Software Testing Process Performance Improvement using Service-Based Testing Support

Jithinan Sirathienchai, Peraphon Sophatsathit, and Decha Dechawatanapaisal

I. Introduction

AS software gradually becomes an important and necessary facet in modern daily lives, software quality should be treated as an utmost issue attentive by all parties involved. Unfortunately, the inherent software quality problems are often not carefully administered from the outset of the development process. Inadequate and inappropriate testing is one common shortfall that culminates defects to be accumulated over its life cycle.

A software development model, namely, V-model presents the relationships between each development and associated testing phases in the waterfall model [1]. Four testing phases are Unit Testing (UT), Integration Testing (IT), System Testing (ST), and User Acceptance Testing (UAT). UT is operated by the development team, IT and ST are performed by the test team, and UAT is conducted by the user team. Some organizations focus on IT and ST only while others pay attention to all phases. The problems are lack of related testing understanding and knowledge of developers and users [2, 3] as far as test plan and test skill in UT and UAT are concerned. Furthermore, the communication and coordination among the teams are not effective. The impact from this issues is the gaps between developers and testers, and between testers and users. This is illustrated as a framework model in Fig. 1.

The software testing performance that we focus on this study encompasses key performance factors such as duration, effort, and quality [4, 5, 6, 7] can affect this gaps directly. This study describes a significant improvement in key performance factors with the concepts of testing service from test team for development and user team in UT and UAT.

The paper is structured as follows. Section 2 presents the survey results in software testing industry and related researches. Service-based testing Support model (SbtS) is presented in Section 3. Section 4 summarizes the practical results of a case study with three pilot projects. A final concluding remarks and future work are given in Section 5.

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II. The Survey Results and Related Works

From our survey of software testing industry in Thailand by using questionnaire and interview, a total of 20 companies with completed survey or 40% of response rate. Based on the literature and problems in industry, the questionnaire was classified into five parts: project, process, support, people, and the future. We collected the interesting answers from two questions are relate to this study. First question is about the way of software testing effort improvement. The top five answers are

(1) The test project needs to use effective test tools.
(2) Testers should work together closely with developers, and users.
(3) Testers must improve test techniques, skills and knowledge.
(4) Testers must improve business skills and knowledge.
(5) The test project should implement a software testing process improvement standard.

Second question is about more demands in accordance with organizational test plan and strategy. The top five answers are

(1) The testing services in UT for developers.
(2) The testing services in UAT for users.
(3) Knowledge sharing center or learning center of software testing.
(4) New testing knowledge and technology development.
(5) Strong support from government and non-government organizations.

From above survey results, the second answer of the first question and the first two answers of the second question show the important information to support this research. For a software project to succeed, most organizations focus on the effectiveness of collaboration between test team and related teams by providing testing services to them. The current perspective, UT and UAT are taken responsibility by developer and user respectively. While the future perspective focuses on test team is the center of complete collaboration.

From the literature review, service management and service science are continuously promoted in software industry [8, 9, 10, 11]. Under the concept of service, five dimensions of perceived service value are tangibles, reliability, responsiveness, assurance, and empathy [12]. The service paradigm can support the organization based on business and technology, in addition to improving effective cooperation and knowledge integration.

Software testing has many services, such as test consulting, test knowledge sharing, test training, test plan preparation, test case management, test environment preparation, test data

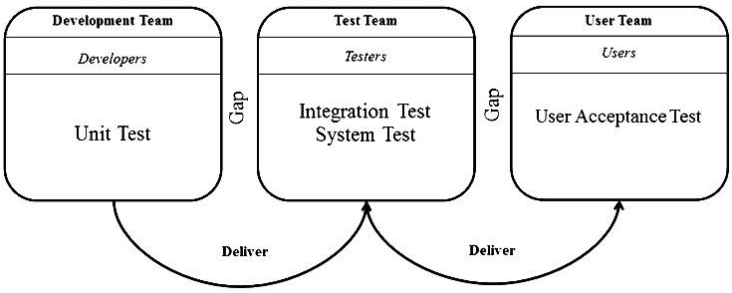

Fig. 1. The Gap Framework of Traditional Software Development Process

preparation, test execution, automated testing, and performance testing [13, 14, 15]. Some testing services can provide both UT and UAT while some services can support either UT or UAT.

Many researches discussed and proposed methods about bridging gaps between development and testing [16, 17, 18, 19]. While a few researches study about software testing and service for development and user teams. The example is a conceptual framework, namely, TESTQUAL which draws from the famous service framework, namely, SERVQUAL [19, 21]. This framework comprehensively explains about services for developers and end users.

III. Service-based testing Support model (SbtS)

We propose Service-based testing Support model (SbtS) as shown in Fig. 2. Our delivery model focuses areas for proposed testing services that include three teams (development, test, user), five people groups (developers, UT testers, testers, UAT testers, and users) and four phases (UT, IT, ST, and UAT).

