

## CHAPTER VI

### IMPROVE PHASE

#### 6.1 Waiting Time Improvement

In order to shorten the Long Waiting Time of Queue Arrangement effectively, the study of key essential factors must be carefully clarified to understand the existing process characteristics and service environments. Unlimited Number of Patient will be the first topic which is needed to be focused for improvement since it directly lead to the heavy traffic, especially, in the rush hour such early morning and after work. The initial cause of this problems points to the medication appointment schedule which allows doctor assistants or information officers make the appointments for patients limitless because they do not recognize the average cycle time of medication service provided by different doctors.

In the mean time, the second key essential factor that increasingly extends a row of patients who will be waiting in front of the doctors' office goes to the Same Duration Appointment. The patients who would like to make appointments with their doctors will generally receive a ticket containing all of necessary information for the next medication service. By the way, although the Appointing Time has been specified in the ticket but it typically shows in duration format as the first come first serve basis, for example 09:00-10:00, so that most of the patients will simultaneously come at 09:00 and contribute the long line of waiting.

The last factor to be considered for Waiting Time improvement at this stage will be the Uncontrollable of Walk-in patients who do not only extend the long line of waiting queue but also interrupt the medication appointment schedule made by the appointed patients. The medication service for walk-in patients have not been regularly specified in the doctor schedule since there is a fluctuation in number of them so that the officers must immediately adjust the schedule at that moment to extend the queue of all patients. Referring to all of above key factors, the concept of Queue Management; therefore, must be in place to efficiently provide the breakthrough solution for these kinds of problems.

Doctor Name	Pornpimol	Doctor Name	Saichol	Doctor Name	Sawanya
Walk-in Patient	Yes	Walk-in Patient	Yes	Walk-in Patient	No
Service Duration	08:00-12:00	Service Duration	08:00-12:00	Service Duration	08:00-12:00
Appointment	Patient Name	Appointment	Patient Name	Appointment	Patient Name
08:00 – 09:00		08:00 – 09:00		08:00 – 09:00	
09:00 – 10:00		09:00 – 10:00		09:00 – 10:00	

Figure 6.1: Existing Medication Appointment Schedule

Doctor Name	Pornpimol	Doctor Name	Saichol	Doctor Name	Sawanya
Walk-in Patient	Yes	Walk-in Patient	Yes	Walk-in Patient	No
Service Duration	08:00-12:00	Service Duration	08:00-12:00	Service Duration	08:00-12:00
Standard Time	10 minutes	Standard Time	20 minutes	Standard Time	10 minutes
Appointed No.	16 person	Appointed No.	8 person	Appointed No.	24 person
Walk-in No.	8 person	Walk-in No.	4 person	Walk-in No.	N/A
Appointment	Patient Name	Appointment	Patient Name	Appointment	Patient Name
08:00 – 08:10		08:00 – 08:20		08:00 – 08:10	
08:10 – 08:20		08:20 – 08:40		08:10 – 08:20	
08:20 – 08:30	Walk-in	08:40 – 09:00	Walk-in	08:20 – 08:30	
08:30 – 08:40		09:00 – 09:20		08:30 – 08:40	
08:40 – 08:50		09:20 – 09:40		08:40 – 08:50	
08:50 – 09:00	Walk-in	09:40 – 10:00	Walk-in	08:50 – 09:00	
09:00 – 09:10		10:00 – 10:20		09:00 – 09:10	
09:10 – 09:20		10:20 – 10:40		09:10 – 09:20	
09:20 – 09:30	Walk-in	10:40 – 11:00	Walk-in	09:20 – 09:30	
09:30 – 09:40		11:00 – 11:20		09:30 – 09:40	
09:40 – 09:50		11:20 – 11:40		09:40 – 09:50	
09:50 – 10:00	Walk-in	11:40 – 12:00	Walk-in	09:50 – 10:00	

Figure 6.2: Proposed Medication Appointment Schedule

New Medication Appointment Schedule, as shown in the prior Figure, will have been exclusively suggested as the strategic solution to improve the service process of PMC. It has been designed according to the concept of queue management to ensure that patients will certainly receive the medication services as fast as possible. The first key factor of unlimited number of patients will be solved through the new design doctor plan which will individually specify the average medication service standard time of doctors and professionals, together with the possible number of patients daily at the top of the schedule. By this way, both of doctor assistants and information officers will always recognize not only for the appropriate number of patients who will be arranged for particular doctors but also the possibilities to arrange walk-in patients in the certain time.

