New Process Design by Using Innovative Six-Sigma Expansion Approach

Song-Kyoo Kim

***Abstract*—The paper deals with setting up the new process in the handset manufacturing company based on the Six-sigma approach with some innovative extensions. The demonstration of the new process design shows the practical application of Six-sigma with some expansions. The key idea of Six-sigma expansion is the variations of Six-sigma application applied for the new process design and allows that other practical tools are adapted as Six-sigma tools. The proposed Six-sigma expansion framework is targeted to give the general guidelines of varieties of Six-sigma applications.**

***Index Terms*—Process design, requirement process, six-sigma expansion, framework design, design for six-sigma.**

I. Introduction

Handling documentations is most common way to communication between manufacturer and mobile operators. Handover the documents means that they are committed whatever it contains in the documents. Regarding the technical view point, there are several types of requirements documents. The detailed requirement documents are one of major part of R&D engineers but all of engineers are involved in development and no time for concentrating the requirement documents.

Six-Sigma is a set of practices originally developed by Motorola to systematically improve processes by eliminating defects. The traditional Six-sigma methodology is DMAIC that is used to improve an existing business process. The part of Six-sigma expansion, DFSS (Design For Six Sigma or DMADOV) is the practical Six sigma methodology for the current industries [1]. Determining the sigma level in the DFSS based Six-sigma project is the key indicator of the whole project. Basic methodology consists of the five steps [2]. Six-sigma is statistical term that covers 0.9999 of quality but its application was subsequently extended to other types of business processes as well.

To official communicate with operators; there are two types of documents group except for legal documents. Sales documents deals with retail prices, quantities of the products, shipment schedule and so on. These documents are less technical and most of parts are about the quantity and price of the products. In case of technical documents, there are generally three types of documents. RFP (Request For Proposal) is for proposal of the products. It means that carriers provide the templates (usually, using Excel file) of the proposal which is technical but not detail. Manufacturers such as Samsung provide the answers for proposed products with the target launches. Even though, the document is not too technical but technical items are usually asked to choose the commercial products [3]-[5]. Submit the RFP means starting the selection process for each operator. In other hand, the detailed technical documents are more technical and covering all of features in mobile devices. Each operator has different services and these services have different requirements of the mobile. Some of documents are based on the mobile standards such as 3GPP (3rd Generation Partnership Project), 3GPP2, OMA (Open Mobile Alliance), GSMA (GSM Association) and WiFi Alliance [6]. But some of requirements are based on proprietary requirements. Usually, the detailed technical documents are requested after selection process and only selected products are requested for the detailed technical documents. Again, all of operators have different requirement sets for the selected products and the items can not be answered by general managers from product planning or sales teams because the documents are too technical [3]. Submitting the detailed technical documents means starting the feature lockdown process before carriers are finally agreed to launch the products. Even all carriers have some sorts of "selection procedure" and "feature lockdown procedure', the technical documents are all different. Each operator has different templates to fill in and has different interests.

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II. Six-Sigma Expansion for New Process Design

Handling the requirement documents is one of important part of the business in the mobile industries. Usually, general managers from product planning team have taken care of the documents but the qualities of the documents are really poor and operators have always complained about the quality of the documents. There are several reasons why general managers can not take care of technical documents. First, they do not have enough knowledge of technologies of mobile industries. They roughly know the mobile technologies but not in detailed which can be covered for the detailed technical documents. Second, there are too many development teams within the company. General managers should contact with dedicated engineers who develop the certain features in the certain development teams. Too many teams, too many fragmentations even within the same target range of the devices. So, the Vice President of development team has set up the new process and the new team who can handle technical documents within R&D department.

III. Six-Sigma Expansion for New Process Design

To design the new process for carrier requirement

document, the special project is set up on 2005. The project is targeted for design the process workflow and evaluates the efficiency of handling the requirement documents. The project that based on DFSS (Design For Six-Sigma) process is target to be completed on 2005.

A. Define Phase

The scope and the schedule of the project are determined in Define phase. How to build the team for the project is also determined in this phase. The plan of the project must be defined in this phase (see Fig. 1).

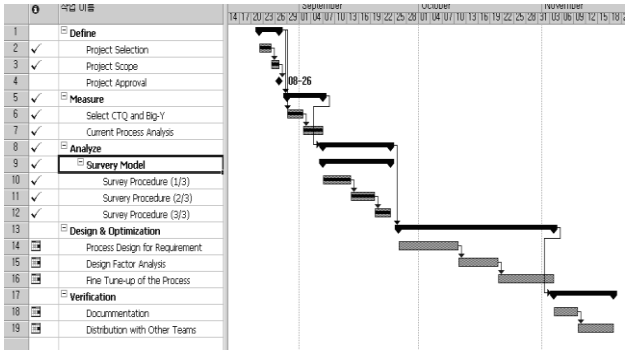

Fig. 1. Project schedule.

