

CHAPTER VII

CONTROL PHASE

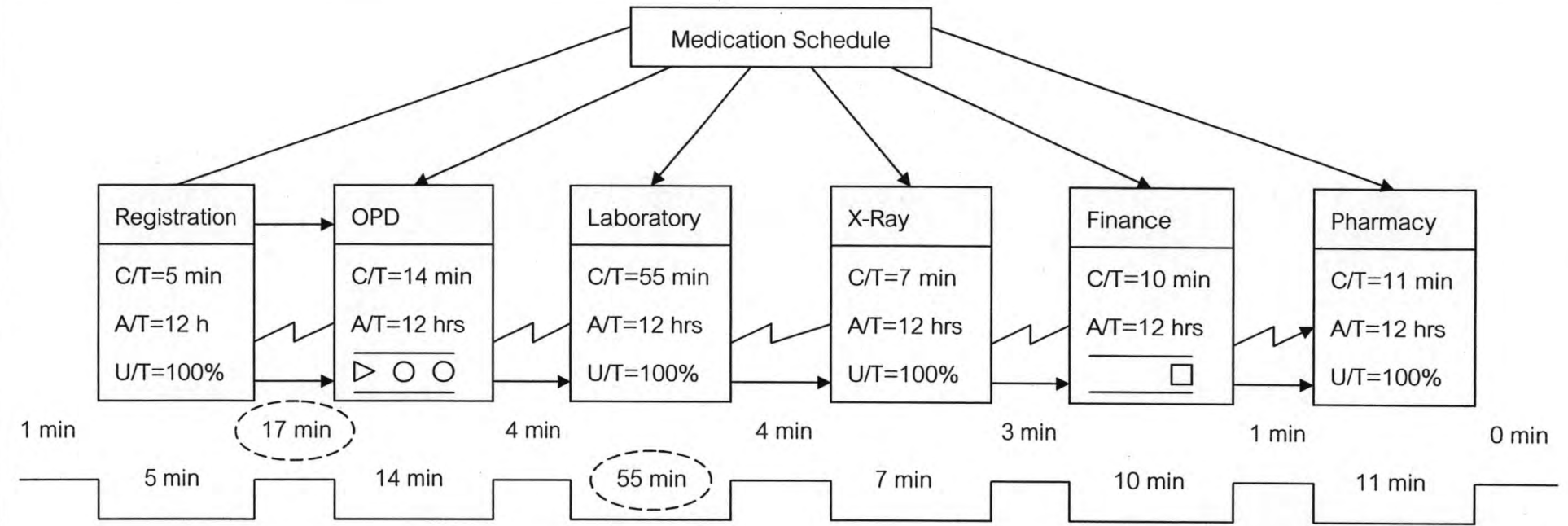
7.1 Service Duration Result

The proposed Medication Appointment Schedule could efficiently eradicate the unnecessary time by reducing unlimited number of patients with the medication service standard time, eliminating same time appointment with the standard time slot and, finally, managing uncontrollable of walk-in customers with the special time gap arrangement. The Waiting Time for OPD function has been enormously decreased from 48 minutes to 17 minutes. Although the new score could not reach 15 minutes as specified in the future state because of medication service variation but, for the improvement results as a whole, the Total Waiting Time has been reduced as low as 30 minutes comfortably.

Moreover, the power of one-piece-flow concept can be introduced by the Semi Operation where the Cycle Time has been shortened suddenly after applying the serum individually, together with, the mitigation of responsibilities redundancy through the philosophy called "put the right man into the right job". The contribution of Cycle Time improvement for Laboratory function which has been inclusively decreased from 81 minutes to 55 minutes, better than 60 minutes as specified in the future state, generates positive effect to the reduction of Total Cycle Time from 130 minutes to 102 minutes as certain.

All in all, the Value Stream Mapping for Current Stage which has been effectively improved through multiple productivity approaches of Lean Six Sigma concept can be described as the following figure. Total Waiting Time has been enormously decreased by the Proposed Medication Appointment Schedule at OPD while Total Cycle Time has been definitely reduced by Design of Experiment at Laboratory so that the overall medical service duration is now leveraged from 195 minutes to 132 minutes. The process capability of service duration which has been shown in the prior state must be calculated to certify the sustainability of improvement as well.

VSM Status	Value Stream	Project Manager	Team
Current State (After)	Medical Service	Peerapatana K.	Pattana Medical Center improvement team



Registration		OPD		Laboratory		X-Ray		Finance		Pharmacy		Overall Service Duration		
W/T	C/T	W/T	C/T	W/T	C/T	W/T	C/T	W/T	C/T	W/T	C/T	Total W/T	Total C/T	Overall
1 min	5 min	17 min	14 min	4 min	55 min	4 min	7 min	3 min	10 min	1 min	11 min	30 min	102 min	132 min