In addition, the average medication service standard time of doctors which will have been applied to limit the number of patients for the prior factor will also be used for mitigating another key factor of Same Time Appointment conveniently. Instead of the old fashion where starts making appointment with the patient in one hour basis such as 09:00-10:00 and 10:00-11:00, the new customized schedule provides customers more comfortable with the medication standard time basis, for example, the schedule for a doctor who properly completes service within 10 minutes will be separated with 6 time slot an hour e.g. 09:00-09:10 and 09:10-09:20. By this way, not only that the customers will not have to come too early as usual but the officers will also easily manage the queue as well.

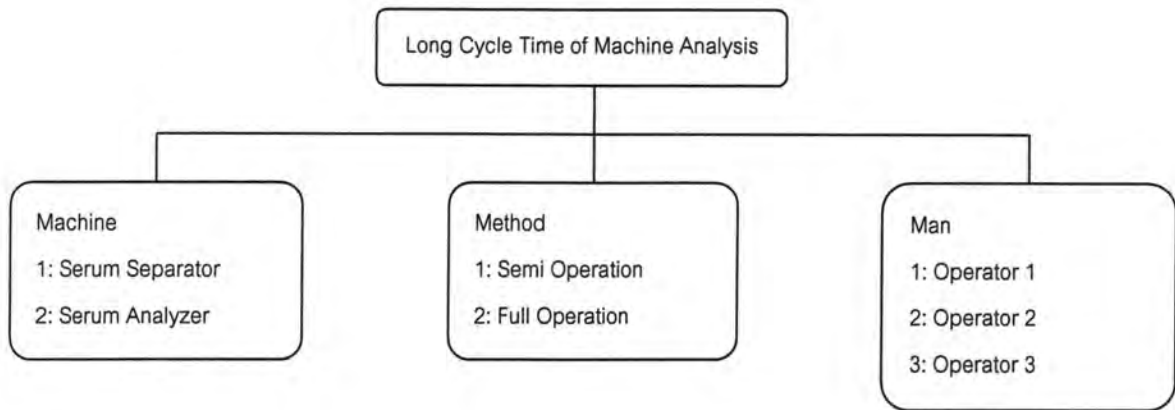
The last approach to manage queue of medication service will help the doctor assistants and information officers to solve the problems of patients who admit without appointment called Walk-in. The smooth operations of medical service process are usually interrupted by the unfortunate number of customers because there is no spare times available for the patients who do not make appointment in advance; therefore, the officers need to provide some time slots for them. The proposed Medication Appointment Schedule will particularly define the time slots according to the historical patient proportion between the case of appointed and walk-in customers such as 2:1 or 3:1. By this way, the key essential factors which impact to the Waiting Time of overall service duration will be effectively mitigated or even completely eliminated through the queue management approach.

## 6.2 Cycle Time Improvement

The Long Cycle Time of Machine Analysis has been critically analyzed in the last stage and delivers a couple of key essential factors that directly impact to the overall service duration of PMC. The first factor which needs to be considered goes to the Large Batch Size Analysis where all of specimens must be kept in place until the number of tube are high enough to put into the machines. It is frequent that the first patient who has been collected blood and liquid for special medication analysis as requested by doctors eventually receives the laboratory result at the same time of patients who comes one hour later because the officers will not operates the neither serum separating machine nor serum analyzing machines until the specimens has been completely collected for full capacity.

Moreover, the Redundancy of Responsibility of laboratory officers is another key essential factor to understand human capabilities that impact the long Cycle Time. Because most of the responsibilities have not been assigned to the officers individually, they are working together for many tasks in order to complete the analysis and deliver medical result upon requests. An officer who just collects blood and liquid from patients may replace with another who operates the serum analyzing machine or insert result into the computer. The result of always switching machine operators is that the laboratory operating cycle time has been fluctuated according to the human variation factor; therefore, the relationship between human capabilities of individuals for different machines should be seriously considered.

According to all above reasons, there are three key variables; Machine, Method and Man, that needs to be considered to improve the Cycle Time. There are two kinds of machines that have been used in the laboratory; Serum Separating Machine and Serum Analyzing Machine, while the solution for eliminating large batch size initiates another process called Semi Operation where the analyzing cycle starts for every tube of serum not for every batch as in the past. The last variable is the human factor to recognize machine operating skill among laboratory officers. All in all, Design of Experiment (DOE) approach which has been widely used to analyze multiple variables in the same time would be selected as the most appropriate productivity technique to find out the finest solution for cycle time improvement.



