A SDLC DEVELOPED SOFTWARE TESTING PROCESS USING
DMAIC MODEL

Oythip Onsuk1, Pongpisit Wuttidittachotti1, Somchai Prakancharoen2 and Sakda Arj-ong Vallipakorn3
1Faculty of Information Technology, King Mongkut's University of Technology North Bangkok, Thailand
2Faculty of Applied Science, King Mongkut's University of Technology North Bangkok, Thailand
3Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand
E-mail: oythip.onsuk.99@gmail.com,

ABSTRACT
This study aims to resolve the software testing processes by creating reliance of a system. With traditional testing processes, there are many issues of unacceptable defects found after the end of testing processes. To solve this problem, we applied quality management according to Six Sigma quality improvements. From the principles of DMAIC, they found the most of mistakes came from runtime error, logical error and syntax error at 3.83%, 2.83% and 5.50%, respectively. This research consists of five stages of problem identification, the root cause analysis to find out the problems, drawn tree and fishbone diagrams help to analyze and solve problems. The quality improvement concepts were implemented by using experiment designed techniques which controlled by standard software testing in the final step to ensure that the problems will not occur again. The results show that using quality management with the principles of DMAIC integration can reduce defects referring to Run Time error from 3.83%, 2.83%, 5.50% to 2.67%, 1.33%, 3.83%. This benefit will improve the confidence level, and raise the good image of the company.

Keywords: software testing, CMMI, six sigma, DMAIC, information system.

INTRODUCTION
This research focuses on software testing processes using technical knowledge to identify errors and mistakes (Ng, 2005). A case study selected one of the software house organization that had local and international business operations in the field of software development services. The software configuration-management (SCM) was one component in the process of creating a software quality standard of CMMI (Capability Maturity Model: CMMI). Because of SCM and CMMI were appropriate approach to software development. The recently report showed increases ability of the organization to manage the software development projects (Brayton, 2009). That means this prototype help to provide quality and promote the trusted image of an organization to customers. The CMMI processes addressed the steps of development. It began with the conceptual designed, development, final implement, and then through to the maintenance steps. Disadvantageous of CMMI process integration usually affects to each artifact, each item and each mistake in the processes caused a lot of work in the document generation area. This research looks for the methodology to solve this problem to reduce errors and loss of earnings from quality of products and services.

Development of the organization used elements of a Six Sigma Quality Improvement which focused on reducing errors and eliminating problems to provide an efficient guideline processes— DMAIC (Define, Measure, Analyze, Control, and Improvement) (Kaur, 2005). As part of the method, defining the problems was the goal of the project management, especially measuring characteristics of the current process and collect relevant data, then analyzed in order to verify and confirm the relationship between causes and effects. Once verified, all relationships and factors deliberated to find out the causes of defects under investigation. The updating or enhancing of the current process were depended on the data analysis process, which used error-checking techniques to ensure the standardization and creates a new process in the future.

These problems must be minimize the error in the manufacturing process. This objective aimed to provide a DMAIC process to solve this problem, increases customer trust, reduces cost, time consumption, and barriers of software testing as in Figure-1.

![Figure-1. Barriers of the software testing.](image-url)

RESEARCH SIGNIFICANCE
Principle of Six Sigma was an important quality improvement process based on customer satisfaction or customer-based center (Yaacov, 2000). The concept of Six Sigma management attempted to reduce the defects that could not be met the customer requirements. That means, the need to know the requirements and expectations of the
customer were very important. This research addressed to
the first stage of development by using the actual
requirement and facts from customer. The management
of Six Sigma complied on appropriated statistical model
to create the decision support based on factual evidences
to take more advantage. In other words, the Six Sigma was
an improvement process that aims to improve the quality
by re-arrangement of management and processes to
generate the best of products and minimize errors
(Suratkar, 2002).

The Six Sigma contained an analytic process and
evaluation to continuity improvement, which consists of
the proactive management that focused on dealing with the
problems, emphases on the important of customer, and
finds a problem by exploring directed causes and
eliminates the root causes of the burden problem
(Santorin, 2003). There were three major goals to
successfully archive when trying to satisfy customers and
reduced the cycle to minimize the defects. The three major
process elements of Six Sigma were as follows (Mandl,
1985). The first element processes of improvement used to
search the problems, approached to improve the existing
processes. Further steps applied to get rid of the existing
problems, and the last steps of the first element discovered
ways to control the permanent of best results. The second
element is the design process (Process design/redesign) in
cases when the organization have chosen a new product to
develop, this process used instead of the correcting the
previous defects or added a new service/product rather
than tried to update from previous mistaken. Because the
original process involved the improving of the previous
process, this was not enough to beat other competitors or
achieve customer requirements (Tatsumi and Keizo,
1987). This struggles brought to develop new concept,
which designed to achieve maximum customer satisfaction
with minimized defects. This new concept aimed to
achieve the highest quality by applying designs of Six
Sigma quality improvement in to the new concept (Design
for six sigma-DFSS) (Brownlie, 1992).