B. Measure Phase

Main objective of Measure phase is define the items to measure and provide the guidelines how to measure them. In this Phase, CTQs (Critical-To-Quality) are determined. CTQs are the indications of the performance enhancement. The CTQs should be transformed into measurable items to compare between the current and the future data (see Table I).

TABLE I: PROJECT CTQ

	CTQ (Y)	Criteria (Unit)	Current	Target	Remarks
Y1	Feedback Accuracy	Portion (%)	70 %	90 %	
Y2	Due date delay	[Day]	+10 [Day]	+0 [Day]	
Y3	Processing Period Forecasting	Forecasting (Yes / No)	No	Yes (1 or 3 wk)	1: Branch model 3: Base model
Y4	Process Design	Satisfaction (%)	18.5%	70 %	Current status is measured on Design Phase
Y5	Communication with ETO	Satisfaction (%)	18.5%	80 %	
Y6	Communication with R&D	Satisfaction (%)	18.5%	80 %	

Regardless of methodologies, measuring the CTQs in MEASURE phase (before improvement) is the one of critical issues for success of Six sigma project. These CTQs turn into the unified measurement value that called sigma levels in VERIFY phase. The special measurement methodology is applied for non-countable measure values and it provides the sigma-levels of each uncountable value [2].

C. Analyze Phase

Determine the items for measure that related with the performance of the project. The control factors that actually improving CTQs are identified in this phase. It is also included in analysis of most important control factors and few of critical control factors called Vital Few X's are delivered at the end of Analysis Phase.

D. Design and Optimize Phases

Main part of design phase for this project is building up the requirement handling process. There are three teams within the company are mainly involved in the requirement handling process. The new proposed team who is mainly handling the requirement documents and branch offices or product planning team get the documents from operators and handover the documents to development team to fill in (after setting up the new team, the team members are the counter part of development team) and the contributions of other teams can be ignored. The process is basically requirement handling process within main teams and it has been categorized as different procedures based on the number of items to be answered (see Fig. 2).

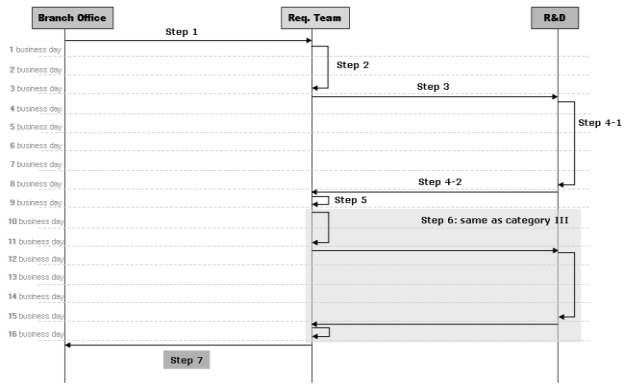

Fig. 2. Requirement handling process.

The new process between the branch office (BO), R&D, product planning tem (PP) and the new team for requirements (RT; Requirement Team) are determined and the detailed of duration for each team is shown as Table II.

TABLE II: DETAILS OF THE PROCESS

Step	Date	Period	Act by	Required (R/O)	Action Items
1	T(0)-16	0	BO/PP	(R)	. To send RFI to *CRC / R&D*
2	T(0)-16	3	RT	(R)	. To analyze and classify RFI **(same as Category I)**
3	T(0)-13	0	RT	(R)	. To send the classified data to developers in charge
4	T(0)-13	5	R&D	(R)	. To review the received data
					. To send the reviewed data to *CRC*
5	T(0)-8	1	RT	(R)	. To merge/review the feedback data . To make the final draft version
6	**T(0)-7**	**7**	**RT**	**(R)**	**. To make the data revised (question and confirmation) – 2nd Revision . The process after this is same as Category III**
7	**T(0) (=T(F)-7)**	**0**	**RT**	**(R)**	**. To send the final official version and transfer its control, to *ETO/PP* . At lease 7 days before T(F)**
8	T(F)-2	2	RT/BO	(R)	. Internal spec. freezing meeting
9	T(F)	0	All	(R)	. Samsung official version is released by ETO

PERT (Project Evaluation and Review Technique) is a statistical tool, used in project management that is designed to analyze and represent the tasks involved in completing a given project. First developed by the United States Navy in the 1950s, it is commonly used in conjunction with the critical path method (CPM). Even though PERT is not the classical tool of Six-sigma, it is applied for this project to give the guidelines to all related teams within the company [1]. The usual expected time is:

$$T_{total} = \sum_{k=1}^{n} T_k = \frac{a_k + 4 \cdot m_k + b_k}{6}$$

where:

a_k= the minimum time estimated at action k,
b_k= the maximum time estimated at action k,
m_k= the most likely time estimated at action k,
T_k= expected time at action k,

In the other hand, the variance of the process time can be solved by the following:

$$\sigma_{total}^2 = \sum_{k=1}^{n} \sigma_k^2, \sigma_k^2 = \left[\frac{b_k - a_k}{6}\right]^2 .$$

Based on the calculation, the estimated time and various are:

$$T_{total} = 17.67[days], \sigma^2 = 1.83[days]$$

and the feasible delivery day under 90% confident rate is around 19.4 days. It means that the teams who involved in requirement document process are needed at least 20 days to deliver on time more than 90%. This period time is the guideline for the requirement document process.