Test No.	Machine	Method	Man	Replicate 1 (Minute)	Replicate 2 (Minute)
1	Serum Separator	Semi Operation	Operator 1	23	27
2	Serum Separator	Semi Operation	Operator 2	26	24
3	Serum Separator	Semi Operation	Operator 3	14	17
4	Serum Separator	Full Operation	Operator 1	29	32
5	Serum Separator	Full Operation	Operator 2	33	28
6	Serum Separator	Full Operation	Operator 3	22	27
7	Serum Analyzer	Semi Operation	Operator 1	13	16
8	Serum Analyzer	Semi Operation	Operator 2	17	19
9	Serum Analyzer	Semi Operation	Operator 3	24	25
10	Serum Analyzer	Full Operation	Operator 1	25	26
11	Serum Analyzer	Full Operation	Operator 2	25	27
12	Serum Analyzer	Full Operation	Operator 3	30	32

#### Analysis of Variance for Cycle Time, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
<b>Machine</b>	<b>1</b>	<b>13.500</b>	<b>13.500</b>	<b>13.500</b>	<b>3.95</b>	<b>0.070</b>
<b>Method</b>	<b>1</b>	<b>308.167</b>	<b>308.167</b>	<b>308.167</b>	<b>90.20</b>	<b>0.000</b>
<b>Man</b>	<b>2</b>	<b>3.250</b>	<b>3.250</b>	<b>1.625</b>	<b>0.48</b>	<b>0.633</b>
<b>Machine*Method</b>	<b>1</b>	<b>10.667</b>	<b>10.667</b>	<b>10.667</b>	<b>3.12</b>	<b>0.103</b>
<b>Machine*Man</b>	<b>2</b>	<b>261.750</b>	<b>261.750</b>	<b>130.875</b>	<b>38.30</b>	<b>0.000</b>
<b>Method*Man</b>	<b>2</b>	<b>4.083</b>	<b>4.083</b>	<b>2.042</b>	<b>0.60</b>	<b>0.566</b>
<b>Machine*Method*Man</b>	<b>2</b>	<b>21.583</b>	<b>21.583</b>	<b>10.792</b>	<b>3.16</b>	<b>0.079</b>
<b>Error</b>	<b>12</b>	<b>41.000</b>	<b>41.000</b>	<b>3.417</b>		
<b>Total</b>	<b>23</b>	<b>664.000</b>				

