

Product Design and Improvement Based On Six Sigma DMAIC Methodology: A Case Study for Health Insurance Information System of C University

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Abstract:

The Redfern Health Centre (RHC) at C University was highly concerned about the increasing rate of customers opting out from their healthcare insurance products due to the inexplicit information provided and decided to introduce Six Sigma for quality improvement. In this research, six-sigma DMAIC methodology was adopted. To explore the use of the six-sigma methodology to optimize health insurance information system in C university and to reduce customer complaints. Following the DMAIC phase, the customer statements was analyzed through research and thus the needs of users were identified. A serial of metrics was designed with the purpose to quantify customer satisfaction, which also enabled to find the key factors influencing the user experience. Concepts and prototypes were constructed, tested and refined for up to 4 iterations for continuous improvement. Results show the new system performed better in all metrics indicating that customer satisfaction was enhanced significantly.

Keywords:

Six Sigma, DMIAC, Metric, Concept

1. Introduction

1.1. Definition of Six Sigma

Six Sigma, a data-driven approach to improve efficiency and quality, first introduced by Motorola Company in late 1980s, is a highly disciplined statistically based, process-focused, data-oriented strategy and methodology for improving quality and reducing costs in fields from manufacturing to transactional and from products to services [1].

The term Six Sigma is derived from the normal distribution used in statistics. The variability of the output of a process is measured by a statistic called the standard

deviation- σ . The sigma level indicates how many standard deviations away from the central mean. Different sigma level indicates different probability and the larger the sigma level is, the stricter the process requirement is. The rate of qualified products of 6σ level is around 99.9999998%, which is close to zero errors, that is, out of 1 million products, only 3.4 of which are defective, approaching the limit of perfection. Therefore, the goal of Six Sigma is to and maximize production by reduce variability till zero-defect and the process of improvement is continuous [2].

1.2. DMAIC method

When implementing Six Sigma projects, the key is to follow the quality improving procedure-DMAIC process. DMAIC (Definition, Measurement, Analysis, Improvement, Control) is a structured five-step problem-solving procedure that can be used to successfully complete projects by identifying problems, investigating causes, and providing solutions for optimizing quality, and to establish best practices to ensure that the solutions are permanent and can be applied in other relevant cases.

The Define phase involves what problem needs to be solved and the scope of the project. The Measure phase involves collecting relevant data to the problem, exposing underlying causes and figure out what is the current performance of the process. The Analyze phase of the DMAIC model enables to identify X's (drivers) that impact a CTQ (critical-to-quality) characteristic and key factors are identified through statistical methods such as analysis of variance, regression analysis, chi square test etc. The improve phase mainly relies on experimental design methods to focus on how to create the solutions for better performance and how to achieve breakthroughs in quality improvement. The Control phase mainly deals with how sustainable quality improvements be made through the institutionalization of the improved process.

2. Problem Description

C university is an international institution located in North America. The Redfern Health Centre (RHC) at C University provides services to address all the healthcare needs of the students in the university and provides health insurance to all eligible students. C University requires that all the students who are enrolled on campus for 9 hours or more have some form of health insurance coverage. The RHC provides a health insurance plan to students offering high quality and reliable health services along with several other benefits. However, recently, the RHC is concerned that many students opt to waive out and go for plans that do not have many benefits.

The current information system of RHC including website, orientations and emails regarding health insurance policies is one of the various kinds of healthcare services the RHC has offered. This study considers the services as product and only focuses on the information products since it is one of the most demanded products.

The main issue is that the details of the Student Health Insurance Plan can be complicated so that some user claims the information provided is confusing and not helpful. In our interview with the client, they highlighted some of the problems they were facing when dealing with students who have various queries regarding insurance. Often, they receive calls with questions from students, the answers for which are already there on the website.

3. Data Collecting and Processing

Following DMAIC steps, this study conducted several iterations for continuous refinement of current system based on the data collected from clients and customers such as statements and ratings. The data collected started from January 2024 to July 2024. A customer selection matrix was developed to identify the wide range of people to be interviewed to gain more insight to the problem at hand. User selection details can be seen in Table 1 and more details during the process will be shown in the following content.

Table 1. User Selection Matrix.

	Stakeholders			
Market Segments		International students (Lead Users)	Other students	Redfern Health Centre
	Infrequent/Nonusers	0	10	2
	Exchange Students (Occasional Users)	10	0	
	Frequent Users	60	30	

4. DMAIC Process

Although originating from manufacturing process, DMAIC's application has evolved into a universal mechanism for process improvement and been adapted to solve problems outside the manufacturing industry, such as transportation companies, financial services organizations as well as health care providers [3].

4.1. Define

In define phase, this study aims to diagonalize the problems clients and users are facing and to define purpose, scope and mission for new information system [4].