Our offerings are organized around three key areas, namely, test personnel, test service, and service benefit.

A. Test Personnel

Traditional software development life cycle (SDLC) consists of many personnel roles. Personnel roles related with testing in each phase are developers in UT, testers in IT and ST, and users in UAT. In real situation, developers conduct testing in three phases or developers perform both development and testing phases. For suitable way, testers in each phase should not be the same person.

The problem about personnel is lack of testing skills of developers and users who conduct testing in UT and UAT. Furthermore, most UT and UAT do not prepare the test plan, test scenario, and test case. From this reason, many outstanding defects from UT remain in testing phases, many defects can be detected in testing phases as if UT were not performed.

Moreover, many defects are passed through UAT and most users or customers do not understand and disapprove. In UAT, users should detect the business defect but they need to face the programming defect from ST outstanding defects. Programming and business defects in several severity levels passed through phase of software product launching.

SbtS proposes two new tester types under the test team. First are testers for UT (call UT Tester) who are experts in technical programming skills. Second are testers for UAT (call UAT Tester) who have business knowledge and experiences. The personnel of both groups should be selected from development and user team respectively. They work together with developers in UT and users in UAT. To effective support, test training will be continuously provided for them.

B. Test Services

From various testing services, we categorize them into two groups:

(1) Group I: Test sharing service. Services in this group need effective collaboration between tester and developer, and between tester and user. The effort percentage of tester is around 20-50% in each service.
All tester types can perform the services in this group. The examples are test consulting, test training, test environment preparation and management, test data preparation, test plan consulting and preparation, and cloud testing service.

(2) Group II: One-stop test service. The test team works as a service provider that needs support from specialists. The effort percentage of UT or UAT testers is around 50-90% in each service. Even if most tasks are taken responsibility by UT or UAT testers, developers and users still work together with testers. The examples are test execution of UT and UAT, performance testing, load/stress testing, automated test, test process management, and Testing as a Service (TaaS).

C. Service Benefits

Both development and user teams can get many benefits from testing services. The first group services give direct benefits to developers and users, for example, test skill improvement both technical and business skills, test process improvement, and reduce costs and time by internally managing resources.