Figure 6.3: Design of Experiment for Cycle Time Improvement

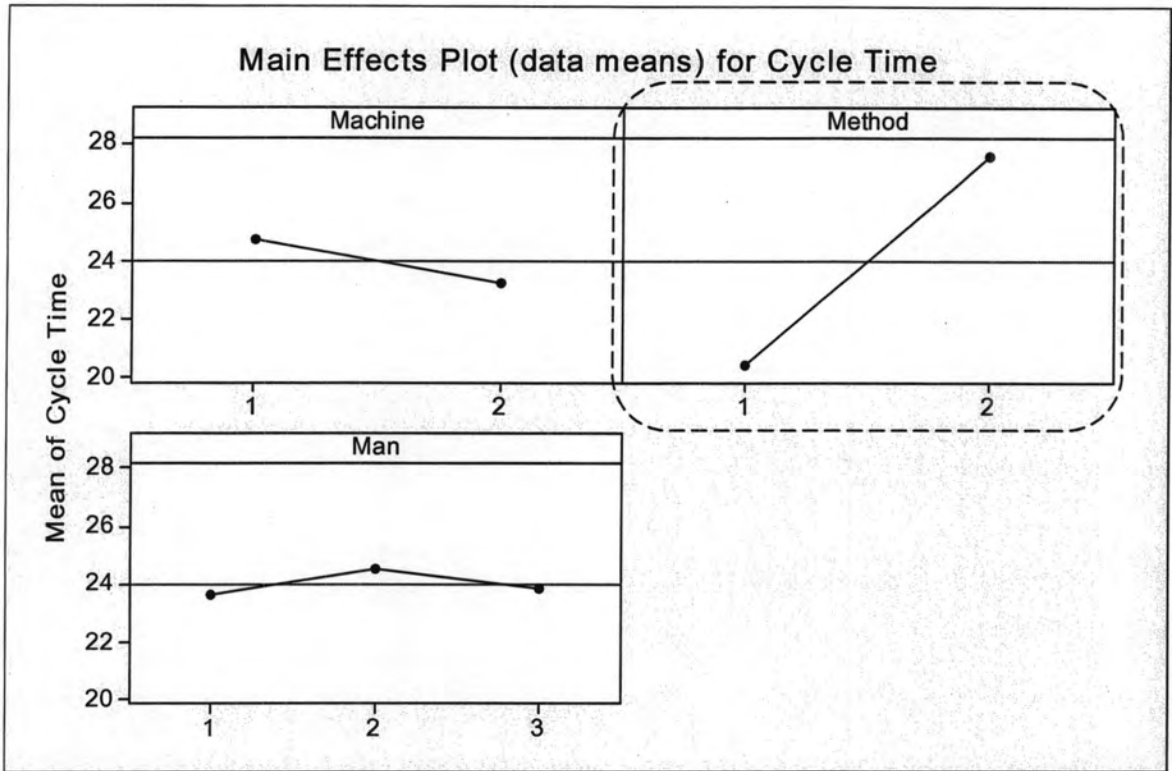


Figure 6.4: Main Effects Plot for Cycle Time

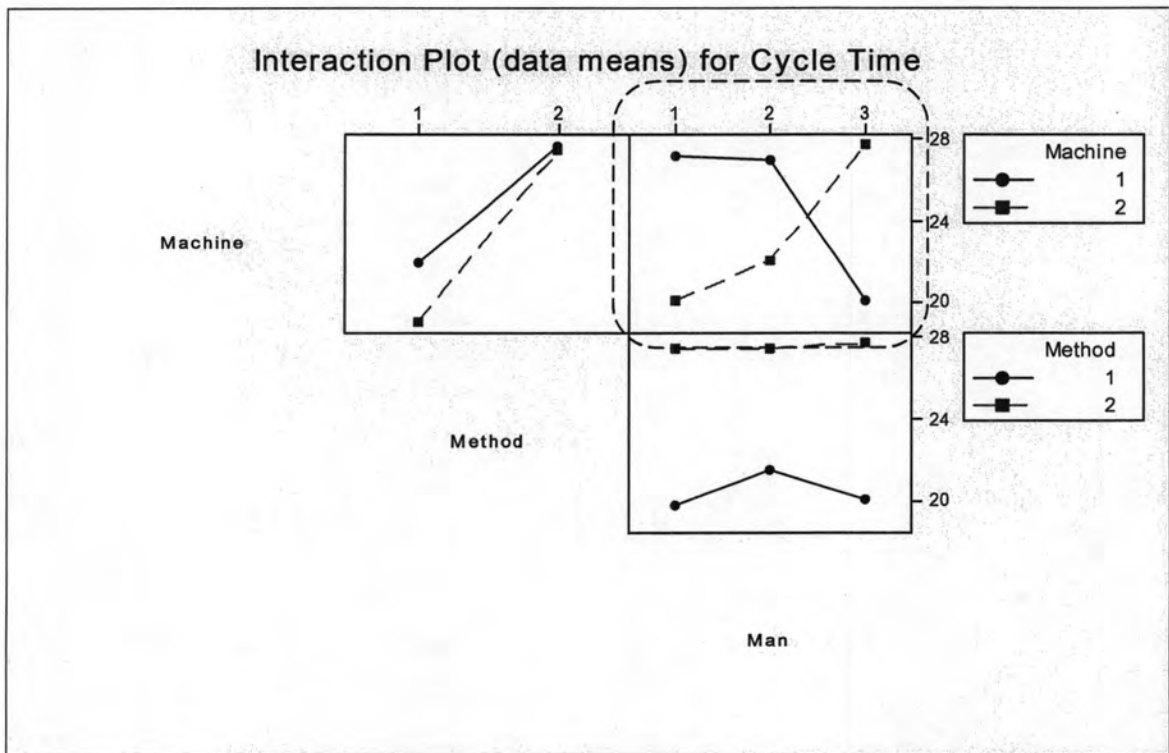


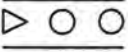
Figure 6.5: Interaction Plot for Cycle Time


The experiment has been designed to analyze three root causes called Key Process Input Variables (KPIVs); Machine, Method and Man, that implicitly impact to the Laboratory Cycle Time called Key Process Output Variable (KPOV). Different levels of particular variables have been randomly specified in the table to ensure that all of the designed experiments will be run without unfortunate bias. Moreover all of which will be replicated twice to ensure that the test result will definitely reflect both of relationships between process input and output variables and interaction among input variables themselves. Determination of the test will be depended on statistical value from the Analysis of Variance model for cycle time. In the case that P-Value of particular interests are lower than 0.05, those variables or their interaction will be determined as the key factors that impact cycle time significantly.