E. Verify Phase

The data for measuring of new process (or system) are delivered to compare between the current processes. Each CTQ is compared between the past status (in Measure) Phase and current status (after Design/Optimize). The data of the current status are usually gathered after the pilot executions (see Table II). Other important part of Verify Phase is Documentations. It is relatively simple task but very important in the view point of the process engineering.

TABLE III: PROJECT PERFORMANCE RESULT

CTQ (Y)		Baseline	Current	Target	Pilot	Remark
Y1	Feedback Accuracy	Portion (%)	70 %	90 %	90%	
		Sigma Level	2.02	2.78	2.78	
Y2	Due date delay	Date (day)	+10	+0	+0	*Vodafone case
		Sigma Level	1.5	1.80	1.80	
Y3	Processing Period Forecasting	(Yes / No)	No	1w/3w	1w/3w	
		Sigma Level	0	1.5	1.5	
Y4	Process Design	(%)	18.5 %	80 %	73.1%	
		Sigma Level	0.61	NA	2.11	
Y5	Communication with BO	(%)	18.5 %	80 %	79.5 %	
		Sigma Level	0.61	NA	2.32	
Y6	Communication with R&D	(%)	18.5 %	80 %	65%	
		Sigma Level	0.61	NA	1.86	

There are uncountable measurement values are also included in the project performance such as Communication with BO/R&D. The special measuring tool is applied to analyze the values and the sigma levels [2], [6].

IV. INNOVATIVE SIX- SIGMA EXPANSION FRAMEWORK

Even though it could not be achieved the actual 6 sigma level, the project is still successful because it is one of unique Six-sigma application for the process design. In addition, it adapts non-classical Six-sigma tools such as PERT and CPM. Six-sigma is very powerful tools for quality management in manufacturing but it is still weak for the process design. Even this project could not be considered as Six-sigma projects if the project leader is only focused on the classical approaches.

Fortunately, as an expansion, Six-sigma can be considered as the general framework for any types of projects and any kinds of tools can be adapted if the tool is more applicable to complete the project or solve the problems. Based on the completion of the project, the framework can be described as Fig. 3.

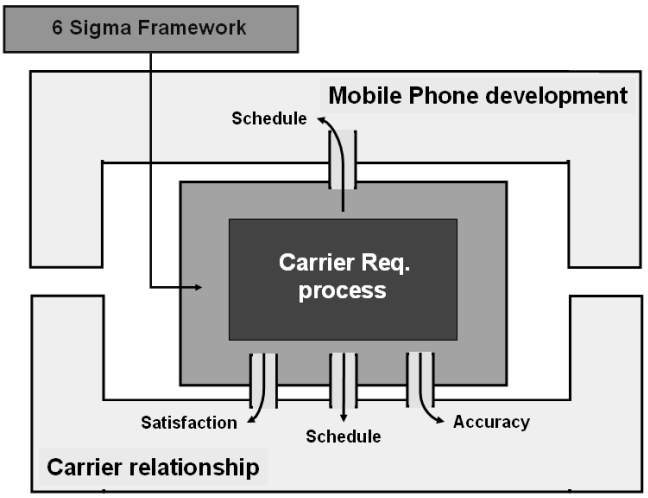

Fig. 3. Six-sigma expansion framework.

In addition, in depth of the technology knowledge to apply the innovation schemes is the mandatory for project success. One of most important key for success is right people. The framework gives the advantages not only for Six-sigma experts but also for general managers. The framework provides the guidelines of the expansion for Six-sigma approach and Six-sigma experts give the room for adapting other specialties if they are more applicable for the situations. Since, it contains the basic procedure of classic Six-sigma, beginners can understand the process more effectively.

V. FURTHER PROCEDURE

The proposed Six-sigma expansion framework is targeted to give the general guidelines of varieties of Six-sigma applications. Based on the framework, practical tools from various areas can be adapted under name of Six-sigma. For instant, TRIZ/TIPS (Theory of Inventive Problem Solving) [8], LP (Linear Programming) [9], Generic Algorithm [10] can be applied extensively during Six-sigma activities. The adaptations of such a practical tools from various areas into Six-sigma region and their case studies will be the next research topics. In addition, open minded leadership is the key success factor of the innovative Six-sigma expansion approach.

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