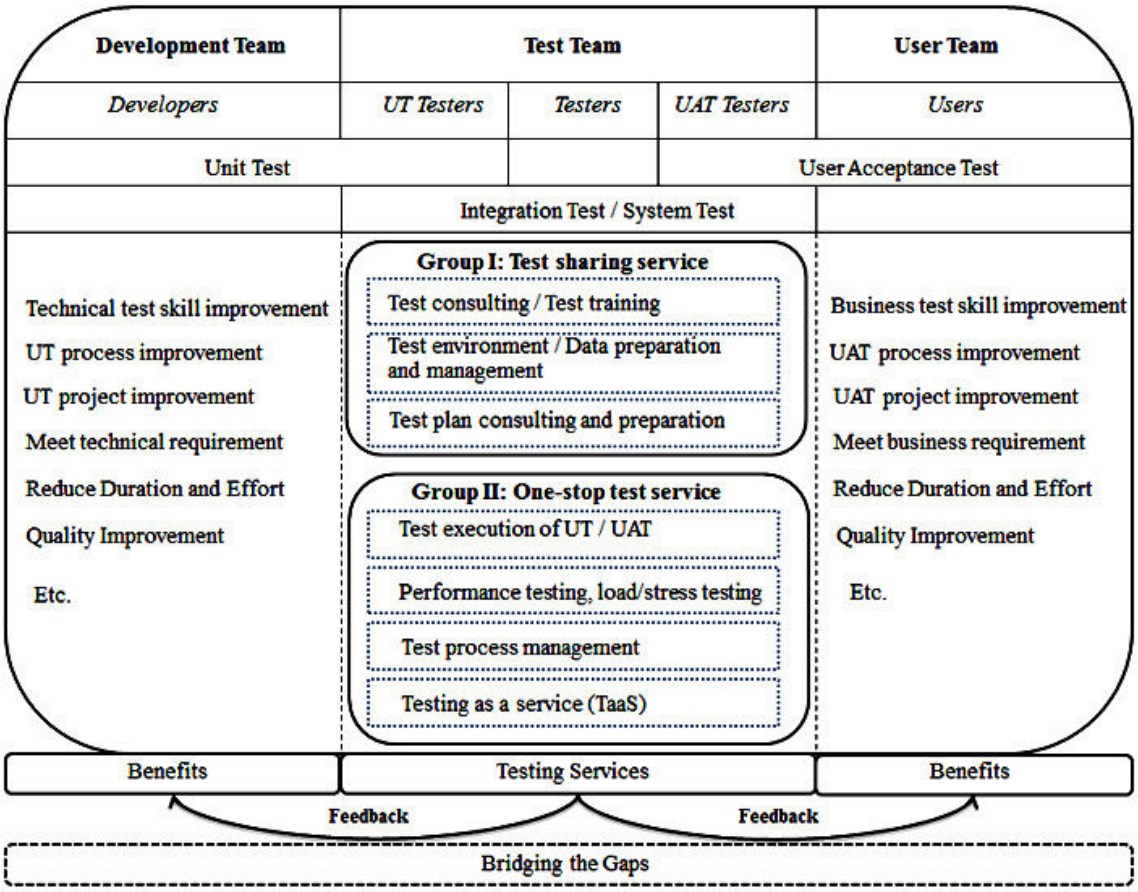

Fig. 2. Service-based testing Support Model (SbtS)

The second group services help the software project to reduce high efforts of software testing from developers and users but increase some efforts from testers. Moreover, software testing process can get higher quality and deliver quicker response to business requirement changes. Resource management is flexible and support the right personnel into the right jobs.

In conclusion, three major factors of performance, namely, duration, effort, and quality will be improved. The people in software project can develop their capabilities. The last important benefit is bridging the gaps between development and test teams, and between test and user teams.

IV. Results: The Case Study

The case study is a medium-large sized company in software industry. The number of people in the test team is approximately 50-60 persons. Two pilot projects are provided by the case study.

The first project is test sharing service while the other is one-stop test service. The first project provides services for development and user teams as test consulting, test environment preparation, and test data preparation. The second project provides service for development team only as UT execution consisting of test plan, test preparation, test execution, and test report.

Both project sizes in the same application are approximately 40,000 - 60,000 lines of code . Staffs in management level consist of one test manager and one test leader. For tester, we will discuss in each subsection. In this case, the test team conducts ST only.

The results present three key performance factors, namely, duration, effort, and quality. For duration and effort, we focus on two parameters as overall project and software testing. For quality, three parameters are considered as total number of defects in UT, ST, and UAT.

They made up the set of results that compare between the baseline or average of current projects and the case study results. Moreover, people skill and perceived service value are evaluated by interviewing related persons.

A. Results of software testing performance

The first project supports both development and user teams. Thus, we need one UT tester, one UAT tester, and four testers (not specific). The main tasks are UT support, ST execution, and UAT support.

The second project supports the development team only. Thus, we need three UT testers and four testers (not specific). The main tasks are UT execution with development team, and ST execution.

The results of three performance factors in seven parameters are shown in Table I .

TABLE I
RESULTS OF SOFTWARE TESTING PERFORMANCE

Parameters	Baseline	Project I	Project II
Duration (Month)			
- All Phases	5	4.5	4
- Testing Phase	1	1	0.5
Effort (Baht)			
- All Phases	1,255,000	1,250,000	1,0450,000
- Testing Phase	352,000	320,000	256,000
Total Number of Defects			
- Unit Test	250	375	553
- System Test	1,530	1,210	1,050
- User Acceptance Test	540	420	250

From the results, both durations of all phases and testing phase are less than the baseline. The all phases effort in project I is not different from the baseline, while decreases significantly with project II. For testing phase, both project efforts obviously reduce from the baseline. The defects could be detected more than the baseline in UT, but less than the baseline in ST and UAT.

B. Results of people skill and perceived service value

For project I, we interviewed three developers and two users who worked with testers of the test team. In fact, all testers of the test team were evaluated, including UT and UAT testers. For project II, two developers and all testers of the test team were discussed with us.

For people skill, the answers from all interviewees show that they can improve their testing skills in both management and technical. Most processes recorded plans, task details, and results in documents or applications for knowledge sharing in the future. They can work with the right tools, techniques, and theories on the right jobs.

Moreover, they need to use more time for additional tasks from the services in the first and second projects but the overall work time will be less in next project. Most interviewees pointed in the same direction that knowledge management and transfer could reduce the gap between theory and practice.

For perceived service value, we consider in four aspects as tangibles, reliability, responsiveness, assurance, and rapport [12, 21]. All participants in the projects, especially developers received all aspects with better performance when compare to the existing situation. Some examples of perceived service value are

(1) Test people can develop, operate, and manage the assets, such as, hardware, software, system, and document.
(2) The utility is available when developer, tester, and user request it.
(3) All related persons receive and give for good relationship, strong cooperation, and effective communication.
(4) Developer and user are confident in the competence of service provider and delivered software products.

For people skill improvement viewpoint, the gaps between development and test team, and between test and user teams could be bridged by applying the test service of SbtS model.

V. CONCLUSION

The proposed model is a multi-facet working model for test service which can be conceptually applied to different test organization with both traditional and novel services. For the pilot test of this case study support for in-house testing projects. In the future, we have plan to apply in test outsourcing project which developers and users are not staffs of their company.

