Information Quality Improvement Model on Hospital Information System using Six Sigma

Dyah Diwasasri Ratnaniyngtyas\textsuperscript{a*}, Kridanto Surendro\textsuperscript{b}

\textsuperscript{a}School of Electrical Engineering and Informatics, Bandung Institute of Technology, Jl. Ganeca 10, Bandung 40132, Indonesia
\textsuperscript{b}School of Electrical Engineering and Informatics, Bandung Institute of Technology, Jl. Ganeca 10 Bandung 40132, Indonesia

Abstract

Hospital provide a number of health services and proper health facilities for society, one of the healthcare is inpatient. Because of the daily high demand of inpatients healthcare in a day, some hospitals seems too overwhelmed to control the information flow. Mainly, hospital already used Hospital Information System (HIS) for helping managing information flow. But some of it does not really care about the quality of information. Information quality is a key element to determine the level of healthcare in hospital. By the improvement of information quality, the quality of healthcare would improve to support the patient’s satisfaction. A method used for information quality improvement is Six Sigma. Six Sigma could be used for reducing information variance in healthcare, especially information that used in Hospital Information System.

Keywords: Information Quality (IQ); Six Sigma; Hospital Information System (HIS); Quality Improvement; Quality Management

* Corresponding author.
E-mail address: dyahdiwasasri@gmail.com
1. Introduction

The availability of health services provided by a hospital is based on the classification of hospital which could be divided into two types which is general hospital and specialty hospital [1]. With the number of health services provided, a hospital ideally should be organized all of the health services to get patient satisfaction aligned with the quality of output data. But the fact is, sometimes a hospital feels overwhelmed when giving over-demand health services from patient but not coupled with a proper health service system. Some hospital has already used Hospital Information Systems (HIS) as an information system which implemented in hospital to manage information, gather information, data storage, data processing, data exchange and extraction in purpose to fulfill the functional requirement of user [2]. The quality of health services depend on the quality of information in hospital and information quality (IQ) is a competitive key element for on-going organization.

Method used in this paper is Six Sigma. Six Sigma is a quality improvement approach which systematically effective to improve organization performance based on the use of various statistic analytic technique [3]. The purpose is to reduce process variance by eliminate defects that bother customer satisfaction [4]. The improvement and enhancement of information quality in the hospital, the health services quality should be increased significantly. The purpose of this paper is to set IQ parameters for hospital and create model of IQ improvement based on the method of Six Sigma.

This paper organized as follow: in section 2 we present about information quality in hospital, in section 3 we explain about Six Sigma as the method used in this paper. In section 4, we present information quality improvement model for Hospital Information System using Six Sigma, then at least in section 5 is conclusion statement as the summarize result.

2. Information Quality in Hospital

Information needed is not only seen by the quantity of information, but also the quality [5]. Information quality considered as the determinant of output data process which will be communicate to the user or can be considered as an input for another process. In this case, IQ plays an important role and should be created as a successful indicator of the process course. IQ determined by seven things which is [6]: (1) Accessibility, (2) Completeness, (3) Accuracy, (4) Exactly, (5) Timely, (6) Clearly, and (7) Flexibility. While Eppler (2006) said there is 70 of widely used IQ criteria [7]

In health section, healthcare quality is a level where individual healthcare will improve the probability of wanted health results consistent with the knowledge from health specialist nowadays [8]. There are six IQ dimension related with healthcare on health institution [10]: (1) Safe, (2) Effective, (3) Efficient, (4) Timely, (5) Patient-centered, and (6) Equitable. IQ in hospital becomes a crucial factor in health services to patient, so that the importantly of IQ in hospital; are [9]: (1) To promote accountability between health provider, (2) To inform the focus policy development, and (3) To possibly the provider and functionary to learn about quality improvement between them.

3. Six Sigma

Sigma is a quality improvement approach which systematically effective to improve organization performance based on the use of various statistic analytic technique [3]. The higher sigma level, the smaller probability level of defects occurs in products. However, a number of organizations prefer to use Six Sigma because it has standard of only reproduce 3.4 Defects Per Million Opportunities (3.4 DPMO) [3]. The purpose is to reduce process variance by eliminate defects that bother customer satisfaction [4]. Six Sigma has concern
on improving quality by reducing defects. DMAIC is a closed-loop process that eliminates unproductive steps, often focuses on new measurements, and applies technology for continuous improvement [11]. Figure 1 shows the clearly description of DMAIC steps. There are five phase in DMAIC steps which are [11]: (1) Define, is define the problem and scope of project; (2) Measure, is measure the performance quality of current process; (2) Analyze, is analyze process performance to separate problems; (4) Improve, is improve performance by giving problem solution (5) Control, is control the process or product which already improved to ensure the target attainment.

