Implementation of Integrated System Six Sigma and Importance Performance Analysis for Quality Improvement of HSDPA Telecommunication Network and Customer Satisfaction

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Abstract

This study focus on quality improvement of High Speed Downlink Packet Access (HSDPA) network in telecommunication industry. The purpose of this study is to improve quality of HSDPA network and customer satisfaction. The research method used in this reaseach is through implementation of Six Sigma DMAIC cycle and Importance Performance Analysis (IPA) as control. From analysis is found that Call Setup Success Rate (CSSR) as Critical to Quality parameter on HSDPA with lowest quality. The result give the average change in CSSR from 98,44% to 99,43% and sigma level from $3,6<\sigma<3,7$ to $\sigma > 4,0$. And the result of IPA measurement show performance score is 3,62 greater than importance score 3,56 that mean the customer is satisfied, so that the improvement was at the same time provide good results on that company.

Keywords
Quality Improvement, Six Sigma, Importance Performance Analysis

1. Introduction

1.1. Background
In the development of the telecommunications industry is very fast and full of competition, pushing each telecommunications businesses to provide the best quality services with the aim of winning the competition. Dynamic changes in the telecommunications market resulting from competition, one of which is the improvement of the quality of competition (Bhargava, Bhardwaj, and Rathore, 2010). In the telecommunications industry by ITU (International Telecommunication Union), the quality of service that is also a KPI (Key Performance Indicator) can be divided into accessibility, retainability, and integrity. Accessibility is the ability of users to obtain the services according to the service provided by the network provider, represented by the CSSR (Call Setup Success Rate). Retainability is the ability of user and network systems to maintain service after the service successfully obtained until the time service was terminated by the user, represented by CCSR (Call Completion Success Rate). Integrity is the ability of user and network systems in order to maintain the integrity of network services are not interrupted when user mobility, represented by SHO (Soft Hand Over).

1.2. Problem Formulation
Decline in the quality of service in HSDPA Telecommunications network through the data indicated that decreased network performance and customer complaint data. This effect lowers customer satisfaction.

1.3. Research Objectives
The study objectives are:

- Improving the quality of telecommunications services in HSDPA networks with methods of Six Sigma approach.
- Evaluating customer satisfaction with the method approach Importance-Performance Analysis (IPA).

2. Theory

2.1. Customer Satisfaction

Customer satisfaction has been transformed into a vocabulary must for any business and non-profit organizations, business consulting, marketing research, and business executives. Therefore it is only by understanding the process and the customer, then the organization can realize and appreciate the meaning of quality.

2.2. Customer Satisfaction Measurement

According to Hill, Brielley and McDouglas (1999) in Tjiptono (2011), customer satisfaction is a measure of the performance of 'total product' an organization rather than a set of customer needs. Customer satisfaction is not an absolute concept, but relative or depending on what the customer expects. Operationalization of customer satisfaction measurement can make use of a number of factors, such as expectations, the level of interest (importance), performance, and ideal factors. Nevertheless one of the customer satisfaction measurement technique most widely used is the "importance-performance analysis" (Martilla & James, 1977), which uses performance ratings and importance ratings.

2.3. Telecommunication Service Quality

In the telecommunications industry by ITU (International Telecommunication Union), the quality of service that is also a KPI (Key Performance Indicator) can be divided into accessibility, retainability, and integrity. Accessibility is the ability of users to obtain the services according to the service provided by the network provider, represented by the CSSR (Call Setup Success Rate). Retainability is the ability of user and network systems to maintain service after the service successfully obtained until the time service was terminated by the user, represented by CCSR (Call Completion Success Rate). Integrity is the ability of user and network systems in order to maintain the integrity of network services are not interrupted when user mobility, represented by SHO (Soft Hand Over).
Minimum quality to be achieved is the accessibility of 99% minimum CSSR, CCSR minimum retainability of 99.5%, and the minimum SHO integrity of 99.95%. As well as closing the achievement of 100% ticket complaint.