Mission: Quality improvement of Health Insurance Plan service products (specified in information system). Purpose: Enhancing customer satisfaction. Scope: Decreasing customer inquiry upon healthcare insurance policies; Making the information about the insurance plan easily understandable and available.

4.1.1. Voice of Customer

Data must be obtained through direct communication with customers, shareholders, and employees. Interviews were conducted with people from different user groups as identified from the customer selection matrix. A customer data template was framed to help with the interview process. Based on the interpreted needs from various customer and client interviews, needs were identified and put in the form of a survey that was administered to the users to rate the importance of the needs. The customer templates indicate that there are some issues and user concerns about this RHC health insurance service, for example, some customer complains that the information introduction is dull, and they are unwilling to spend time to understand this. Some of them cannot find the critical information regarding what benefits is covered and what is not covered; Some claims that the mails sent by the Redfern is too long etc. While clients emphasized the primary needs of making system more appealing, making it hassle free, giving information prior to enrollment along with few secondary needs.

In a whole, Client and user interviews yield twenty-three need statements, and were refined and simplified into 14 metrics, the details of which will be shown in Table 2.

4.2. Measure

The purpose of measure phase is to thoroughly understand the current state of the RHC health insurance information system [4]. The first measurement is the process being able to quantify customer satisfaction for current system. The second measurement identifies which factors produce user complaints. This study conducted rate survey (Rate on a scale of 1 to 5) of metrics established in define phase.

From Table 2, it can be proven that the current system does not perform well on almost all metrics, especially on providing organized information prior to enrollment and information understandable for all people. Most of metrics received a value around 3.0 out of 5.0 and all the value was under or equal to 3.5 out of 5.0.

4.3. Analyze

In analysis phase, the main task is to identify the key factors contributing to user satisfaction, which means identifying X's (drivers) that impact a CTQ (critical-to-quality) characteristic. CTQ was interpreted as importance ratings in this case. To figure out the key Xs, importance assessment among users were conducted to further understand the influence of factors. In Table 2, each affecting metrics referred as X was revealed and sorted in descending order. It is obvious that both clients and customers are concerned about cost most, whereas pay less attention to timely response. To verify root causes of the problems, this study continued to clarify the problem through problem decomposition into information that is sent directly to users and information that is sought after by users.

Table 2. Importance Rating of Metrics.

Metric no	Metric	Average Importance Rating (on a scale of 1 to 5)	Current System Average rating (on a scale of 1 to 5)
x1	Cost of Implementation	5	0.00
x2	Maintenance Cost for 1 Month	5	0.00
x3	Amount of information provided prior to enrollment	4.95	2.17
x4	Amount of information present in the system	4.85	3.33
x5	Amount of information in the system that is integrated with information in the C University website	4.85	3.5
x6	Time taken for 10 users to find specified information (stop after 15 mts)	4.78	4min, 20 sec
x7	The system is convenient to access	4.75	3.33
x8	The system provides information upon request	4.35	3.5
x9	The system provides organized information	4.35	2.83
x10	Time taken to read specified information	4.15	5min, 45sec
x11	Informed that the user is covered by insurance	4.1	Yes
x12	Understandable for all people	3.9	2
x13	The system sends customers information in a visually appealing way	3.65	1.67
x14	The system is responsive to users all the time	3.65	3.16

4.4. Improve

In improve phase, concept generation and concept screening were effectively completed in reference to the problem. A final set of seven separate concepts were

generated, combined, refined for each part of decomposition. Concepts for information sent directly to the user: A color-coded email; B text alerts; C mandatory orientation class; D brochure; E Facebook ads; F posters; G video link. Concepts for information sought after by users: A Personalized health info page; B Graduate Assistant; C Virtual agent; D Webpage by level of complexity; E Alphabetical list; F Flash news; G One PDF contains all the information. This study conducted 4 iteration of concept screening to reach the final concepts. During the process, the current system was used as reference for the first iteration of concept screening. Each concept was rated along the selection criteria as being better (+), worse (-), or the same as (0) the reference concept (current system). Then each concept was ranked based on its net score (subtract 'minuses' from 'pluses') and made decisions on whether the concept would be kept, combined, refined, or removed. Selections were made based on net scores, ranks, and the specific selection criteria that each concept did particularly well or poor on. A series of screening iteration for each of these functions was completed and finally arrived at final concepts: Concept AD (Color-coded emails, Brochure) for "Information sent to users" and Concept O (a single PDF) for "Information sought after by users". A sample of 4th iteration for "information sent directly to the user" part is shown in Table 3.

Concept selection was fully completed during improve phase and then the first version of prototypes regarding these concepts were designed. Therefore, this research proposes to move on to control process, in which prototypes will be tested, and refined iteratively until achieve the goals.

Table 3. 4th Iteration of Iteration Concept Screening Matrix: information sent directly to the user.