Figure 7.1: Improved Value Stream Mapping for Current State

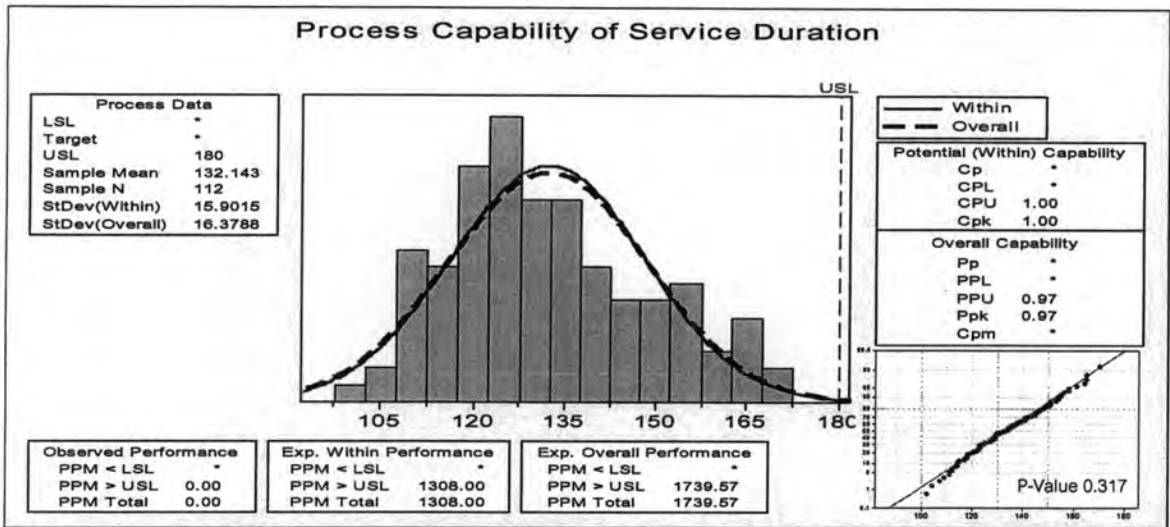


Figure 7.2: Process Capability of Service Duration after Improvement

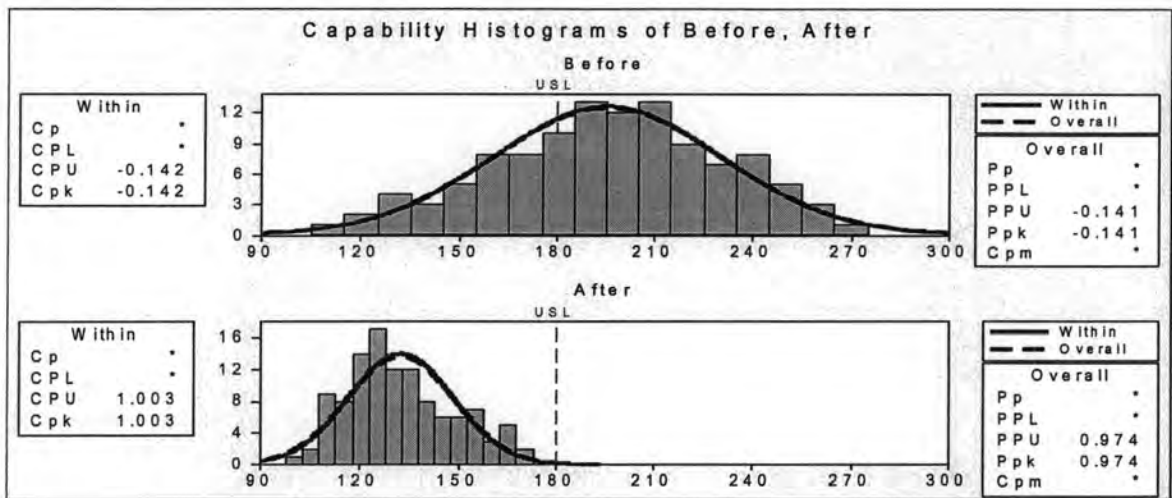


Figure 7.3: Comparison of Process Capability of Service Duration

The prior figure definitely performs the service durations whose the schedule has been set for the second week of the month, as same as in the prior stage, to gather the data from regular clinic conditions. P-Value of 0.317 illustrates that the data are normal distributed. After improvements, customers could shorten their time in the clinic from 195.13 minutes to 132.14 minutes in average with the a half cut standard deviation form 35.38 minutes to 15.90 minutes. More important, the process capability index, C_{pk} , has been significantly improved from -0.142 to +1.003; therefore, it could be implied that PMC process performance is now aligned with what customers want and the former huge gap between expectation and perception of Service Quality has been fulfilled through the improvement perfectly.

Hypothesis Test method which is one of the powerful productivity tools in Lean Six Sigma approach has been intentionally implemented to ensure that the medical service duration is now being improved consistently. T-Test between two groups of data called 2 Sample T-Test will be complementarily used to prove the Alternative Hypothesis whether the Mean of service duration before improvement is greater than the period after improvement or not and at what level. Below figure clearly illustrates that P-Value of the test is less than 0.05 (0.031) which means that, with 95% of confidence level, the Alternative Hypothesis will be accepted. The service duration of PMC, therefore, has been significantly improved from the prior stage for 56 minutes at most.