2.4. Six Sigma

Six sigma is a quantity (metric) which we can translate as a measurement process using statistical tools-tools and techniques to reduce defects to no more than 3.4 DPMO (Defect per milllion Opportunities) or 99.99966 percent focused to achieve customer satisfaction. Six Sigma is a disciplined approach that is based on five stages, namely Define, Measure, Analyze, Improve, and Control (Hargrove and Burge, 2002). According to Woodard (2005), Six Sigma is a program that uses analytics to achieve defect-free process and to reduce variation. William (2006), Six Sigma is a methodology called DMAIC problem-solving, where DMAIC is a set of tools used to identify, analyze, and eliminate sources of variation in a process. Six Sigma to rectify the problem that occurred with a focus on the factors that cause the problem. Six Sigma is a business strategy which also supplied equipment to improve the ability of a business process (Yang, 2005).

2.5. Importance Performance Analysis

Importance-Performance Analysis (IPA) is a descriptive qualitative-quantitative methods in analyzing research data to answer the problem formulation regarding the extent to which indicates the level of customer satisfaction on the performance of a company. Analysis of the level of interest and occupant satisfaction can result in a Cartesian diagram to show the location of the factors or elements are considered to affect occupant satisfaction, which in the Cartesian diagram factors will be described in four quadrants.

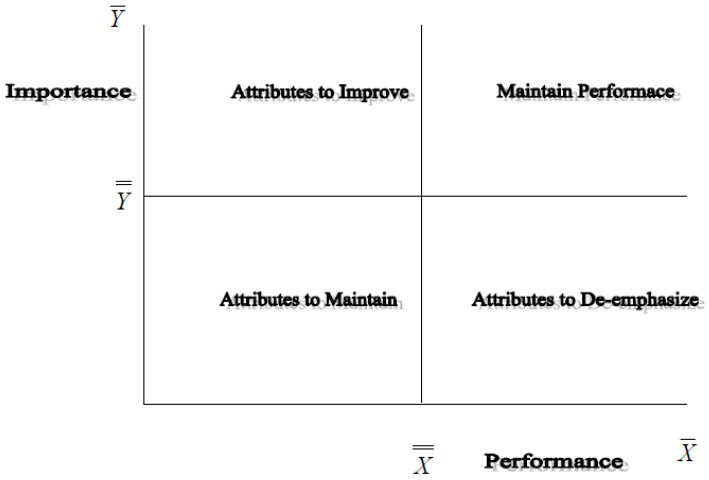

Figure 2.1: Importance-Performance Analysis Diagram

According J.Supranto (1997), the horizontal axis (X) in a Cartesian diagram contains the average satisfaction score (performance), while the vertical axis (Y) contains the value of the average score of importance (importance), which is described as follows:

According to Hill, Brierly & MacDougall (1999) in 2011 Tjiptono, customer satisfaction is a measure of an organization's performance compared to total product range of customer needs. Customer satisfaction is not an absolute concept, but relative or depending on what the customer expects.

2.6. High Speed Downlink Packet Access

The development of mobile communication technology evolved from 2G towards 3G has created a communication system that is not only for voice communication but also for data, text, images, and video. Communication world moving towards high-speed data communication. Hence the third generation UMTS technology (Universal Mobile Telecommunication System) with WCDMA networks possess the concept of presenting the data transfer speed of up to 2 Mbps in indoor coverage, 384 Kbps data transfer in industrial areas, and 144 Kbps data transfer on the state moves, even the speed of the data can be up to 10 Mbps with HSDPA technology implementing the WCDMA network. Here is a picture of the position of HSDPA is an evolution of the GSM.

