. With the addition of objective dimension, the completed real-time monitor grid shown in Fig. 4.

BUFFER ANALYSIS AND REAL-TIME MONITOR MECHANISM DESIGN

Objective buffer in real-time monitor mechanism: Current studies of control project deviation mainly focus on risk early warning or objective performance evaluation, which acquire objective situation through multiple index comprehensive evaluation. The application of some quantitative model, such as fuzzy comprehensive evaluation, BP neural network algorithm, earned value management (Hayashi and Kataoka, 2008) also contributed a lot to the development of this research. Inspired by these research results, according to the characteristics of MO in the software project, in this study we develop a dynamic and practical algorithm, buffer analysis, to measure objective deviation on the basis of real-time monitor grid structure. The idea of "Objective buffer" come from the critical chain management theory (Geekie and Steyn, 2008), in critical chain management, project buffer at the end of the critical path is the difference between the due date and the expected completion time. The buffer will absorb the uncertainty in the project and reduce the possibility of delay (Trietsch, 2005). Inspired by this method, in this study, buffer not only represent the time difference, but expanded to the costs, workload and other MO quantity, we try to judge project deviation and warning level by observing the change of each objective Buffering Consumption (BC) (Gonzalez *et al*., 2011). We define the BC as the D-value of actual objective value and planned value.

As mentioned above, the total quantity of MO clearly defined in the project plan and is consumed gradually with the project going. According to this situation, we add three kinds of buffer in every MO. First one is Activity Buffer (AB), added in every single grid cell, which may prevent deviation on this grid cell from affecting the back closely activity; the second one is Stage Buffer (SB) added at the end of each project stage (level 2 in grid structure), which will absorb the deviation in front stage and reduce the influence to next stage; the third one is project total buffer (PB) added at the end of the project, which reflect the difference between the limit value in contract and the expected completion value, to absorb the deviation in the whole project. AB, SB and PB in every objective have been advance designed in the project planning phase, according to project contract and organizational design file. The quantities of AB are not the same for all grid cells, some even equal to zero.

Figure 5 shows buffers added in one of MO. During the R and D process of software project, because of consumption of buffers in previous grid cell, the objective buffer quantity of subsequent grid cell will dynamically change. Therefore, when project reach a new grid cell, SB, PB and AB in this grid cell should be dynamically calculated, buffer dynamic calculation method is as follow:

- AB of one grid cell didn't work out, the rest AB added to SB of this stage; SB of one stage didn't work out, the rest SB added to PB. On this occasion, AB and SB in the subsequent grid cells remain unchanged
- BC in one grid cell is bigger than AB, the lack of consumption deducted in SB, PB and AB of subsequent grid cells, the priority is: SB in this stage→PB→SB in subsequent stage→AB of subsequent grid cells

Deviation level partition: Compare real-time BC (the D-value of actual objective value and planed value) of one grid cell with corresponding preset buffer,the deviation level at that moment can be got. According to the relationship between BC and preset buffer, we can identify that how much impaction did objective deviation aroused to the overall project. According to the impaction, objective deviation severity can be divided into 6 levels. Suppose BCi is BC in grid cell j below stage K:

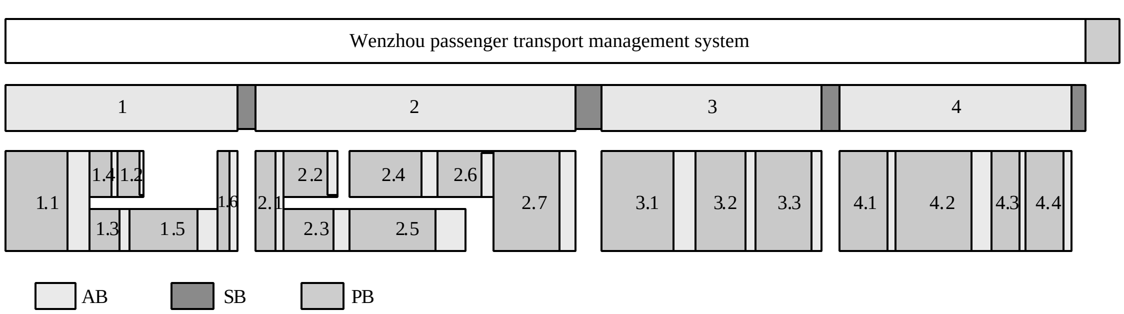

Fig.5: Description of MO buffer distribution

- **No deviation:** $Bc_i = 0$, AB_j has not been consumed, it is indicated that this objective working well and completely in accordance to the predetermined plan
- **Deviation□:** $0<BC_i = AB_j$, only AB_j has been consumed. So, deviation existed in this grid cell, but not affects other activities
- **Deviation□:** $Ab_j<BC_i = AB_j+SB_K$, AB_j and SB_K both been consumed, but PB and SB in other stages has not been consumed. So, deviation existed and will affect the plan in this stage, but will not affect the whole project plan and activities in subsequent stages
- **Deviation □:** $AB_j+SB_K<BC_i = AB_j+SB_K+PB$, in this situation, deviation existed and will consume PB, but will not exceed the limit in contract and affect plan of subsequent stage
- **Deviation □:** $Ab_j+SB_K+PB<BC_i = \sum AB+\sum SB+PB$, deviation will affect the plan of subsequent grid cell and whole project, but deviation still can be corrected if activities in the subsequent grid cells stick to the plan
- **Deviation □:** $\sum AB+\sum SB+PB<BC$, objective deviation has exceeded all the buffer, even if activities in the subsequent grid cells stick to the plan, objective cannot be corrected and will certainly exceed the contract limit