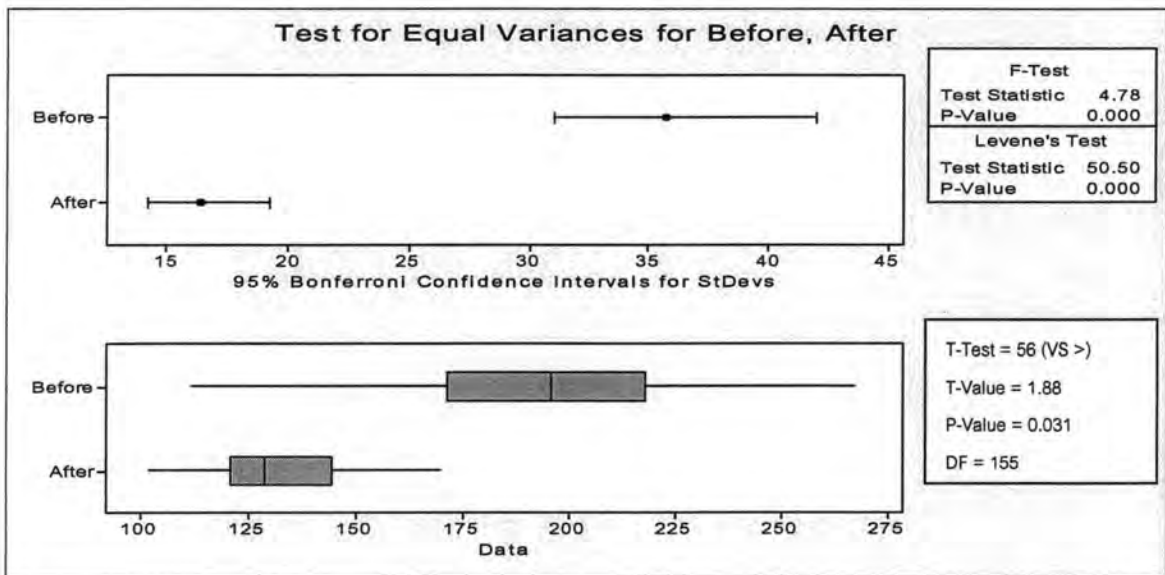


Figure 7.4: Test for Equal Variances of Service Duration

In the same time, the analysis of variances or F-Test will be carefully implemented to ensure that not only the Mean of service duration has been improved through the initiated solutions but also the Standard Deviation of the medical service process as well. Above figure reinforces the improvement assumption through the Alternative Hypothesis which has been specify that Variance before improvement is not equal to the one after improvement. With 95% of confidence level, P-Value of the test is under 0.05 so that the variance after improvement is reduced considerably. All in all, both of Hypothesis Tests could be concluded that the proposed solutions which have been carefully formulated through the approach of Lean Six Sigma could improve the service duration of PMC significantly.

Regarding to the primary concern that the patients who could not make appointments with the doctors will switch from the proposed appointing system to admit as the walk-in customers, the fraction of different customer segments will be considered as one of the key measures for negative sign. The proportion for different segments of customers, appointed and walk-in patients, before initiating process improvement is about 65 and 35 respectively. About 35.30% (7,527 persons) has been typically set as the baseline information for the average numbers of patients who come to the clinic without making any appointments. This prior walk-in fraction must be compared with the number after improvement to ensure that by implementing all of the proposed solutions, there is no critical uncertainty.

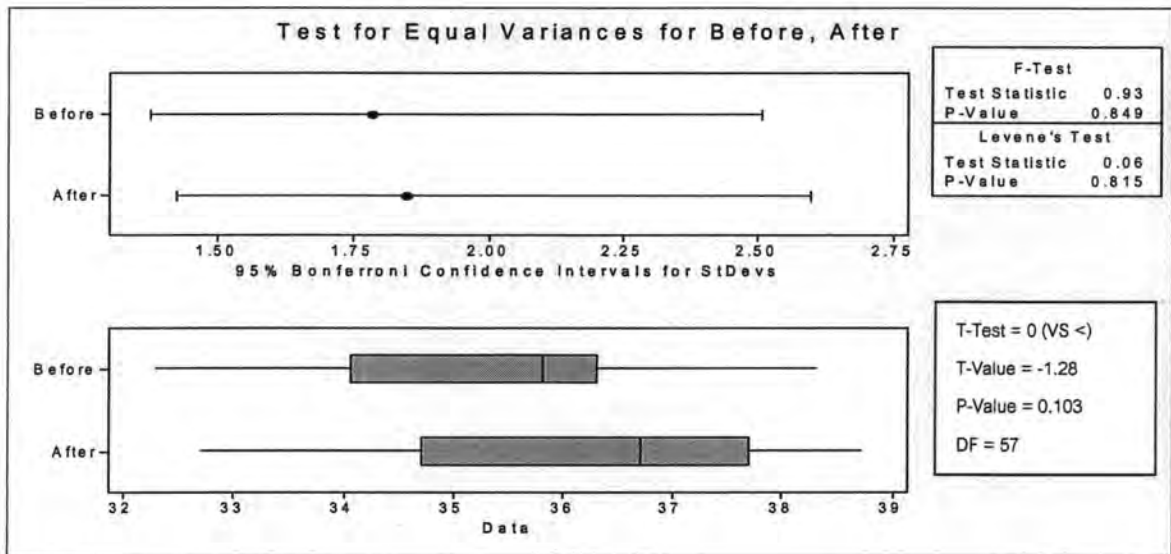


Figure 7.5: Comparison of Walk-in Customer Proportion

Above figure illustrates Hypothesis test for the fraction of walk-in customers between before and after improvement. 2 Sample T-Test has been used to prove whether the average percentiles of walk-in customers after improvement are more than the prior stage or not. The P-Value of 0.103 performs the Alternative Hypothesis rejection which means that, with 95% of confidence, there is no significant different between before and after improvement data. F-Test has been also used to confirm whether the standard deviations between two groups of data are enormously different or not. P-Value of 0.849 completely shows that, with 95% of confidence, there is no significant difference between those of which. The proposed Medication Appointment Schedule, therefore, could be implemented in PMC comfortably.

Regarding to the secondary concern that operating cost would be increased after changing the machine process from Full Operation to Semi Operation where the operators have to start and stop machines more frequent, the Laboratory Expense will be considered as one of the key measures for negative effect. The expense for operating machine, before initiating process improvement is about THB 120,761.21 per month for total of fixed cost and THB 549.45 per patient per month for total of variable cost spent by Laboratory in the prior stage of this research. This expense will be carefully compared with the number after improvement to ensure that by implementing the new methodology for machine operations, there will have no critical matter.

