Measurement of Sigma in Operation Process of PACS for Quality Assurance

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Abstract

This study purposes to develop the quality assurance model for PACS, one of major hospital information systems. 6 sigma process was chosen for virtual 'zero defect' effect since the system relates to the life and health of patients. The implication of 6 sigma is specified by the DMAIC process, and each stage for this process is applied to PACS for standardization of quality control process. The sigmas are calculated in each essential element of PACS operation. Six Sigma method will be the useful statistical and measurement tool for the quality improvement of hospital information system.

Keywords:

Six Sigma, Quality Assurance, PACS, Hospital Information System

Introduction

As health environment changes, most hospitals are interested in an efficiency and effectiveness of hospital management. The management board in hospitals tries to introduce hospital process reengineering which is a new methodology of management renovation for improving the business process. Especially, the major efforts were put on the powerful information system such as order communication system(OCS), picture archiving and communication system(PACS), and electronic medical record(EMR), etc. This leads high productivity, quality improvement of health services, and other sustaining changes such as financial benefits. However, despite the growth of information systems and their outcomes in hospitals, it is common not to have the management and control technique for hospital information systems, which assures the quality of the system itself and the system in action.

In the context of quality assurance, the concepts of quality control(QC), statistical quality control(SQC), continuous quality improvement(CQI), total quality control(TQC), etc. have been developed in the last decade. The most comprehensive terminology TQC is defined as the effective system for integrating the quality-development, quality-maintenance, and quality-improvement efforts of the various groups in an organization so as to enable production and service at the most economic levels which allow for full customer satisfaction [1][2][3]. Recently, TQC is applied to the management of enterprise because of industrial environment with highly competitive global market. Therefore, the methodology of total quality management(TQM) is regarded as a tool for improving the competitiveness and its implications are profound [4][5].

As one of TQM methodology, Six Sigma is a management innovation methodology to produce virtually all products that are defect free based on the process data. This methodology is emerged from statistical process control(SPC) concepts in the 60's and 70's and developed in the discrete parts-manufacturing environment in the 80's. GE and Motorola are two most well known success cases of Six Sigma activity even to the general public. Now Six Sigma has been widely adopted in a variety of industries as a proven management innovation methodology to produce high-quality outcomes and reduce the cost at all the levels of an organization. Many organizations use the Design-Measure-Assess-Improve model to effectively manage their business process.

The motivation for Six Sigma is that every improvement activity should be based on the facts or data, rather than abstract or subjective discussion. Therefore, statistical knowledge or problem solving skills are employed as a universal language based on managerial view. Specifically, since Sigma, σ, represents the variance of the distribution, roughly 0.002 parts per million will not perform per specifications if the upper specification limit is 6σ. This fact implies a virtual 'zero defect' effect.

The implication of Six Sigma on Hospital Information System is considered as appropriate since the system relates to the life and health of patients which are one and only. The systematic process of Six Sigma implication is classified into definition, measurement, analysis, improvement, and control steps, and the measurement process needs good and reliable data to monitor the current status of the process. Therefore, first of all, the present study intends to measure the sigma level for five components of PACS. This will be a foundation to develop the quality assurance model for other hospital information systems as well as PACS.

Methods

To compute the Sigma level, the Halting Time per Hour(HTPH) is developed as an indicator. It is calculated as the halting period due to communication failures divided by total operating period of PACS.

$$\text{HTPH} = \frac{\text{Halting Period}}{\text{Total operating period}}$$

The key point at the measurement step in Six Sigma process is to acquire accurate and relevant data. This is effectively facilitated with the use of a checksheet. The

checksheet for failure cases of PACS operation is filled for one year, 2002.3.1 to 2003.2.28 in A University Hospital. The information of failure case includes failure day and time, origin and halting period. The communication failure cases and their halting periods are summarized by five components of PACS, which are server, network, gateway, monitor, and workstation.