Real-time monitor process: As a practical method, the real-time monitor process is simple and comprehensibly. Before project start, software project manager should build grid structure and insert objective buffer in grid cells first according to the project contract and objective plan. After project begins, when arriving at on milestone, objective BC of this grid cell should be calculated (attention that when calculating BC, the planned and actual objective value is value take placed in this grid cell, instead of accumulated value). After BC calculation, compare BC with corresponding preset buffer, deviation level can be real-time got. Based on the deviation level, project managers should analyze the reason caused the deviation and take corresponding measures to reduce the deviation. Through the objective deviation, some concealed defect in objective plan may be discovered, so manager could do a suitable adjustment to the plan. Then, after dynamically calculated buffers in subsequent grid cells, project could go into the next grid cell.

EXAMPLE APPLICATION

Taking the example above (Wenzhou passenger transport management system) to illustrate the real-time monitor process in detail. Given space limitations, we only intercept data in the first and second stage of schedule objective as calculation example. (In schedule objective, the specificity of non-critical activities should be taken into consideration.)

Before the project begins, grid monitor structure should be built first, the build step and the completed grid have mentioned earlier (Fig. 4). Refer to the progress plan of Wenzhou passenger transport management system (Table 1) and workforce capability, the preset buffers of stage 1 and 2 are shown in Table 2. The actual progress of stage 1 and 2 shown in Table 3. According to the data in Table 2 and 3, deviation level measure process shown in Table 4.

Table 2: Preset buffers of wenzhou passenger transport management system

Activity	1.1	1.2	1.3	1.4	1.5	1.6	1	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2	3	4	
Planed value (workday)	11	5	5	8	18	2		5	9	10	14	23	12	10				
AB (workday)	2	0	1	14	3	0		1	2	1	2	7	2	3				
SB (workday)							3								9	8	8	
PB (workday)																		13

Table 3: Actual progress of stage 1 and 2

Activity	1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	2.5	2.6	2.7
Actual value (workday)	10	8	6	10	23	5	7	9	13	15	25	15	11

Table 4: Deviation level measure process

1.1		10-11<0	No deviation	$SB_1' = 3+1 = 4$
1.2	8-5 = 3	$3+2<AB_{1.2}+AB_{1.4}$		
1.4	10-8 = 2	(Non-critical activities)	Deviation	--
1.3		$6-5 = 1 = AB_{1.3}$	Deviation	--
1.5		$AB_{1.5}<23-18 = 5<AB_{1.5}+ SB_1'$	Deviation	$SB_1'' = 4-(5-3) = 2$
1.6		$AB_{1.6}+SB_1'' <5-2 = 3<AB_{1.6}+SB_1''+PB$	Deviation	$SB_1''' = 0$ $PB'=13-(3-0-2) = 12$
2.1		$AB_{2.1}<7-5<AB_{2.1}+SB_2$	Deviation	$SB_2'= 9-(7-5-1) = 8$
2.2		9-9 = 0 (Non-critical activities)	No deviation	--
2.3		$AB_{2.3}<13-10<AB_{2.3}+SB_2'$	Deviation	$SB_2''= 8-(13-10-1) = 6$
2.4		$AB_{2.4}>15-14$	Deviation	$SB_2'''= 6+[2-(15-14)] = 7$
2.5		$AB_{2.5}>25-23$ (Non-critical activities)	Deviation	--
2.6		$AB_{2.6}<15-12<AB_{2.6}+SB_2'''$	Deviation	$SB_2''''=7-(15-12-2) = 6$
2.7		$AB_{2.7}>11-10$	Deviation	$SB_2'''''=6+[3-(11-10)] = 8$

By the data in the Table 4, it can be seen that in stage1, as the project developing, the schedule deviation is gradually increased, so managers need to take further actions to decrease the deviation. After some adjustment, in stage 2, the schedule deviation stayed around □to□, the project is in regular condition in this objective.

BC represents different things in different project MO, such as time, cost, resources, etc. The method we exampled above is suitable for BC calculation of other MO.

CONCLUSION

This study provides a mechanism for the monitoring of software projects MO through the application of grid management and buffer analysis. Real-time monitor is emphasized because the dynamic sensitivity of management has gained increasing importance in the software developing process. This study firstly designed the real-time monitor grid structure in level, milestone and objective dimensions. The grid structure position monitoring points into project whole process, classified the emphasis of monitoring and eliminated blind area of project monitor. Based on the grid structure, this study attempted to judge the project objective deviation level through the change rule of objective buffer. Example application "Wenzhou passenger transport management system" is used to vividly describe the process of grid structure design and objective deviation analysis.

Our future research efforts will focus on two aspects. First, the validation of our findings on more real project data and refinement to more case-specific settings is a future research topic. Testing of this finding on more actual project data is necessary to enhance the findings, increasing the applicability of the method to a wider range of projects. Second, in our never-ending effort to enhance the practical applicability of the grid monitoring mechanism, current research results will be embedded in the design of the software project grid monitor information system, which will enable the project manager and research personnel to operate more conveniently.

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