Type of Cost	Description	Before (THB per Month)	After (THB per Month)
Fixed Cost			
- Direct Labor	Full-Time Operator	102,810.27	102,467.06
	Part-Time Operator	17,951.00	17,126.00
	Total Cost	120,761.27	119,593.06
Variable Cost			
- Direct Material	Equipments and Chemicals	1,807,680.20	1,452,333.85
- Overhead	Electricity & Water etc.	542,304.06	435,700.16
	Total Cost	2,349,984.26	1,888,034.01
	No. of Patient	4,277	3,371
	Total Cost per Patient	549.45	560.08

Figure 7.6: Comparison of Laboratory Expense

Before improvement, Laboratory has regularly spent THB 120,761.27 for their Full-Time and Part-Time Operators which is as close as what it typically pays for THB 119,593.06 after improvement; thus, it is almost indifferent for the fixed cost model. On the other hand, the variable cost has been increased from THB 549.45 to THB 560.08 per patient per month after improvement; therefore, with 3,973 as the average number of patients in 2006, the increment of THB 10.63 per patient would increase Laboratory expense as high as THB 42,232.99 per month. Management has considered the projected business impact and concludes that it will be considered as the investment of PMC not only for leveraging the customer satisfaction but also extending their opportunities from the available service time.

7.2 Service Quality Result

The study of Perceived Service Quality must be intentionally conducted again in this stage to realize how effective that overall medication process of PMC has consequently provided to the customers after improvements. The modified SERVQUAL instrument will be in place to recognize the differences between customers' expectation and perception for particular dimensions of service quality. The survey has been typically designed as the Define Stage where the t-value (t) of 1.96 reflects 95% confidence level, the standard deviation (s) of 1.06 will be used as the result of prior survey and the Acceptance Tolerable Error (TE) of 0.2 is used widely for simple random method survey (Hayes 1998). Sample size of at least 108 or 16 sets of questionnaires daily (112 sets for one whole week) must be scheduled.

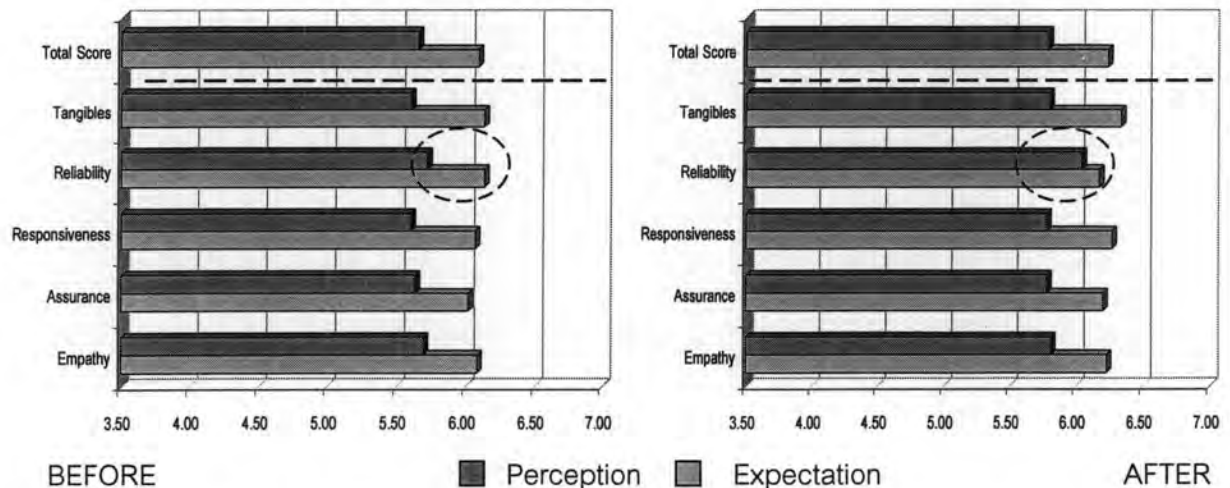


Figure 7.7: Comparison of Scores for Expectation and Perception

Referring to the modified SERVQUAL questionnaires, each statement could implicitly refer to the gaps in particular five dimensions of total service quality; 1 to 5 for Tangibles, 6-10 for Reliability, 11 to 15 for Responsiveness, 16 to 20 for Assurance and 21 to 25 for Empathy. Comparing with the prior survey, the figure for after improvement clearly illustrates that most of scores still locates between 5.5 and 6.5 means that the customers still almost strongly agree for PMC's Service Quality. The Total Score for both of expectation and perception are higher than the past due to the requirements' increasing trend. Although the customer perceptions for all of five dimensions are still lower than their expectations but the Reliability gap has been significantly leveraged through the process of service duration improvements.

By the way, a set of designed questionnaire not only composes of 25 statements of expectations and another 25 statements of perceptions but it also includes another essential part called importance weight ratings. It has been randomly conducted through the interview arranged by PMC during different period of time with the customers who just immediately complete overall medication service process. Although there is no significant difference between particular dimensions of service quality but importance weight in the prior survey shows some interesting information. Reliability dimension is intensively judged by the customers as the highest rate of 0.27 while all of the rest are lower than 0.2. By this reason, the importance weight will play a significant role for the total score definitely.