Selection Criteria	Concepts			
	AD Color coded emails, Brochure	ADE Color -coded emails, Brochure, Facebook Ads	AD' Color coded emails, D' indicates sending brochures in every email	AC'D Color coded emails, C' indicates orientation class with a video shown during the class, Brochure
Team feasibility	0	-	-	-
Ease of implementation	0	0	0	0
Ease of maintenance	0	0	0	0
Cost effectiveness	0	0	0	-
Prior info availability	0	0	0	+
Completeness	0	0	0	0
Understandability	0	0	0	+
Accessibility	0	0	0	0
Attractiveness	0	0	0	0
Organized	0	0	0	0
update alerts	0	+	0	0
Personalized	0	0	0	0
Sum +s	0	1	0	2
Sum 0s	12	10	11	8
Sum -s	0	1	1	2
Net score	0	0	-1	0
Rank	1	1	4	1
Continue?	Yes	No	No	No

4.5. Control

The main goal of this stage is to conduct projects through the establishment of operational standards and guidance documents after defining, measuring, analyzing, and implementing improvements, so that good results can be maintained in the long run. The color-coded email, brochure, and single PDF prototypes were created and tested among our client and users and comments were collected from them for further refinements. New problems were identified and solved to implement continuous improvement, and thus pursue excellence. For example, the users requested better colors and less information to be provided. Regarding the brochure, client wanted the information to be reorganized and asked if terminology definitions could be included at the end. The client liked the format of the single PDF file but wanted links from table of contents to information within the single PDF, whereas the users wanted the section numbers in the table of contents to correspond with the information within the body.

The next step is to set marginal and ideal value for continuous improvement and in this research. For instance, the marginal and ideal values of the metric “time taken for 10 users to find specified information” were set to <2.5 min and <1.5 min, respectively. Up to four iterations of refinement were conducted to meet the values. For each iteration, the content on all our prototypes were revised based on the comments from users. All the three prototypes were shown to our client and tested then. The suggested changes by our client were made immediately. From Table 4, it is obvious that after last iteration, all metrics met the marginal value and 12 out of 14 metrics met the ideal value. Besides, it is also obvious that the current system performed better than current system for all metrics. From Table 4, it is also shown that, compared with before the improvement, the metric value of “Understandable for all people”, “The system sends customer information in a visually appealing way”, “The system provides organized information” and “Amount of information provided prior to enrollment increased significantly.

The template and data during the process will be kept in the form of standardized documents to ensure the continuity of improvement measures and be introduced to conduct more iterations for perfection.

Table 4. Metrics Table with Final Testing Results.

Metric no	Metric	Importance	Marginal value	Ideal value	Current System	Final Products
1	Cost of Implementation	5	< \$50000	< \$40000	0.00	\$0.00
2	Maintenance Cost for 1 Month	5	0*	0*	0.00	\$0.00
3	Amount of information provided prior to enrollment	4.95	> 4	> 4.5	2.17	4.625
4	Amount of information present in the system	4.85	> 3.8	> 4.5	3.33	4.625
5	Amount of information in the system that is integrated with information in the C University website	4.85	> 4	> 4.5	3.5	4.875
6	Time taken for 10 users to find specified information (stop after 15 mts)	4.78	< 2min, 30sec	< 1min, 30sec	2min, 20 sec	45 sec
7	The system is convenient to access	4.75	> 3.8	> 4.5	3.33	4.75
8	The system provides information	4.35	>4	> 4.5	3.5	4.065

	upon request					
9	The system provides organized information	4.35	> 4	> 4.5	2.83	4.75
10	Time taken to read specified information	4.15	< 2min, 30sec	< 1min, 30sec	2min, 45sec	1 min 1 sec
11	Informed that the user is covered by insurance	4.1	Yes	Yes	Yes	Yes
12	Understandable for all people	3.9	> 4	> 4.5	2	4.5
13	The system sends customer information in a visually appealing way	3.65	> 3	> 4	1.67	4.75
14	The system is responsive to users all the time	3.65	> 3.6	> 4.5	3.16	4.94

5. Conclusions

This study aims to present a case study on the implementation of the Six-Sigma DMAIC methodology with the purpose to eliminate users' doubts regarding healthcare information, and thus to reduce the waving out rate of RHC healthcare insurance system in the end [1]. The novelty of this study is to consider the information system as products and to conduct product design and improvement following Six Sigma DMAIC process. The final products were designed successfully and approved by the client and Student Affairs. Comments got from client and users were very positive, indicating that the changes made did make sense to quality improvement. This research will be valuable, and the new products will help improve users' satisfaction of Health Insurance Plan. The fact that all the metrics increased as compared to the current system along with the fact that all metrics met marginally accepted values support this conclusion (Table 4).

However, due to time constraints, this study was not able to work on the insurance website which would have been a more feasible solution for the customer needs identified. In addition, the metric "Understandable for all people" and the metric "The system provides information upon request" did not meet the ideal value finally.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

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