![Fig. 1. DMAIC Steps [11]](image)

### 4. Information Quality Improvement Model for Hospital Information System Based on Six Sigma

The proposed model of IQ improvement using Six Sigma for healthcare in Hospital could be seen on Figure 2 below.

![Fig. 2. Model of IQ Improvement for hospital based on Six Sigma](image)
General explanation of the IQ improvement model is explained below.

- **Identification**: Identification contains four main areas: (1) Scope and objectives identification, (2) Critical Success Factors (CSF), (3) Critical information, and (4) IQ measurement parameters. The deliverables from this step are critical information and IQ measurement parameters.

- **Analysis and Solution Planning**: In this step, Six Sigma method is used to detail the solution planning aligned with DMAIC steps, which include: (1) Defining parameters for each DMAIC step, and (2) Tools and technique selection for each DMAIC step. Every step has already focused on information in hospital healthcare. The deliverables are analysis and solution planning document.

- **Assessment and Evaluation**: Assessment and evaluation is done after there is solution recommendation as the result of analysis and solution planning step. This step should be completed before submitting solution to the hospital management board.

- **Solution Implementation**: Before implementing solution, acceptance and agreement should be done between project team and hospital management board. The acceptance and agreement is based on the result of assessment and evaluation before.

4.1. Identification

Scope and objectives have been determined based on hospital vision and mission because every hospital should have different vision and mission. Better if the vision and mission is supporting the hospital. However, in this model, scope and objectives will be fitted with the purpose study-case hospital. Critical success factors (CSF) is a critical factor that determine the successful implementation of a process. In this step, CSF is a translation from hospital objectives. Each hospital would have different CSF in association with the vision, mission, and requirement of it. Critical information is important information which rules the process running. There are two ways to define the critical information in hospital. First is by derived it directly from CSF with the perspective of information importance based on hospital standard. Related with the CSF standard defined before, the critical information for hospitalization in Smart Hospital is information about: (1) patient identity, (2) hospital functionary, (3) checks referral, (4) anamnesis, (5) diagnosis, (6) medical action, (7) laboratory results, (8) pharmacy and medicine given, (9) health facilities, (10) healthcare cost, (11) mortgage companies, and (12) the media of writing information such as: receipt, control card, paper, etc.

Second, we can define critical information by identify the relation between information and total amount of defects/error. For ease of understanding, take a look to graphic shows on Figure 3 about the comparison of information and defects/error.

![Fig. 3. The Relation of Critical Information and Defects/Error](image-url)
Based on Figure 3, there are some things indicate from it: (1) How critical information is, (2) The priority of IQ improvement. The higher amounts of defects, it means that the more critical information is. The more critical information, it means that the higher priority of IQ improvement. The second way can be used if there is fact data completed with the statistical defects for each data. The IQ measurement parameters for hospitalization in hospital which should be fulfilled by every critical information is explained below. Each of the criteria will mapped into critical information defined before so that it will produce the results of detailed parameters critical information.

- **Accuracy**: Information should be free from error/defect and not ambiguous.
- **Accessibility**: Information should be easy to get by interested and needed parties, so that the healthcare process should be easier to implement.
- **Completeness**: Information should be easy to get by interested and needed parties, so that the healthcare process should be easier to implement.
- **Timely**: The delivery time of information. If information delivered late, it will occur to the importance level of information.
- **Clearly**: It will be better if information has been packaged with the easy-to-read format.
- **Relevance**: Information should be useful and related to user requirement. It is the same with the effective level of information. Information should be use to meet the right things.
- **Safely**: Information should be secure and has its own security system to protect the confidentiality of the information.
- **Efficient**: Information is not overused and should meet the right things to get the maximum results.

### 4.2. Analysis and Solution Planning

There are two things of doing these steps: (1) Selecting tools and techniques for each DMAIC steps; (2) Create the detail of solution planning based on DMAIC steps. The model of IQ improvement for hospital divided into five main areas corresponding with five steps of DMAIC: define, measure, analyze, improve, dan control. Each step has key process and tools selected for each steps due to Table 1 below.