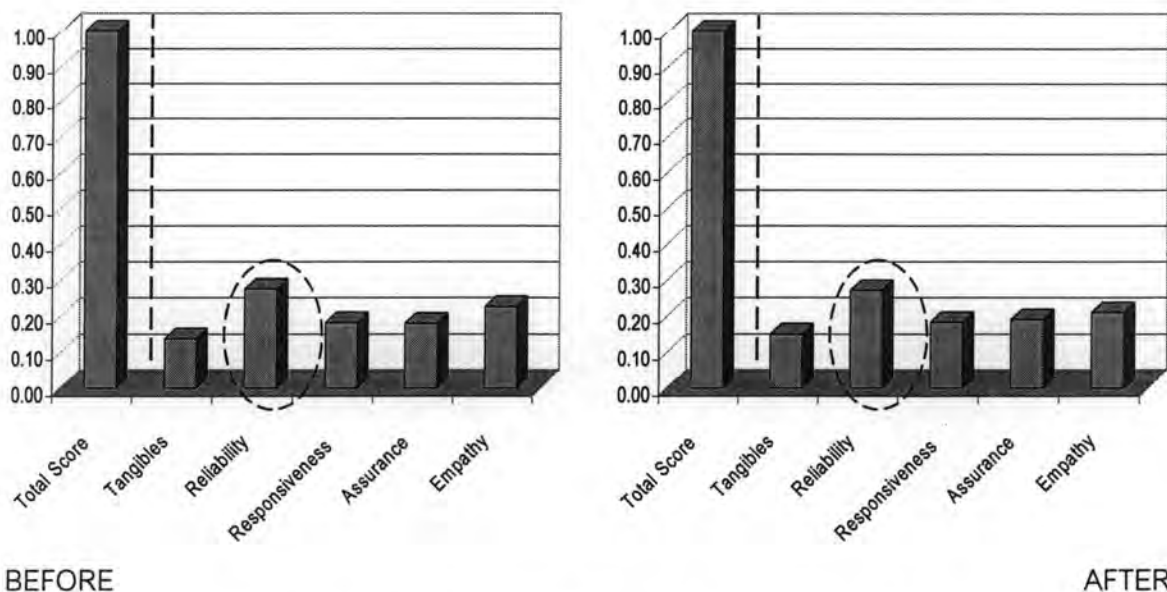


Figure 7.8: Comparison of Scores for Importance Weight

According to the Figure, the weights for particular five dimensions for before and after improvement are 0.14 and 0.15 for Tangibles, 0.27 and 0.27 for Reliability, 0.18 and 0.18 for Responsiveness, 0.18 and 0.19 for Assurance and 0.23 and 0.21 for Empathy. Even though most of the scores are generally changed according to the customer characteristics and service behaviors but the importance weight rating still shows the same implications as same as the prior survey where Reliability has been intensively specified as the most imperative Service Quality dimension. The SERVQUAL score, therefore, will be inclusively directed by the importance weights more than the individual scores for statements of perception and expectation questionnaires.

Considering the SERVQUAL score (gap between perception and expectation) in the prior survey at the thesis starting point, Tangibles, Responsiveness, Assurance and Empathy dimension inclusively perform equally or even higher scores than the Total score of -0.09 except the Reliability which score the lowest as -0.11. In contrast, before multiplying raw scores with the importance weights, every dimension illustrate almost equal differences but, after all, Reliability stands out of the row because its importance weight is as high as 0.27 which more than $\frac{1}{4}$ of the total weight (1.0). It is essential that customers highly pay attention to the reliable outcomes that they perceived from PMC; therefore, Reliability has been selected as the key dimension to improve the organization's performance.

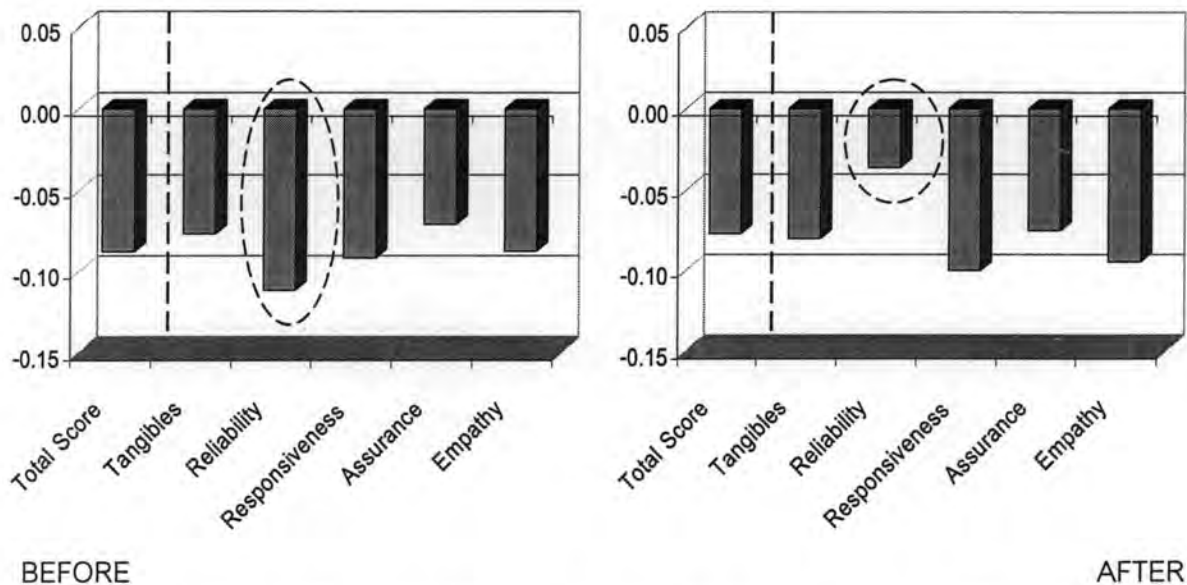


Figure 7.9: Comparison of Scores for Perceived Service Quality

According to the Figure, although the Total Score of modified SERVQUAL instruments for both of before and after improvement has been shown almost the same as -0.09 and -0.08 respectively, but there are different matters between those two graphs. In fact, the SERVQUAL Total Score should be highly increased, together with the Reliability improvement, but the other four dimensions perform lower scores according to the higher importance weights which are not related to the proposed solutions. On the other hand, the Reliability score which has been formerly rated with the highest importance weights has been improved significantly in line with the objectives from -0.11 to -0.04 through the approach of Lean Six Sigma and its effective solutions.