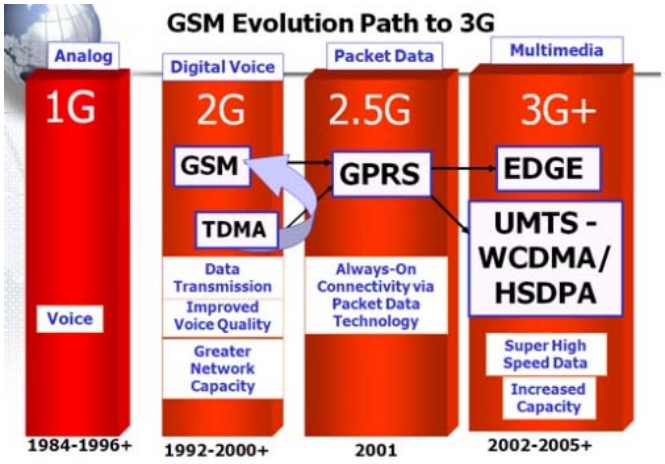

Figure 2.2: HSDPA Evolution

With so many advantages, HSDPA technology has a tremendous opportunity to be implemented to meet the high-speed data access services through wireless. HSDPA is an evolution of WCDMA Release 5, is compatible with release 99 which incidentally is the GSM evolutionary path. On the other hand, with an architecture similar to facilitate the deployment of 3G network HSDPA in UMTS dual-band GSM. HSDPA implementations do not

change the elements around the existing WCDMA networks. Several vendors have provided a Node B in the market that supports HSDPA only by improving the ability of software, the addition of hardware modules and adjustments core network elements. This will reduce the amount of investment HSDPA.

3. METHODS

The research method uses the concept of the Six Sigma DMAIC. DMAIC concept is the concept of closed-loop where the output of each stage will be the input for the next stage. Stages of the DMAIC concept which includes the step of:

3.1 Phase Define

Define phase is the first stage in the six sigma methodology. This phase has the function to identify the process or product quality will be improved. The main components in the define phase is the translation of the customer's voice is associated with quality components in a process. Component quality is what will be a major concern, measured, analyzed and corrected later.
Tools that can be used include:

- Project charter
  Project charter is a statement of purpose scope, and participants in a project. The project charter includes roles and responsibilities, project objectives, identify stakeholders key stakeholders, and define the authority of the project manager. Case The authority serves as a reference for future projects.
- Critical to Quality (CTQ)
  Critical to Quality (CTQ) attributes are highly important to note because it relates directly to the customer's needs and satisfaction. CTQ is an element of a product, process, or practices that have a direct impact on customer satisfaction.

3.2 Phase Measure

Function at this stage to measure the current level of performance. This stage function validate or refine the problem and begin to examine the roots of the problemto analyze targets. Before measuring the level of performance masurement system is necessary to ensure that is done. by doing analysis of the measurement system, we can know the variations that occur whether derived from measurement error or due to product variation.
Tools that can be used include:

- FMEA (Failure Mode and Effect Analysis)

Another way to determine the significant few opportunities are with FMEA, especially if we do not have enough data to make a Pareto diagram. The use of FMEA in the beginning is in the safety or reliability of industrial maintenance, but later widely used in various processes. From the results of FMEA, priority will be given to the component refinement which has a priority level (RPN) highest.

3.3 Phase Analyze

In the analysis stage, a stage of looking for and determine the root cause of a problem. The problems that arise are sometimes so complex that it makes us confused which one will be completed.
At this stage of the tools that can be used:

- Cause and effect diagram or fishbone diagram

Causal diagram is used to identify problems and find the root cause of quality problems.

3.4 Phase Improve

Improve phase has the objective to find solutions to be implemented with the aim of creating an improvement. The selected solution is an action that can eliminate the source of the problem, reduce unwanted variation in a process, and can prevent the same source of the problem appears again.

3.5 Phase Control

Stages to determine the achievable control standards to maintain the performance measurement results and to correct problems as needed, including problems in the measurement system. At this stage the tool used is the run chart, and the integration method Perforamnce Importance Analysis (IPA).