Define phase explain about current condition, process, and organization general problem. It is included explanation about customers, customer requirement, scope, goals/objectives, business process and plot. After know about current condition, process, and general problem, next step is measure phase, which is creating a data collection planning before performing data measuring on hospital. The purpose of this step is to know the main problem and process capability of hospital. From the measurement results about a process performed, next is do analyze phase, which is doing the deep analysis about the data and process to know the root-cause problem of the hospital. Next, if root-cause has already defined, alternative solution for each problem should be formed. Later, the prioritization of each alternative solution should be done to make a decision about which is the best solution. Before implementing the solution, it needed to test it first to know the feasibility of the solution. In control phase, control of the solution implementation is performed. Therefore, control plan is needed to track the implementation process and as the evaluation of the next process.
| Steps | Key Process | Tools and Technique | Deliverable |
|-------|-------------|---------------------|-------------|
| Define | Define customer and customer requirements  
Define the process map and map the process to business plot  
Define the general problem  
Define the project timeline | Project charter  
Cause and effect diagram  
Process map  
SIPOC | Project charter  
General problem identification  
Business process and plot  
Process mapping to business plot |
| Measure | Create data collection plan  
Collecting and comparing data to determine problem and process capability | Data collection matrix  
Measurement system analysis (MSA)  
Process capability analysis | Data needed  
Accuracy of measurement system and process  
Process capability in purpose to meet customer requirement |
| Analyze | Analyzing data and process to determine process variance  
Analyzing the root-cause problem  
Create the priority of root-cause problem as the improvement target | Cause and effect diagram  
Pareto analysis  
Control chart (current condition)  
Scorecard  
FMEA (current condition) | Root-cause problem  
Root-cause prioritization |
| Improve | Create potential alternative solution  
Select and create prioritization of alternative solution  
Test the solution  
Implement the solution | Control chart (current condition)  
FMEA (after improvement) | Potential risk  
The cause and effect of risk |
| Control | Create process control plan  
Implement the process control plan | Control plan | Stability control and process output |

4.3. Assessment, Evaluation, and Implementation

In the assessment and evaluation step, assessment and evaluation needed to know if there is revision of the solution recommendation before give it to the hospital management board. The result of this step is assessment and evaluation document. The result of solution assessment and evaluation is influent to the decision process of solution recommendation. If the solution marked as good, there is a chance of implement it to the hospital. But, if the result was bad, it needs to take some improvement to the solution given.

5. Conclusion

Information quality is a critical element in a hospital because information quality as one of the determiner of the hospital healthcare level. Method used for improving information quality in hospital is Six Sigma. The purpose of this method is to reduce variance information on the healthcare process. Proposed model to improve the information quality in hospital consist of four steps, which are: identification, analysis and solution planning, assessment and evaluation, and implementation. The adoption of Six Sigma methodology (DMAIC) implemented in analysis and solution planning. The result of solution planning is key process and selected tools for each steps.
References

[1] C. Siregar and L. Amalia, Farmasi Rumah Sakit Teori dan Penerapan, Jakarta: EGC, 2004.

[2] C. Morris, "Perspective of Hospital Information System," International Journal of Medical Informatics, no. 21, pp. 965-973, 1998.

[3] T. Pyzdek, The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels, McGraw-Hill, 2003.

[4] P. Pande and L. Holpp, What is Six Sigma?, McGraw-Hill, 2002.

[5] B. Sabarguna, Sistem Informasi Manajemen Rumah Sakit, Yogyakarta: Konsorsium RSI, 2005.

[6] D. U. Daihani, Sistem Pendukung Keputusan, Jakarta: Elex Media Komputindo, 2001.

[7] M. Eppler, Managing Information Quality, Germany: Springer, 2006.

[8] R. D. Snee, "Six Sigma: The Evolution of 1000 Years of Business Improvement Methodology," International Journal of Six Sigma and Competitive Advantage, pp. 4-20, 2004.

[9] Y. Kwak and F. Anbari, "Benefits, Obstacles, and Future of Six Sigma Approach," Technovation, pp. 708-715, 2006.

[10] L. Hambleton, Treasure Chest of Six Sigma Growth Methods, Tools, and Best Practices, United States of America: Pearson Education, Inc., 2008.

[11] OECD, "Improving Value in Health Care: Measuring Quality," Health Policy Studies, 2010.