The third element interested in process
management (Process management) (Bernstein, 1993).
The Six Sigma process could not be fully creative with
sustainable results without the participation of quality and
process management appropriately (Tatsumi and Keizo,
1987). This means that the management had to determine
the direction and strategy of the organization, using
leadership strategy to create a quality culture in the
development of the Six Sigma. This included finding out
customer needs, seeking development opportunity, quality
monitoring, as well as trying to control sustainable results
of development in the organization. Tatsumi, et al. highly
emphases the third element as the leadership quality of Six
Sigma.

PROCESS SIX SIGMA

D-Define was the first step of Six Sigma to define
the topics and scopes of the project (Lyu, 1996). This
project implemented to improve or change the objectives
beginning with the search for the true customer (Apichat,
2012). Followed the customer needs, which met the
customer’s specification, or what could compete in the
same business to draw the target of project (Von, 1993). In
addition, it needed to define the scope of the project to
ensure the project had an appropriate size and direction
within a timeframe. Usually, we marked steps by writing a
process map to clarify the work process involved in each
step from the beginning to the project’s completion.
Commonly, each project takes at least 3 months to
complete, there needs joint of projects among several
involved people who come from different departments.
These needed to define and understood the framework of
the project to ensure effective collaboration.

M-Measure was a collection of information of
theirs output (Gokhale, 1997). The services of the process,
started from a defined data input plans, data formats,
method of data storage in which appropriated to
requirements. After that, data evaluation process was done
to reflecting effectiveness and performance of the process
compared to the target, which relevant with customer
needs and specification (Michael, 2008). In Six Sigma,
anything that does not conform to the target counted as
defects and Sigma Level reflecting the occurred chance of
defects.

A-Analyze was the analytical process to make the
assumption why the output did not met the goal of
customer needs (Michael, 2008). This was the same as the
cause of defect (Xs): the mathematical equation was $Y = f$
(Xs). If the targets were not met in Six Sigma, they
considered defect (Y), so this gathering of statistical data
statistically analyzed what factors affect the defects and
then arranged in order of precedence to determine the
causes, and secondary causes (X1, X2, X3, ....) (Bubevski,
2008). The Six Sigma working steps must be verified and
clarified, and not rely on beliefs or feelings for the final
decision. There was a variety of statistical tools that must
be chosen correctly fit with the data and the process
worked to provide precision analysis. Then the results can
be trusted (Bubevski, 2009).

I-Improve, could analyze until the main causes
were knew (X1) (Gokhale, 1997). This step directly
directly addresses the improvement process by focusing on
eliminating or reducing main cause of problems in Six
Sigma that must to evaluate (Paul, 1983). Each X was
able to deliver results to improve as many of Y values
especially useful in the field of academic and cost-
benefits. Because some changes may require more
investment, it necessary to study the ways of improved
work. The guidelines applied evaluate the most
appropriate guidelines or sorted option on before-after,
thus appropriated according to the real situation and their
expense (Paul, 1983).

C-Control was the final stage of the Six Sigma
project. It was an important step, especially after an
updated or after changed to improve procedures of work, it
necessary to place the control system to maintain the
results for long-term. If one needed control, it required
both creating an accepted new process with continuous evaluation of risks which needed to be analyze to ensure no adverse effects.

PRELIMINARY INVESTIGATIONS

I. Problem defining processes (Define Phase)
   a) The overviews of software testing process studies from case study of the software companies. The authors started with system testing referring to education, studied the process to test system, assigning personnel, a device used for the test, to prepare the data in testing and testing case’s document prepared as a basic knowledge of research to understand before making analyses and process improvements (Thomas, 2005). By gathering information from a document in the system, the quality of each of the relevant procedures, the data collected will be used to display information in tables, graphs and flow charts to show in each step to make more understandable (Schaeuf, 1999) (Burke, 2002).

   b) Select a sample in a study using the method of group selection (Cluster Sampling) those were divided into 3 groups of 12 systems based on the relationship of each group and selected the 3 systems to study (Wang, 2006) (Petrovic, 2004). Those were System Security Module, Card Interchange System Module and System link Dispute Manager Module. After already made a selection to collect classified data from the fault testing system from retrospective considered to System Security Module Card system link Module and System Manager Module Interchange Dispute to choose problems that occurred and affected the most quality for improvement (Ming-Hsien, 2008). The data collected has made the process of successful end of each process, and then have collected the fault information from all qualifying issues that were significant. Then, using the principle of pareto to prioritize of these problems.

   c) Identification of the research problem, sorted from most fault information primarily to find defects as possible into the analysis made in order to find the problem that caused most of these faults. The information provided on each of the issues that arose for finding fault percentage and cumulative percentage used to qualify the significant problems (Anite SAS, 1999).

   d) Team preparation of related security problems were a system of systems, three modules system, link Manager, and system Module Card Interchange Dispute Module, divided into 3 groups of works by testing the old system and to test by the Six Sigma. The audit team used in the same series (Biehl, 2004), (Deming, 1975).