4. Results

4.1. Phase Define

Define phase is the first stage in the implementation of six sigma methodology. In this phase, the author defines some important terms that describe conditions or problems that will be the object of research.

4.1.1. Team Charter

Creating a team charter is a very important thing in the define phase as it aims to establish and validate the team charter. Here are a charter team in research quality improvement HSDPA PT. Telkomsel.

4.1.2. Voice of the Customer

Voice of the customer is an essential part of the work process was observed. In this case, the voice of the customer in question is a customer complaint. The data obtained from both direct customers through direct care workers or by phone. Then the data is processed on a web-based application that is Remedy Helpdesk System, then automatically distributed to the relevant information to be analyzed.

4.1.3. HSDPA Network Performance

HSDPA network performance is an important part in the work process was observed. HSDPA network performance obtained from the data processing on the server automatically NMS (Network Management Service), which routinely produces data 24 hours a day. Here is a brief description of the NMS server as a data center performance measurement:

4.2 Phase Measure

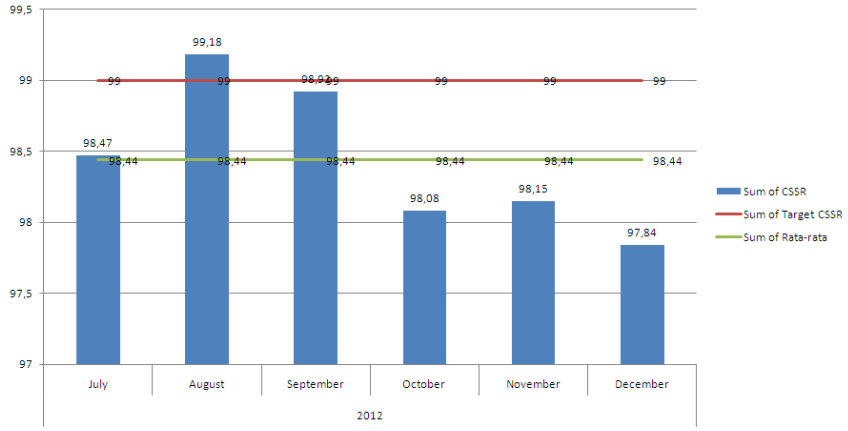

Figure 4.1: Monthly chart CSSR in july-December 2012

4.2.1. HSDPA Network Performance Measurement

From the graph above shows the three parameters to be Critical to Quality is CSSR, because performance dropped since October, compared with SR SHO CCSR and no increase in the next month. Therefore, the research will be prioritized on increasing performance CSSR. The following table shows the data description of the CSSR:

Table 4.1:Data description CSSR

Month	CSSR (%)	CSSR Attempt	CSSR Success	CSSR Fail
July	98,47	49218594	48465815	752779
August	99,18	39493840	39170189	323651
September	98,92	43022095	42557493	464602
October	98,08	28467376	27920335	547041
November	98,15	26413531	25924746	488785
December	97,84	26836724	26256816	579908

From the above table can be determined the value of DPMO its value is known that defects in the 5th column, while potential CTQ in column 3. DPMO is calculated by the equation:

$$DPMO = \frac{number\ of\ Defect}{\text{CTQ repaired unit of potential}*\text{CTQ potencisl}}*1000000 \qquad (4.1)$$

Take a sample of DPMO in July 2012, is known from table 3.1 the number of defects = CSSR Fail = 752 779, CTQ potential = opportunity = CSSR attempt = 49,218,594, an improved unit = 1. DPMO will be obtained using equation (1) as follows:

$$DPMO = \frac{752779}{1*49218594}*1000000 = 15295,$$

So also next month onwards for DPMO in the same way, so the DPMO obtained as in the following table:

Table 4.2: Descripton of data CSSR and DPMO

Month	CSSR (%)	CSSR Attempt	CSSR Success	CSSR Fail	DPMO
July	98,47	49218594	48465815	752779	15295
August	99,18	39493840	39170189	323651	8195
September	98,92	43022095	42557493	464602	10799
October	98,08	28467376	27920335	547041	19216
November	98,15	26413531	25924746	488785	18505
December	97,84	26836724	26256816	579908	21609
Rata-rata	**98,44**	**35575360,10**	**35049232,40**	**526127,70**	**15603,17**

4.2.2. Measurement Process Capability

Process capability analysis is used to determine whether the ongoing work process meets established specifications. The process is called capable if it is capable of producing nearly 100% output in accordance with established specifications. According to the table koversi Sigma The Six Sigma Performance Handbook by Praveen Gupta Cpk values obtained from HSDPA network performance as follows:

Table 4.3: Description of data CSSR, DPMO, Sigma, dan Cpk

Month	CSSR (%)	CSSR Attempt	CSSR Success	CSSR Fail	DPMO	Sigma	C_{pk}	DPMO Target	Sigma Target	C_{pk} Target
July	98,47	49218594	48465815	752779	15295	$3,6<\sigma<3,7$	$1,20<C_{pk}<1,23$	10000	$3,8<\sigma<3,9$	$1,27<C_{pk}<1,30$
August	99,18	39493840	39170189	323651	8195	$3,9<\sigma<4,0$	$1,30<C_{pk}<1,33$	10000	$3,8<\sigma<3,9$	$1,27<C_{pk}<1,30$
September	98,92	43022095	42557493	464602	10799	$3,7<\sigma<3,8$	$1,23<C_{pk}<1,27$	10000	$3,8<\sigma<3,9$	$1,27<C_{pk}<1,30$
October	98,08	28467376	27920335	547041	19216	$3,5<\sigma<3,6$	$1,17<C_{pk}<1,20$	10000	$3,8<\sigma<3,9$	$1,27<C_{pk}<1,30$
November	98,15	26413531	25924746	488785	18505	$3,5<\sigma<3,6$	$1,17<C_{pk}<1,20$	10000	$3,8<\sigma<3,9$	$1,27<C_{pk}<1,30$
December	97,84	26836724	26256816	579908	21609	$3,5<\sigma<3,6$	$1,17<C_{pk}<1,20$	10000	$3,8<\sigma<3,9$	$1,27<C_{pk}<1,30$

4.2.3. Cause and Effect Diagram / Fish Bone

Causal diagrams are useful for analyzing and finding factors that significantly influence in determining the performance characteristics of HSDPA. In addition, to find the real causes of a problem.