Then the computation is performed by Six Sigma academic module version 2.1 in MINITAB version 13 Statistics Program [6][7]. "Quality tools" in STAT menu requires to input data for total operating time, halting time, etc. The denominator, total operating time, is 8760 hours for one year, and the numerator, halting time, is measured halting hours by each five component of PACS.

Results

The computer output for each component of PACS creates Rollup Statistics with product performance and two plots of Product Benchmarks. The example output is shown in Figures 1, 2 and 3 for the first component of PACS server. For server management, three items of server, accessories, and other part were monitored. Total 29 failures were noticed and resulted in 28 halting hours. The resulting sigma level of 4.23 is shown in ZBench of Figure 1. And two plots in Figures 2 and 3 showed the position which needs to be improved.

Like the sigma level of Server, sigma values of Network, Gateway, Monitor, and Workstation were also produced. They were 4.37, 4.70, 5.67, and 5.27 respectively, as shown in Table 1. The overall results turned out to be good at present.

Table 1. Sigma level for five components of PACS

	Management items	Number of unit	failure cases	halting period	Sigma level
Server	3	1	29	28	4.227
Network	8	1	57	18	4.370
Gateway	5	1	11	6	4.701
Monitor	3	405	48	53	5.674
workstation	26	331	297	239	5.268

Conclusions

This study measured the Sigma level for PACS to diagnose the current quality status of PACS and to develop the quality assurance process in the future. The measurement process was performed by five operation processes, and the Sigmas were 4.23 to 5.67, which are fairly good. The key ideas to improve sigma are either to reduce the standard deviation or to center the process around the target or to take both. In practice, "zero defect" can be achieved by preventive management activities and administrative techniques. Because PACS is considered as one of important diagnostic tools for patients, the necessity of statistical management process is essential for "zero defect and no halt time".

The results obtained in the measurement step should be further analyzed with a Pareto chart, Fish-bone chart, vital few or other graphical methods to evaluate the factors in obstacles, to analyze the significant factors, and to assess the relative importance of each element or factor in the study. Then the reform measurements and obstacle factors should be graded in the next step of improvement, and a steady stream of preventive strategies such as elimination of critical factors, maintenance of established check points, and obstacle factors in PACS operation should be proposed in the last step of control. There are generally great deals of variation in the hospital information system. Six Sigma method will be the useful statistical and measurement tool for the quality improvement of hospital information system.

References

1. Juran JM. Quality Control Handbook, 3rd. ed. McGraw-Hill, New York, 1974.
2. Deming WE. Elementary Principles of statistical Control of Quality, 1950.
3. Feigenbaum AV. Total Quality Control, McGraw-Hill, New York, 1961.
4. Powell TC. Total quality management as competitive advantage: a review and empirical study. Strategic Management Journal 1995; 16(1): 15-37.
5. Hackman JR. Wageman R. Total quality management: empirical, conceptual and practical issues. Administrative Science Quarterly 1995; 40: 309-42.
6. . MiniTAB Inc. MiINITAB User Guide, 1998.
7. Ryan BF. MINITAB Handbook, 4th edition, Brooks Cole;, 2000.

Charact	Defs	Units	Opps	TotOpps	DPU	DPO	PPM	ZShift	ZBench
1	28	1	8760	8760	28.000	0.003196	3196	1.500	4.227
Total	28			8760		0.003196	3196	1.500	4.227

Server : Product Performance

Characteristic	Defs	Units	Opps	TotOpps	DPU	DPO	PPM	ZShift	ZBench
1	28	1	8760	8760	28.000	0.003196	3196	1.500	4.227
Total	28			8760		0.003196	3196	1.500	4.227

