An empirical trial of multi-dimensional in-process measurement and feedback on a governmental multi-vendor software project

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Abstract

Government procured multi-vendor software development projects can use project measurement based on empirical software engineering concepts to measure progress and guide project management. This paper reports on experimental use of multi-dimensional project measurement and feedback in a consortium-based development project. The paper describes measurement functions, analyses, and intermediate results from the project. Two empirical software engineering research and investigation organizations, the Empirical Approach to Software Engineering (EASE) project and the Software Engineering Center (SEC) Japan are conducting the experiment, supported by the government. The target of the development project is an experimental Probe Information Platform for automotive information in the field of Public Information Systems. The trial suggests that multi-dimensional measurements along with the empirical concept are highly useful for projects using the consortium method with no main contractor.

Introduction

The EASE project is a Ministry of Education, Culture, Sports, Science and Technology (MEXT) supported, academia-based research project in collaboration with industry. Previous work on this project had developed a software project measurement platform named the Empirical Project Monitor (EPM). It collects software development management data from sources such as configuration management tools, bug tracking tools and mailing list management tools. The EASE project has distributed it to several software companies and formed several collaborative investigations using real field data based on the medium of it. [1][2][3]

SEC is a Ministry of Economy, Trade and Industry (METI) supported industry-based research organization in collaboration with academia. SEC has formed various task forces and aims to publish software engineering standards, process reference models and white papers. SEC has succeeded in collecting benchmark data of over 1,000 projects from software companies and analyzed this data for the first time in Japan.

Both activities are eager to create new knowledge by sharing field data with industry and academia.

The target project for this report is consortium-based development of kernel software for a probe information system platform. The probe information system platform collects car location information from various automotive elements called probe cars such as taxis, trucks and busses. From this collected information, the probe information system generates useful public information. This project is supported by METI. The target software runs on several Linux servers for data processing and personal computers for data display. This system assimilates various kinds of probe car information and data processing methods.

This project started in February 2005. The development period is separated in two phases, with the first phase being 10 months from basic design to the end of integration test.

The project consortium is composed of seven companies: four major software development companies, a consumer electronics manufacturer, a major automobile component manufacturer and an automobile manufacturer. The automobile manufacturer acts as evaluator, with the other six companies developing the platform. These six development companies are rivals in the probe information system field, so this project clearly distinguishes between collaboration and competitive materials. Information in the collaborative field is shared and in the competitive field is confidential.

This project has both consortium intrinsic characteristics and governmental project oriented features.

The project faced the problem of how to organize and manage development spread across rivals with development information that is partly confidential and partly collaborative. To help resolve this, SEC and the EASE project collaborated to provide multi-dimensional project measurements and in-process feedback of analyses while protecting confidential information.
1. Project context
In the consortium, one of the six development companies plays the role of PM (Project Manager) and the other five companies develop the system under its management, with the target system divided into functional blocks. In the last phase, a total integration test is planned on a total experimental environment.
Those five development companies are major companies in Japan and practical development has proceeded under the Japanese hierarchical software industry structure.
Among the consortium companies, development information about requirements definition, basic design and common interfaces in the detailed design are shared, but the major parts of the detailed design, program size and source code are confidential.
The consortium method is characterized by its specification management, development expense flow and information sharing. System specification is managed by the consortium itself, not by the owner METI. The development expense is directly distributed to each of the consortium member companies, and there is no main contractor. So project management information is relatively limited compared to the general main contractor system. For project management, software development information is confidential in individual development and only the official declaration level overview report is available. The inter-company integration test phase will be the first point where project management will be able to assess the real developed software characteristics.
This project contains general characteristics of governmental multi-vender software development such as a hierarchical development framework reflecting the industrial structure, wide area distributed development and relatively infrequent management from the project owner, the government.

2. Measurement plan and execution
The following project measurement items were planned and executed.
1) Measurement items
Configuration management repository with source code, bug tracking data and inter-company mail by mailing list with attachment for product and process data collection.
Bench-mark data for project attribute record.
Review report.
Project context data including interviews with each project leader.
2) Measurement tools and methods
The project used EPM to collect process and product data. EPM gathered data from CVS as configuration management system, GNATS as bug tracking system and mailman as mailing list management system. EPM translates those data into a standard XML form and stores them in a relational data-base for basic analysis. Review records are reported by special electronic data form from basic and detail design process and as well as code review.
Bench-mark data is reported by a 400 item data sheet. Those items were defined by an SEC task force last year, based on Japanese major software companies’ internal collected data items and ISBSG. Planning data and intermediate data at the end of the basic design phase were reported using this data sheet. The final resultant data will be reported after the end of this project. The 400 item data sheet is available in Japanese from Nikkei Business Publications Inc., and will be available from SEC.