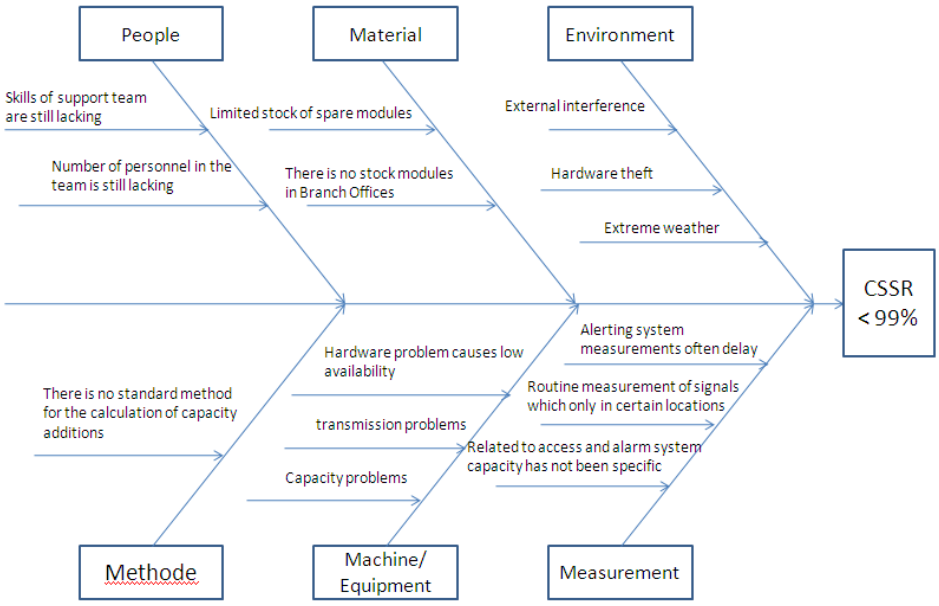

Figure 4.2: Causal diagram

5. DISCUSSION

5.1. Phase Analyze

To identify the root cause of Network Performance HSDPA used FMEA. FMEA is used to examine the failure of a potential product or process, evaluate the risk priority, and help determine the appropriate action to avoid the problems that have been identified based on causal diagram / fish bone that previously made. Here is a table of FMEA are made through the brainstorming process with the competent parties:

1	2	3	4	5	6	7	8	9
Product characteristics expected	Mode of Failure	Cause of Failure	Effect of Failure	Frequency of Occurrence (1-10)	Degree of Severity (1-10)	Chance of Detection (1-10)	Risk of Priority (1-1000) 5x6x7	Rank
CSSR HSDPA performance above the threshold of 99%	External interference	signal illegal	quality of access is interrupted	6	7	6	252	11
	Hardware theft	less maintenance intensive	reduced capacity	8	9	7	504	1
	Extreme weather	erratic weather	faulty devices	6	8	7	336	7
	Limited stock of spare modules	only certain modules in stock	it took a long time to repair	6	5	5	150	13
	There is no stock modules in Branch office	stok modul ada di gudang kantor pusat	it took a long time to repair	6	5	5	150	14
	Skils of support team are still lacking	inexperience	it took a long time to repair	8	8	6	384	4
	Number of personnel in the team is still lacking	calculation of the ratio of personnel in an area not to be implemented yet	problem when a lot of disruption	9	7	6	378	5
	Alerting system measurements often delay	capacity of the server is overloaded	handling the problem so late	6	6	6	216	12
	Routine mesurement of signals which only in certain locations	limitations of measuring instruments	can not monitor the signal at another location	9	6	5	270	10
	Alarm system related to access and capacity has not been specific	limitations script software vendor	difficulty in analyzing	7	7	6	294	9
	Hardware problem	reliability of the device is already declining	quality of access is interrupted	8	10	6	480	3
	Transmission problem	adverse weather: heavy rain, lightning	quality of access is interrupted	7	8	6	336	6
	Capacity problem	the limited capacity of the device	quality of access is interrupted	9	9	6	486	2
	There is no standard method for the calculation of capacity additions	reference between vendors is different	less effective	8	8	5	320	8

Table 5.1: FMEA of CSSR HSDPA performance

From the table above FMEA generated several failure modes that have a high risk values are:

- Rank 1, RPN 504
  Theft module that often occurs causing a reduced number of device capacity, so it will directly interfere with service to the customer.
- Rank 2, RPN 486
  Capacity of the device causing the problem directly to the customer service is disrupted, especially at peak hours, weekends, and public holidays.
- Rank 3, RPN 480
  Hardware problem generally occurs due to the reliability of the device began to decline in line with the life time of the device. But there are also specific things that make hardware becomes damaged or not working properly ie room temperature factors (related air condisioning), air flow (related to the fan).

5.2. Phase Improve

5.2.1. Repair hardware theft problem

Respect the rampant theft of hardware at BTS Telkomsel, then do preventive measures as follows:

- Created 24 hour guard and routine patrol in the area prone to theft
- Created at the critical severity external theft alarm system on hardware

After the repair, the result is a device safe from theft. For the future will diberlakuakan also in all locations to ensure the safety of the device, so it will not interfere with service to customer.