Figure 1. Rollup Statistics of PACS Server

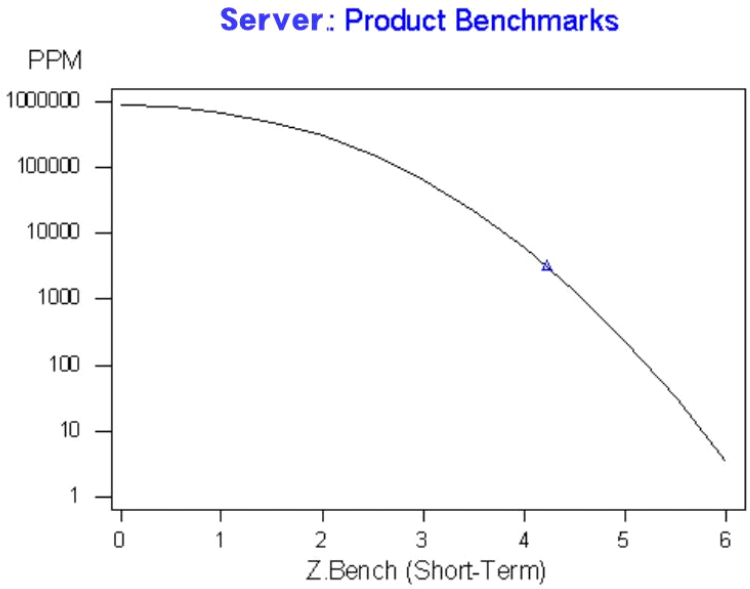

Figure 2. Product Behchmarks of PACS Server I

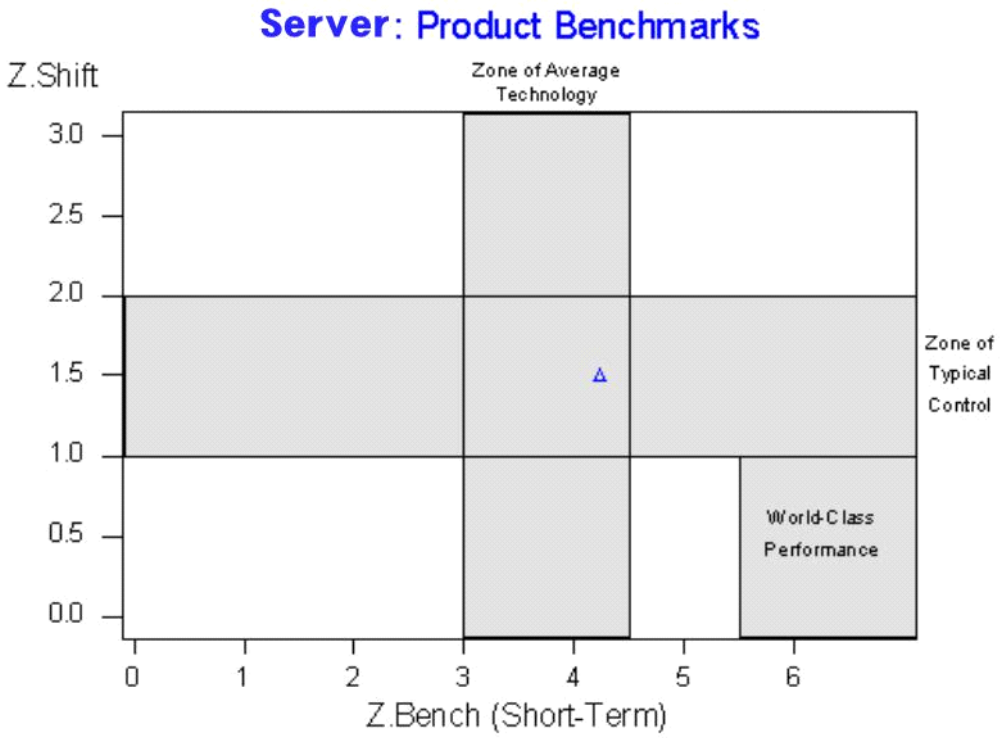

Figure 3. Product Behchmarks of PACS Server II