SbtS model is an achievement instrument that pushes the success to software testing process and software development by the concept of service. SbtS can also support development and user teams in closing the gaps perception for sustainable development.

For this research, we implemented with two pilot test projects that the results may not reflect the long-term investment. Thus, we need to execute the model with different projects and develop a simulation to evaluate the long-term results. Furthermore, skill and capability evaluation should be measured by examination to clarify the areas of skill improvement.

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REFERENCES

[1] W. E. Lewis, *Software Testing and Continuous Quality Improvement*. 3rd Ed. Auerbach Publications: Boca Raton, FL, 2009.
[2] C. F. Cohen, S. J. Birkin, M. J. Garfield, and H. W. Webb, "Managing conflict in software testing," *Communications of the ACM*, vol. 47, no. 1, pp. 76-81, 2004.
[3] H. Barki and J. Hartwick, "Interpersonal conflict and its management in information system development," *MIS Quarterly*, vol. 25, no. 2, pp. 195-228, 2001.
[4] R. Martin and D. Raffo, "Application of a hybrid process simulation model to a software development project," *Journal of Systems and Software*, vol. 59, no. 3, pp. 237-246, 2001.
[5] D. X. Houston, S. Ferreira, J. S. Collofello , D. C. Montgomery, G. T. Mackulak, and D. L. Shunk, "Behavioral characterization: finding and using the influential factors in software process simulation models," *Journal of Systems and Software*, vol. 59, no. 3, pp. 259-270, 2001.
[6] F. Stallinger, "Software process simulation to support ISO/IEC 15504 based software process improvement," *Software Process Improvement and Practice*, vol. 5, no. 2-3, pp. 197209, 2000.
[7] S. Ferreira, J. Collofello, D. Shunk, and G. Mackulak, "Understanding the effects of requirements volatility in software engineering by using analytical modeling and software process simulation," *Journal of Systems and Software*, vol. 82, no. 10, pp. 15681577, 2009.
[8] L. Yu, L. Zhang, H. Xiang, Y. Su, W. Zhao, and J. Zhu, "A Framework of testing as a service," *Proceedings of 2009 International Conference on Mangement and Service Science (MASS 2009)*, 2009.
[9] M. Turner, D. Budgen, and P. Brereton, "Turning software into a service," *IEEE Computer Society*, vol. 36, no. 10, pp. 38-44, 2003.
[10] L. Riungu, O. Taipale, and K. Smolander, "Software testing as an online service: Observations from Practice," *Third International Conference on Software Testing, Verification, and Validation Workshops*, pp. 418-423, 2010.
[11] J. Black, C. Draper, T. Lococo, F. Matar, and C. Ward, "An integration model for organizing IT service management," *IBM Systems Journal*, vol. 46, no. 3, pp. 405-422, 2007.
[12] A. Parasuraman, V. A. Zeithaml, and L. L. Berry, "A Conceptual Model of Service Quality and Its Implications for Future Research," *Journal of Marketing*, vol. 49, pp. 41-50, 1985.

[13] W. E. Perry, *Effective Methods for Software Testing*. 3rd Ed. Indianapolis. IN: Wiley Publishing, Inc, 2006.
[14] T. Koomen, and M. Pol, *Test Process Improvement: A Practical Step-by-Step Guide to Structured Testing*. Addison-Wesley, 1999.
[15] C. Kaner, J. L. Falk, and H. Q. Nguyen, *Testing Computer Software*. 2nd Ed. New York. USA.: John Wiley Sons, Inc, 1999.
[16] M. Grechanik, J.A. Jones, A. Orso, and A.V.D. Hoek, "Bridging gaps between developers and testers in globally-distributed software development," *In Proceedings of the FSE/SDP workshop on Future of software engineering research (FoSER '10)*, ACM, New York, NY, USA, pp. 149-154, 2010.
[17] J. A. Jones, M. Grechanik, and A.V.D. Hoek, "Enabling and enhancing collaborations between software development organizations and independent test agencies," *Proceedings of the 2009 ICSE Workshop on Cooperative and Human Aspects on Software Engineering*, pp.56-59, May 17-17, 2009.
[18] H. Zhu , P. A. V. Hall , and J. H. R. May, "Software unit test coverage and adequacy," *ACM Computing Surveys (CSUR)*, vol.29, no.4, pp.366-427, Dec. 1997.
[19] Y. Yang, C. Onita, J. Dhaliwal, and X. Zhang, "TESTQUAL: conceptualizing software testing as a service," *Proceedings of the 15th Americas Conference on Information Systems*, San Francisco. California. USA., 2009.
[20] H. Kang and G. Bradley, "Measuring the performance of IT service: An assessment of SERVQUAL," *International Journal of Accounting Information Systems*, vol. 3, no. 3, pp. 151-164, 2002.

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