To closely monitor improvement result of the service quality for overall medication process in PMC, each statement which is linked to the Reliability dimension must be particularly considered. Figure of the prior survey clearly illustrate that statement no. 9 is rated as the lowest score of -0.22 while the others are higher than -0.15 so that the primary conclusion is to improve Reliability dimension. In depth, statement no. 9 has been intentionally designed to understand whether an organization provides services at the time they promise or not. Questionnaires let the customers to make comparison between the excellence clinic and PMC. Strong minus score means that PMC's processes could not provide their medical services at the time they promise to deliver or should deliver.

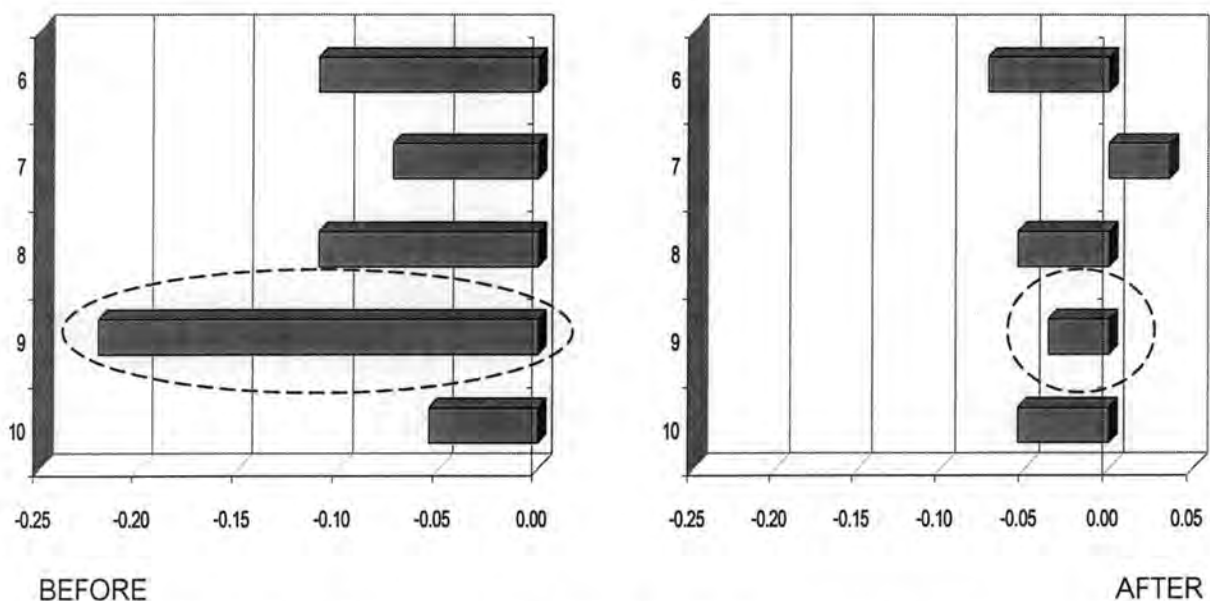


Figure 7.10: Comparison of Scores for Individual Reliability Statements

In contrast, the figure for Service Quality after improvement definitely illustrates the higher score for every individual question which are directly related to the Reliability dimension, especially for statement no. 9. Because question no. 9 asks the customers about how efficient PMC provides services at the time they promise, therefore, the score development from -0.22 to -0.04 reflects the excellent result of service duration improvement perfectly. Moreover, question no. 7 that also focuses how effective PMC shows a sincere interest in solving problems has been highly leveraged from negative to the positive side. This means customers could recognize that what they have suggested has been sincerely interested and exclusively improved by the clinic and It is essential than the improving results.