5.2.2. Repair capacity issues

Repair capacity issues do the following steps:

- Increasing the number of sectors in eksisiting BTS antenna / node B
- The addition of the BTS / Node B new
- Improvement coverage or normalization coverage

After the repair, the result is a significant increase in the CSSR. The results are the average exceeds a predefined target.

5.2.3. Repair hardware problems

Hardware problem, as already mentioned above is generally because the life time of the device, so the process of diagnosing routinely need for early detection of the things that could potentially be a problem.

In addition to the diagnosis process, which needs to be considered is the environmental conditions such as temperature, smooth air flow, leaks, etc., so that the reliability of the device performance more stable and secure.

5.2.4. Measurement results of improvement

Data measurements taken after repairs from January to May 31, 2013. The data is taken accessibility HSDPA performance is CSSR.

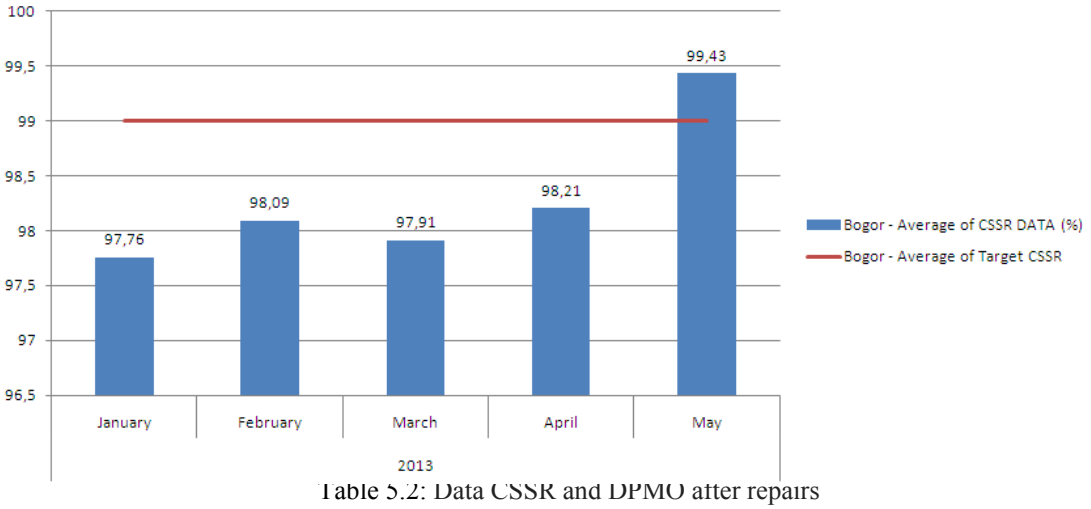

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Table 5.2: Data CSSR and DPMO after repairs

Month	CSSR (%)	CSSR Attempt	CSSR Success	CSSR Fail	DPMO	DPMO Target
January	97,76	24702743	24149402	553341	22400	10000
February	98,09	19649955	19274641	375314	19100	10000
March	97,91	15217888	14899834	318054	20900	10000
April	98,21	9113910	8950771	163139	17900	10000
May	99,43	7989356	7943817	45539	5700	10000

From table 5.2. above shows that the improvement occurred in the month of May where the DPMO reach 5700 target (10000). Likewise if converted again the importance of the dg Sigma Sigma table above 4.0, and Cpk over 1.33.