To provide a context for data collection, some members of the data analysis group have joined all the project meetings, and also interviews were conducted with each company’s development leader using the SEC defined 110 items project questionnaire check-list. The questionnaire will be available in Japanese from SEC.

3) Coordination for measurement plan
To realize those measurements, it was important to discuss and coordinate with each development companies and acquire their support. As a result, the following coordination elements were set.
- Utilization of CVS, GNATS and operational rules for those tools and mailing list.
- 40 items for bug tracking, review report form.
- 13 items for data analysis target, use of code clone analyzer, 400 items bench-mark data collection.
- Data management rule to keep corporate secrets. This rule includes the role of the SEC/EASE analysts in collecting and distributing measurements and information derived from the measurements.

4) Measurement system structure and data analysis methods
The overview of the measurement tools is illustrated in Fig.1.
EPM basic analyzer: Displays a number of basic reports visually from EPM collected data, including SRGM (Software Reliability Growth Model) curve and actual bug number transitions.
EPM extended tools: Logical coupling analyzer, file renewal analyzer and other cut and try tools were tried to analyze CVS repository and to realize combination analysis. Code Clone Analyzer: Code clone analyzer named CCFinder from Osaka University, a core member of EASE project, was adopted.[4]. Collaborative Filtering tool: This tool retrieves and makes similar data group from deficit data sets provided by NAIST (Nara Institute of Science and Technology), also a core member of
EASE project [5]. This tool is adapted to the bench-mark data analysis.
Review reports: Templates review reports which could be shared with the other project members.
Benchmark data analysis: Collected date is analyzed and compared with SEC collected data-base.
The interviews provide a context which is reflected in the analyses.
The total measurement system structure is shown in Fig. 2. Collected data is gathered into SEC, where it is physically separated from development and test environment to ensure information secrecy requirements of each consortium company. Each development company sends their own CVS repository and GNATS file to SEC periodically. In inter-company integration test phase, a common GNATS environment will be used for bug tracking.

5) Analysis feedback to project management
SEC/EASE analysts provide periodic reports to the project manager. They also provide individual analysis reports to each development company.
These analyses report only from the viewpoint of software engineering, unlike the political and logical official report made to the project owner METI.
The use of SEC/EASE analysts as a trusted independent group which collects sensitive data and analyzes it, providing shared results to the project manager and other development companies, provides the information to make the collaboration of competitors possible.

3. Results
At present, this project has just finished each development companies' internal development and testing phase, and is going to start inter-company integration test. So, this experiment's evaluation for each company will become further developed as a later issue, but there has already formed some consensus about the meaning of software project measurement and feedback in the development process.
Even at this point, this measurement activity was meaningful for the Project Manager. This measurement brought development inside the black-box into the daylight and helped form a consensus about how to advance project management.
For example, the following characteristics were identified.
- From source code transitions and bug handling information, measures of the total development and project progress emerged.
- From the code-clone content ratio and its transitions, understanding of the software code situation such as scratch development or reuse and re-factoring could be seen.
- CVS repository analysis showed source-file renewal history, such as cut-and-try development or waterfall type making.
- The review report analysis illustrated each company’s attitude towards review.
- The Project Manager used such measurement data and combination analysis of them to manage the project.
For example, some company’s development looked smooth, with low code-clone content ratio, included scratch development, and cut-and-try type development in the logical processing part. Another company had a huge reuse part and it seemed that the key factor to success of this development depended on its adaptation. Furthermore, in one company's case, it looked as if this company expected the integration test to uncover problems rather than finding them by review activities.

4. Evaluation and Future Directions
Total evaluation of this experiment will follow the coming inter-company integration test, but the significance of using the measurements and in-process feedback for governmental multi-vendor development projects has already become clear. This project has shown the importance of having sufficient discussion with the development groups to acquire collaboration from them to provide the base for a meaningful measurement and feedback process. The discussion issues include measurement items, target, tools and their operational rules along with the feedback process and data management rule.
The measurement and in-process feedback tried in our experiment can be considered as an important part of software process innovation. The authors expect to develop a software engineering standard that includes the measurement and feedback process and tools reflected from this trial.

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IPA: Information Technology Promotion Agency, Japan
NAIST: Nara Institute of Science and Technology