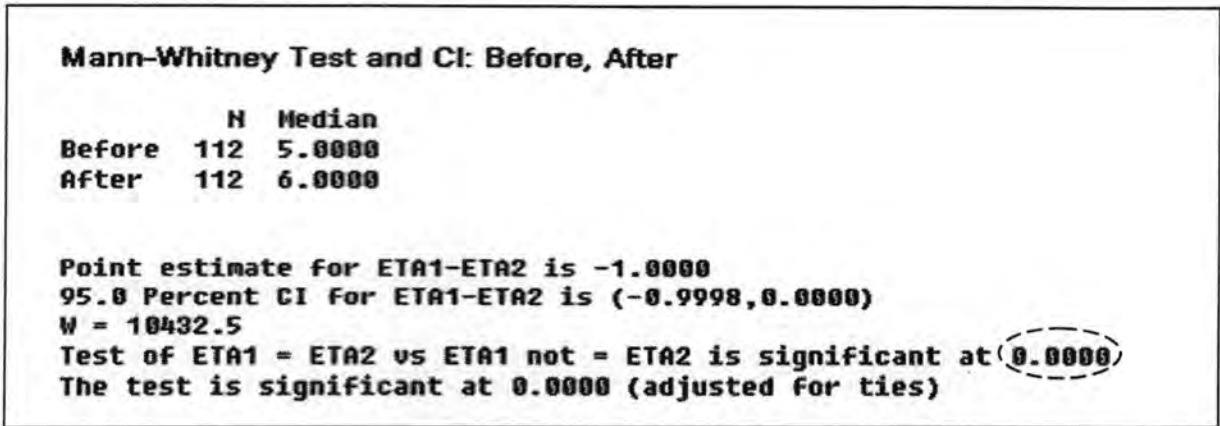
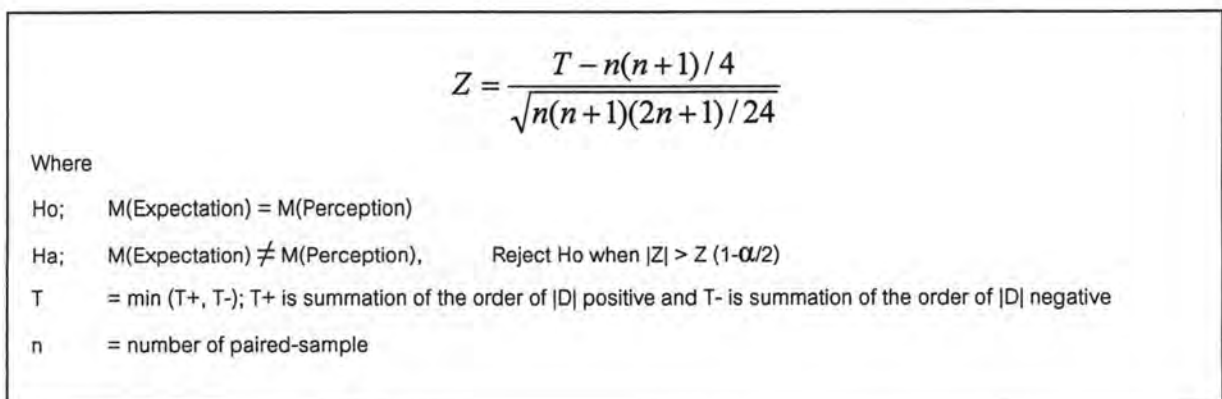


Figure 7.11: Mann-Whitney Test for Perception (Before VS After)

Even though the SERVQUAL scores have been improved enormously but the nonparametric tests will statistically reinforces the results. The first test primarily focuses whether the SERVQUAL scores after improvement is higher than prior scores through the 2-sample rank test called Mann-Whitney test. P-Value of 0.00 in above figure certainly reflects their significant difference so that the satisfaction level perceived by customers in the present is higher than what they received before improvement consistently. Another essential test points to the equality of SERVQUAL scores between customers' expectation and perception after improvement to prove whether the performance gap has been closed. According to below figure, the Wilcoxon Signed Rank Test illustrates that, with T of 0 and n of 112 from the surveyed data, Z value equals to -9.1855 ($|Z|=9.1855$) which higher than $Z(1-\alpha/2)$ of 1.96 with 95% of confidence level; therefore, H_0 will be rejected. The gap between expectation and perception has been existed but its difference is now improved considerably.



Source: Wanichbancha (2003)

Figure 7.12: Wilcoxon Signed Rank Test (Expectation VS Perception)

7.3 Statistical Process Control

In the final section of process improvement methodology, it is important for PMC to verify whether the proposed solutions which have been systematically formulated through the approach of Lean Six Sigma could be leveraged its overall service duration consistently or not. Statistical Process Control (SPC) which is one of the most powerful techniques of Six Sigma will be comfortably implemented for this stage in order to monitor the sustainability of result in a mean time. A Control Chart called Xbar-R Chart will be used to collect the service duration for 5 data per day within 30-day period both for monitoring the process characteristics and validating the solution after improvement.