II. The measurement procedure (Phase Measure)
   a) Measurement procedure, an error value as an introduced to improve was started from creating a flow chart (Mapping Process) of the test system in the production of software. Awareness of the factors and the relation of each process then led the associated factors of knowledge problems and created a flow chart (Mapping Process), a conceptual chart, tree or fishbone diagram, respectively. To use the analyses of the problems and questions why these problems occurred (Tree Why-Why) In order to show causes and effects related to the problems that resulting from this process (Vriendt, 2002), (Florac, 1999).

   b) Determining the process flow chart of the Process Mapping to study the software test process map (Graham, 1999). The procedure consisted of several working steps. The first step of studied of quality and development of production will be aware of the factors and relationships in each step of the process. The team must have an understanding of the level that was capable of providing more details of their duties; responsibilities reside in the production process in order to be able to identify the problem. That may be the cause of the fault (Harry, 1998). The result of this step, noted which opportunity step to pose problems and aware of the severity of the problems that arose from the process to arrange the order in which to consider the information and to edit it-have to do further diagnostic analysis.

   c) Provide a reason using the Fishbone chart (Cause and Effect Diagram) and tree maps (Why-Why Tree Diagram) were consider to the relationship of causes and effects of the issues. The affected factor and distinguish according to the characteristics of this type of research selected by using Fishbone chart, tree chart, and that analyzed the question why the problem occurred (Tree Why-Why Diagram) (Pettichord, 1996), (Humphrey, 1998). Because of they wanted to make the team aware of themes and approached to analyze problems systematically. By showing the relationship of the problem with the map in the form of a reason that it was easier to understand and be able to identify the cause of the problem was clear. The initial reason given by the Tree diagram in the last slot will be the determining factors in making the analyses with the statistical principles (Rahnema, 1993).

III. The analysis phase (Analyze Phase)
   a. Experimental method to find new faults proportion of trials required to find a reason to verify if the reason was not able to confirm the faith of needed to accept the alternative (Graham, 1999). We chose it because of there was no reason of fail to reject alternative. In contrary, if the reason was to confirm the belief of the acceptable test (Harry, 1998). The reasons for the beginning of each treatment was analyzed by trials to find out how a new type of defect and measure the rate of crashes by controlling the other constant factors, then the method used to compare the original method of hypothesis testing to demonstrate the significantly differences (Humphrey, 1998).
IV. The Process improvement (Improvement Phase)

a. The design factors that affect the process as much as possible for the experiment because it made work more efficient. By studying the old software and system test to test the Six Sigma for development (Siebra, 2007).

b) The present guidelines to revise the fault issues when we had the most appropriate values of each of the individual processes that were fault. Get the value of the response variables from the best process. The next step will be proposed to revised guidelines, the error problems, and some of fault issues that were not difference but can be better improved (Walsh, 2004).

c) The original test, see Figure-2.

Figure-2. Traditional software testing process.

d) The new testing process diagram of the Six Sigma testing, see Figure-3.

Figure-3. The process of software testing in Six Sigma.

- Test analysis to define test scenario that corresponded to the Test Requirement, Functional Specification, Specification System and Business Process Specification for use in the design, development, Test Case and Test Script, as well as to prioritize testing of the subject (Tortoise, 2008).
- Test Case and Test Design by prepared the Test Script that were used in the test, which was a detailed Checklist covers every Feature or Function of the software. Under test process when the testing was completed to identify the results (pass/fail), and any other details that were necessary evidence to be used as a Checklists for delivering or receiving grants (Raghuraman, 2001), (Simon, 2007).