5.3. Phase Control

In the control phase was also conducted monitoring of customer satisfaction is the method of approach Importance Performance Analysis (IPA), which conducted the survey directly to the customer to determine the customer's user experience. The study population was Telkomsel customers who never file a complaint related to HSDPA data access problems in Bogor. The reason is that the control is effective, in order to precisely target what has been done before repairs can be directly perceived customer. The number of customers there are 22 people. The survey was conducted via telephone. The following questions were posed to pertanyaam customers Linkert scale with response options ranging from 1 (not very important / satisfied) to 4 (very important / satisfied):

- Ease of internet access
- Ease of access calls
- Quality of data upload and download speeds
- Quality of coverage / strong signals
- Quality sound clarity

Following the calculation of importance and performance of each customer survey results:

Table 5.3: Data processing IPA

		Ease of internet access	Ease of access calls	Quality of data upload and download speeds	Quality of coverage / strong signal	Quality sound clarity	Ease of internet access	Ease of access calls	Quality of data upload and download speeds	Quality of coverage / strong signal	Quality sound clarity
NO	MSISDN	IMPORTANCE					PERFORMANCE				
1	85312236xxx	3	4	3	4	4	4	4	3	4	4
2	8121397xxx	3	3	4	4	4	3	4	4	4	4
3	81385214xxxx	4	3	4	4	4	4	3	4	4	4
4	82375405xxx	3	3	4	4	4	3	3	4	4	4
5	82125306xxx	3	4	4	3	3	3	4	4	3	3
6	81216829xxx	4	3	3	3	3	4	3	3	3	3
7	8111800xxx	3	4	3	4	4	3	4	3	4	4
8	81210245xxx	3	3	4	4	4	3	4	4	4	4
9	8111107xxx	4	4	3	4	4	4	4	4	4	4
10	81215304xxx	3	4	3	4	3	3	4	3	4	3
11	82110743xxx	3	4	3	4	4	3	4	4	4	4
12	82111840xxx	3	3	4	4	4	4	3	4	4	4
13	81212039xxx	4	3	4	4	4	4	3	4	4	4
14	8111621xxx	3	3	4	4	4	3	3	4	4	4
15	81212191xxx	3	4	4	3	3	3	4	4	3	3
16	8121397xxx	4	3	3	3	3	4	3	3	3	4
17	8111120xxx	3	4	3	4	4	3	4	3	3	4
18	8111119xxx	3	3	4	4	4	3	3	4	4	4
19	81219385xxx	4	4	3	4	4	4	4	3	4	4
20	811940xxx	3	4	3	4	3	3	4	3	4	3
21	81319131xxx	4	3	4	4	3	4	3	4	4	3
22	8111187xxx	3	4	4	4	3	3	4	4	4	3
	Rata-rata:	3,32	3,50	3,55	3,82	3,64	3,41	3,59	3,64	3,77	3,68

Table 5.4 shows the calculation of the average per-item questionnaire that summarized the importance and performance scores.

6. Conclusion

1. HSDPA telecommunications network quality parameters on the object of this study, which is critical to quality (CTQ) is accessibility (CSSR) because the value of the average percentage is 98.44% below the target of 99%.
2. Implementation of Six Sigma to improve the quality of telecommunication networks HSDPA in particular:
   a. Accessibility (CSSR) increased from 98.44% to 99.43%.

b. DPMO improved from 15603.17 to 5700.
c. Sigma increase of 3.6 <σ <3.7 to σ> 4.0.
d. Cpk increased from 1.2 <Cpk <1.23 a Cpk> 1.33.

3. Implementation Importance Performance Analysis shows customers are satisfied with the performance value of 3.62 exceeds the interest value of 3.56.

Table 5.4: Score the average per-item importance and performance

No	Item	The average Importance	The average Performance	Gap
X1	Ease of internet access	3,32	3,41	0,09
X2	Ease of access calls	3,5	3,59	0,09
X3	Quality of data upload and download speeds	3,55	3,64	0,09
X4	Quality of coverage / strong signal	3,82	3,77	-0,05
X5	Quality sound clarity	3,64	3,68	0,05
	Average :	**3,56**	**3,62**	

7. Advice

Suggestions for further research are preferably added more items than previously studied five things to adjust to the purpose of the study, to be more visible distribution and customer satisfaction results more valid anymore.

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