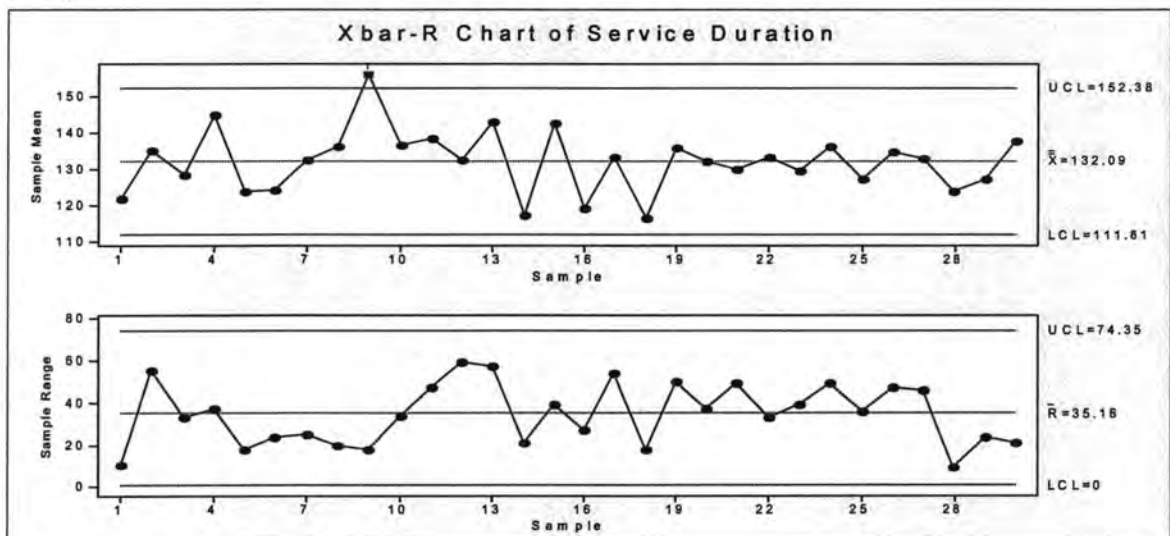


Figure 7.13: Xbar-R Chart of Service Duration

According to above figure, even though the Xbar-R Chart has clearly illustrated that the collected service duration for the subgroup of 5 data in 30-day period is 132.09 minute in average but the data number 9 appears to be Special-Cause Variation which means there is statistical uncertainty for that data. The improvement team has carefully focused on the problem and found out that, on 9th day, the Medical Computer Software was interrupted for many times because the Existing Information System was out of memory so that they has made a decision to initiate Out of Control Action Plan (OCAP) to prevent this error in the future and release that uncertain data out of the Control Chart.

Below figure illustrates the Xbar-R Chart whose the raw data has been intentionally adjusted after releasing the uncertain data called Special-Cause Variation out of the Control Chart. The average service duration which is provided by PMC in 30-day period after the proposed solutions have been implemented in the clinic is 131.26 minute with the solid Control Limit. The graphs that definitely perform the service duration for each subgroup without Out-of-Control data reflect the steady process capability with normal distribution characteristics. It could be implied that the medical service core process of PMC has not been only improved by the proposed solutions through the approach of Lean Six Sigma significantly but also sustained by the employee through the standard operating procedure consistently.

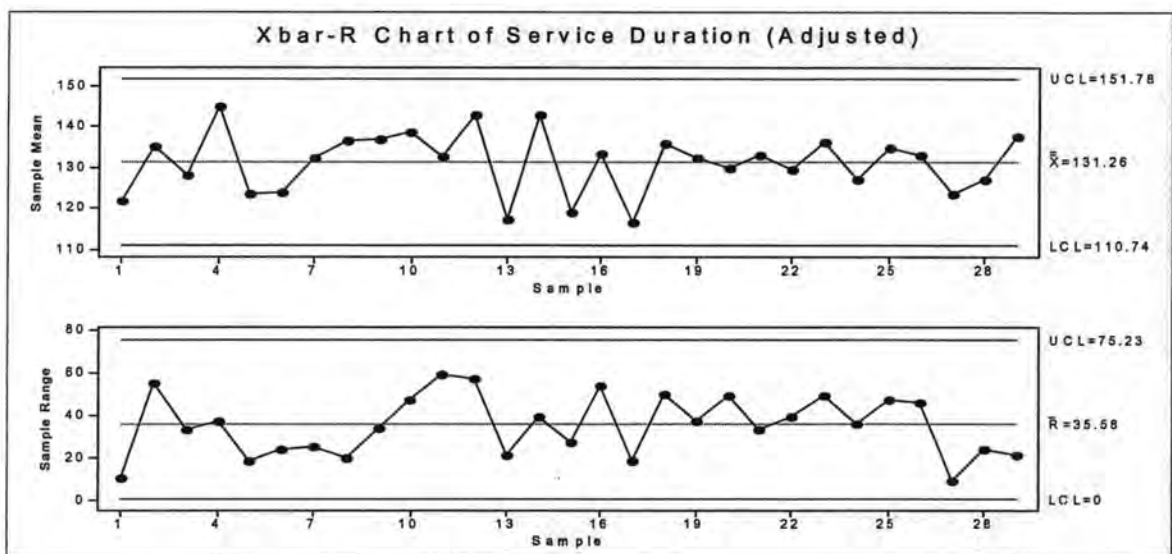


Figure 7.14: Xbar-R Chart of Service Duration (Adjusted)

In addition, the improvement team has also created the succession plan which will specify the period of time to monitor the service duration through the Statistical Process Control within the clinic for every quarter. The plan has been well established by the commitment of management and improvement team not only to investigate the distribution format of service period from Normal Cause Variation but also to identify the uncertain format of service duration from Special Cause Variation as well. All of special distribution will be managed by OCAP and documented as the lesson learned for future prevention while the normal distribution will be closely monitored by team and intensively analyzed in the case that there are trends of uncertainties available.

In order to ensure that the overall medical service duration which has been improved through the approach of Lean Six Sigma will be last long and consistence, the indicator dictionary will be created by the improvement team to monitor the improving results regularly. The Figure clearly illustrate the indicator dictionary that contains all of useful information such Indicator name, Responsible Person, Indicator Definition, Measure Unit, Interpretation, Data Collection Frequency, Indicator Formulation, Source of Data, Data Collector, Specified Target and Baseline Information. It will be a standard guideline for both of implementer and management to monitor the improving progress as well.

Indicator Name	Service Duration		Responsible by	Head of Medical Function	
Indicator Definition					
The duration spent by customer starting from contacting at Registration to finishing at Pharmacy function					
Measure Unit	Minute		Interpretation	Lower is Better	
Data Collection Frequency					
Random sampling 5 data daily at 9:00, 11:00, 13:00, 15:00 and 17:00					
Indicator Formulation					
The time discharging at Pharmacy function minus the time admitting at Registration function					
Source of Data	IT Function		Data Collector	IT Officer	
Target	Baseline	Q1	Q2	Q3	Q4
130	132				

Figure 7.15: Indicator Dictionary for Service Duration

Department	Month/Year	Out-of Control Point	Document No.
Problem Statement	Possible Cause	Preliminary Solution	Action Plan
Prepared by		Approved by	

Figure 7.16 Out of Control Action Plan (OCAP)