According to the Figure, KPIVs that create the significant impact to KPOV such Cycle Time can be definitely described in two characteristics; Main Effect and Interaction. The Main Effects Plot clearly illustrates that Method is the only variable that has the strong relationship with process output. The average cycle time when runs the experiment with Semi Operation is about 20 minutes while the Full Operation contributes the average cycle time for almost 28 minutes. Semi Operation refers to the activity that laboratory officer does not wait to collect blood and liquid from patients until meet the machine capacity but start operating machine whether it is full or not. By this way, many analysis results will not have to be issued at the same time but can be issued to the patients according to the order individually.

On the other hand, the Interaction Plot definitely point out that there have been a very close relationship between two KPIVs; Machine and Man which interact to contribute significant effect to the cycle time. Once Operator 1 and Operator 2 completely operate the Analyzing Machine, the average cycle time is as low as 21 minutes; where as, they have spent about 27 minutes for the average cycle time of the Separating Machine. In contrast, Operator 3 performs totally different than colleagues because she could powerfully operate the Serum Separating Machine much better than another one. The most appropriate solution is to let Operator 1 and Operator 2 fully operates Serum Analyzing Machine while assign Operator 3 for Serum Separating Machine. Both of which will finally lead to the significant improvement not only for the Laboratory Cycle Time but also the overall service duration as well.

### 6.3 Future State Summary

The modified FIFO (First-In-First-Out) sign (  ) has been intentionally added in the OPD function box in order to illustrate the most appropriate solution for Waiting Time improvement. The Proposed Medication Appointment Schedule would probably 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. By these reasons, not only that Waiting Time for OPD function would be decreased from 48 minutes to be 15 minutes but the Total Waiting Time overall will be immediately improved from 65 minutes to 32 minutes as well.

In addition, Semi Operation sign (  ) has been put into the Laboratory function to explain the most appropriate way for increasing process capability in the blood and liquid analyzing activities. The power of one-piece-flow concept can be described by Semi Operation where the Cycle Time will have been shortened suddenly after applying the serum individually to the machine instead of the old fashioned batch flow. Redundancy of responsibility of the officers which used to be obstructed flow of activities will be mitigated through the philosophy called "put the right man into the right job". After implementing both of which, the Cycle Time for Laboratory function would be leveraged from 81 minutes to 60 minutes and the Overall Cycle Time, as the reflection, will be 109 minutes as certain.

All in all, the Value Stream Mapping for Current Stage which has been carefully analyzed through multiple productivity approaches of Lean Six Sigma concept will be formulated as the Value Stream Mapping for Future Stage and could be completely described as below Figure. Total Waiting Time will be enormously decreased by the Proposed Medication Appointment Schedule at OPD while Total Cycle Time will be definitely reduced by Design of Experiment at Laboratory so that the overall service duration should be significantly improved from 195 minutes to 141 minutes. By the way, the actual reflection for all of proposed solutions in the Improvement Stage must be evaluated, adjusted and summarized through the Stage of Control consequently.