- Test Implementation activities under the implementation process such as;
  - Produce a table in the Test Execution Schedule Test
  - Prepare Environment and data for use in testing.
  - Prepare the process that used to keep track of test results.
  - Prepare the process that used to track the defect caused by the tests.
  - Prepare tools
  - Test controls according to plan.
  - Evaluating Exit Criteria and Reporting to check the test results (Alexandre, 2006). For example, the testing reports of all Test Execution Schedule or Defect has been corrected that caused all of the testing.
and whether or not and also the test progress report to know, such as:

- The number of test case, pass/fail test, or in the process of being tested.
- The number of defect found by severity (Severity) (Status)
- The number of change requests (CR) which were occurred, etc. test closure activities an activity that was subject to closure activities such as test events.
- Check the completeness of the test that accordance with the test execution schedule, and whether the defect were detected, or not found (Allen, 2003).
- Continue to deliver the work, incident data, test results that generated by the tests and reports processes, those involved the acknowledgement (Bae, 2007).
- Storing important documents and test results information incident arising from the various reports on the test and its storage (Configuration Management System)

V. The revision procedure (Phase Control)

The monitoring and evaluation of work performed by comparing the experimental results (Design of Experiment) were used to find out the optimal conditions of improvement (David, 2005). Because of the improved performance was satisfied. Thus, controls (Control) system worked by creating a standard of work (Operation Standard) for the process to avoid those problems repeated.

APPLICATION MODULES

I. Process of selecting problem (Define Phase)

Storage in proportion to the problem of software testing from April to May period 2014. Approximately six weeks, the number of tested cases, 300 test was divided into 50 cases a week tested in phase 1 (Phase 1) had encountered a problem Error Run-time in case of defects (errors during execution, caused unwittingly: Run-time Error) The operations review was a 3.83%, 5.50%, 2.83 respectively can be seen in Figure-4.

![Figure-4. The number of flaws of each system.](image)

e. The problem analysis can be done using the 3W2H question as follows: (Brodman, 1994)

- What: found a defect in a test case Where Error Run-time: error during operation did not understand the test data.
- When: April to October
- How: a report from the quality inspection
- How much: 3.83%, 2.83 %, 5.50%

Above information showed the main problems that occurred and affected the most quality problems Error Run-time by selecting this issue to continuity develop and improve in the next step.

II. The measurement procedure (Phase Measure)

The study on workflow processes (Mapping Process) was the study of the process and workflow processes. It is possible to show the process of running a test case called the Run-time Error. That was an error that was not a Syntax error, but had a logical error is caused by a zero-divisor, or errors that occur while the program was operated by either due to unexpected conditions (Dorling, 1993) (Patcharin, 2005). The unexpected conditions have shown in Figure-5.
Measurement (Measure Phase) was found to cause a major impact study that caused the three problems, which consisted of operational program error due to lack of customer knowledge tests. The analysis was done by three reasons why, find out the average of each system and compare your system's reliability (Garcia, 2003).

III. The analysis phase (Analyze Phase)
See Figure-6.

IV. The process improvement (Improve Phase)
Experimental analysis from the process mapping was examined to identify the defect factors. The causes of defect were found and adjusted to three main factors. By the proposed ways to improve, the scaling procedure by standard six sigma was applied to improve from the original test process, monitor the process of the adjusted settings and planning and execution process of working.

Figure-6. Six Sigma is the number of defects.
V. The process control (Phase Control)

Control of defects, which earned both direct and indirect results. This was needed to control and prevented the problem through monitoring problems, and shown abnormalities of the process. This phase needed to control both the internal and external factors by doing the design and establish follow-up methods and quality control operations (Garcia, 2003), (Goldenson, 1995).

a. Stages control to test the software division of most Runtime Error. Control at this stage has made modifications to the details of the software test process.

b. Results of observation after defected of control defects. From the purpose of this research aimed to reduce the problem of software test process by applying principles of DMAIC. After an operation to correct the problem, perform the check new data capture results show dancing after adjustment on the part of the operating result to comparison the effect of Error Runtime problems before and after to making the adjustment, as well as control factors.

CONCLUSIONS

This study aims to solve the problem of the software testing process by use the example case of Accellence Company, Thailand by conducting a study on the problems and Run-time Error, Logical Syntax Error, consisting of a system of work by using the DMAIC process. Mostly of the Six Sigma approach performance are as follows:

a) Factors that affect Run-time Error problems, other errors, Logical, and Syntax Errors.
b) Operational error
c) The lack of knowledge test and customer needs

This research also illustrates the principle of DMAIC can be used as a tool to reducing many error in software testing processes such as Run-time problem, Bug, Error, Logical and Syntax Error that mostly occurred in the software testing process. Because of they can analyze to find the causes of the problem with brainstorming, collecting all of causes as well as to find out the cause of the problems, defect work processes using charts from Fishbone (Fishbone Diagram) and Tree (Tree Diagram). Moreover, we can determine the problem, consideration, execute on the experimental design to see whether appropriate factors that are causing the problem. Then the run-time error, syntax error, logical error was solved until reduction of defect reflected the use of Six Sigma, standard and quality improvement can reduce the number of defects, and enhancing more quality of work.

REFERENCES