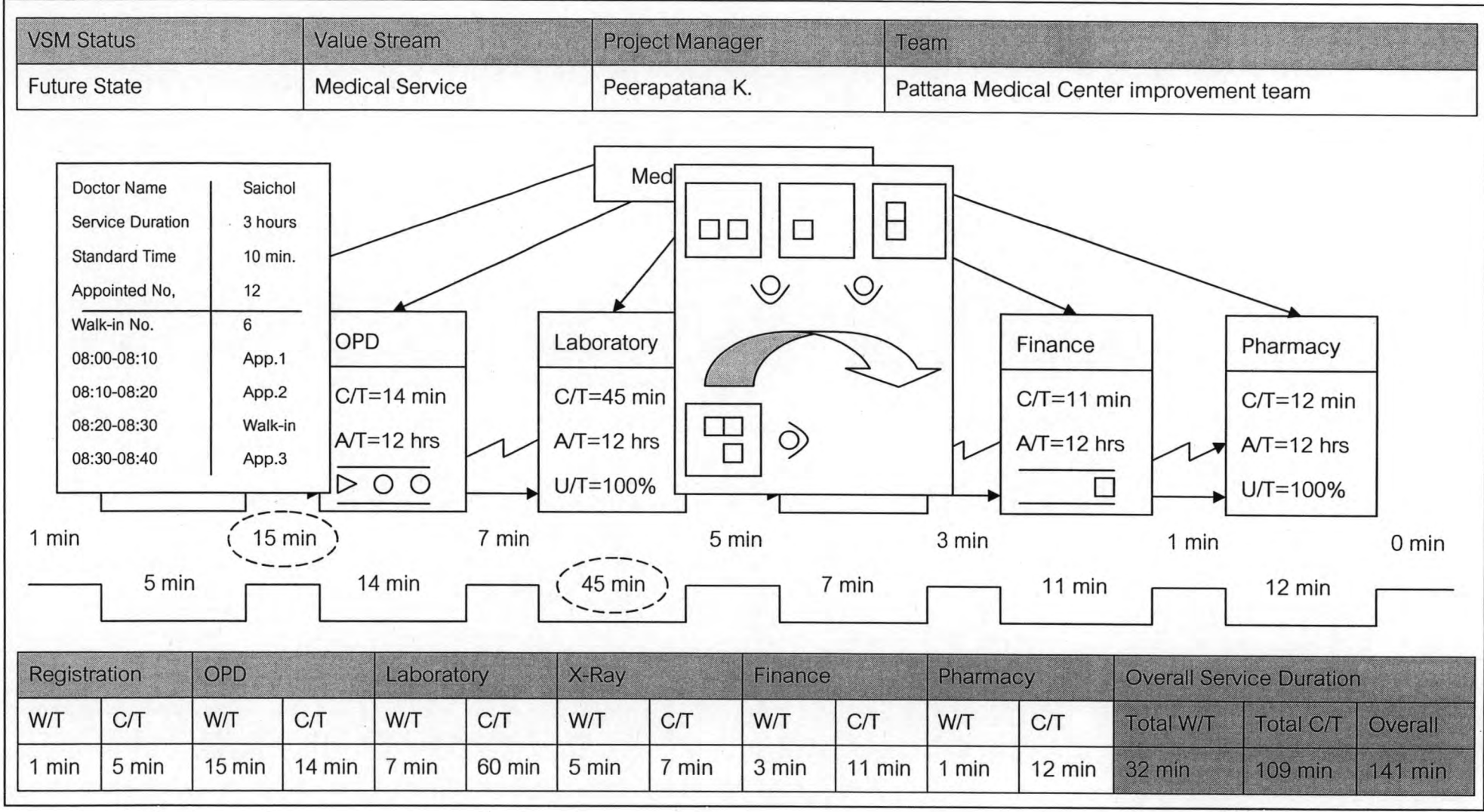


Figure 6.6: Value Stream Mapping for Future State

In addition, the consequences of medication process improvement will not only decrease the Waiting Time for OPD function and Cycle Time for Laboratory function but also simultaneously reduce a number of non value-added activities in the other Medical Service Core Process as well. The Medication Appointment Schedule which will have been used to manage uncontrollable number of in-coming patients could automatically mitigate the exiting long queue of the following functions such X-Ray, Laboratory, Finance and Pharmacy, where as, the Laboratory Man-Machine Interaction could eliminate the queue arrangement of analyzing reports in front of the OPD desk since the results will be issued piece-to-piece instead of the old-fashioned bundles. All of which, therefore, would reinforce the major solutions to contribute service duration lower than 141 minutes as estimated.

On the other hands, the proposed improvement solutions to improve Medication Appointment Schedule and Laboratory Man-Machine Interaction could deliver some negative effects to the other related factors. The limitation for numbers of appointed patients, the schedule arrangement for appointing duration and the time-slot for walk-in customers could unfortunately lead to uncontrollable traffic in front of the OPD desk. The patients who could not make appointments with the doctors on the date they available are possible to escape from the proposed appointing system and admit to Registration function as the walk-in customers so that the proportion of different customer segments; appointed and walk-in, should be put into consideration as one of the key measures for negative sign.

About the possible concern in implementing Laboratory Man-Machine Interaction solution, the opportunity of cost increment by changing the process from Full-Operation to Semi-Operation has been also critically considered at this stage. Although the methodology to insert blood and liquid into the Serum Separator and Serum Analyzer has been changed, but any other conditions are all the same; for example, calibrate in the morning daily, operate 12-hour basis and maintenance by supplier because they are all rental machines. The only machine related expense that Laboratory pays for is the chemical solution costs which have been varied due to the number of patients. It could be concluded that the proposed solution for Laboratory activities will not only improve the service duration but also do not lead to any crucial negative effect as certain.