



## Using LSS DMAIC in Improving Emergency Department Waiting Time

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### ABSTRACT

The objective of the study is using Define, Measure, Analyze, Improve and Control (DMAIC) in improving emergency department waiting time. Emergency department is the first line in hospitals to face emergency patients. The goal of this study is to use Lean Six Sigma (LSS) methodologies, specifically DMAIC improvement format within the emergency department in order to address the dissatisfaction of patients who encounter long waiting time. The root causes of long waiting time in emergency department are equipment, registration and treatment process, patient and staff factors.

**Keywords:** DMAIC, Lean Six Sigma, Emergency Department, Waiting Time, Improvement, Healthcare.

### INTRODUCTION

Overcrowding in the Emergency Department (ED) has become a phenomenon all around Malaysia. Patients have to wait for hours and the ED staff had to work overtime to solve patient's illness. Most patients experience very lengthy waits before receiving care, and some leave without being attended. Staffs in charge for daily operation are medical officers (doctors), paramedic (medical assistant and nurses) and hospital attendant.

The ED must deal with a 24-hour cycle and be expected to handle all the abundant patient demands. The medical staff must be adequately equipped in order to meet the rising demands of basic acute medical care. The challenge in ED is the people expectation to always be opened in order to serve community. In addition, not all patients arriving in ER are equally sick. Shortage in human resources, high patient care cost in private hospitals and the increase in patient volume have placed more burden for ED to provide the best quality care in the most efficient way.

Quality of healthcare in Malaysia is based on the accreditation by the Malaysian Society for Quality in Health (MSQH). MSQH role is to stimulate continuous, systematic improvement in an organization's performance and the outcome of care. Thus, the organization performance in ED is also to be emphasized. To enhance the quality of emergency department flow, the application of Lean Six Sigma is used.

This study is conducted to identify the weakness of patient flow in emergency department in a district hospital of Pahang. Observation was executed within five days from 3rd April 2013 (Wednesday) to 7th April 2013 (Sunday). It was found that, if the waiting time can be reduced, the overall patient satisfaction will increase.

### Literature Review

David and Yariv<sup>1</sup> found that waiting time comprise 51-63 percent of total patient turnaround time in ED. Its major components are: time away for an x-ray examination; waiting time for the first physician's examination; and waiting time for blood work.

Medeiros<sup>2</sup> developed and implements a new approach to patient flow in the ED where Provider Directed Queuing (PDQ) places an emergency care physician at triage. The emergency care provider listens to the patient's complaint and the triage nursing assessment and works as part of a team to provide the resources necessary for patient care.

Johnson<sup>3</sup> uses Define, Measure, and Analyze stages in Six Sigma methodology to improve the quality of care while reducing patients' length of stay (LOS) and process errors in ED located in central of Texas. The simulation aspects of the study utilize ProModel's MedModel software and is the "as-is" model building stage.

In this paper, DMAIC has been chosen as a process to create breakthrough improvements in quality of ED waiting time in Malaysia. Within the context of the five phases, this study chooses SIPOC, Fishbone Diagram, FMEA table, and Gantt chart to make decision.

### DISCUSSION

LSS Define-Measure-Analyze-Improve-Control (DMAIC) is the core methodology used in LSS project<sup>4-8</sup>. This methodology assists medical practitioners to utilize the concept of DMAIC when a process is in existence at a company but is not as per customer specifications. DMAIC methodology also refers to practical problem that is converted into statistical data that is encouraged through lean six sigma method by improving certain areas of business processes<sup>9,10</sup>. Each phase of the DMAIC is



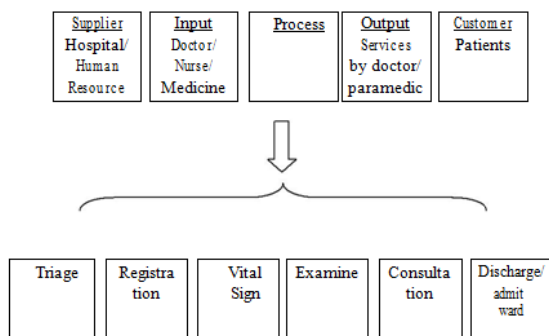
based on actual data, rather than opinion or perception. This section will discuss on the DMAIC stages.

**Define**

The Define stage is the most crucial amongst other DMAIC process because how well it's completed will direct to the success of the project. Here, we have to scope down the problem into a manageable level. In the define stage, the problem to be solved is defined.

SIPOC (Suppliers – Inputs – Process – Outputs – Customers) analyses are performed in this stage as shown in Figure 1. SIPOC analysis is a simple tool for identifying the suppliers and their inputs into a process, the high-level steps of a process, the output of the process, and the customer segments interested in the outputs<sup>10</sup>.

The process begins when patients arrive at the triage desk and ends when the patient is admitted or discharge. Figure 1 shows a SIPOC that contains the process of a patient. When patients arrive at the ED, they will be classified to three stages, red, yellow, and green. Triage red is for critical patients, yellow for semi-critical patient and triage green for non-critical patient.



**Figure 1: SIPOC**

**Measure**

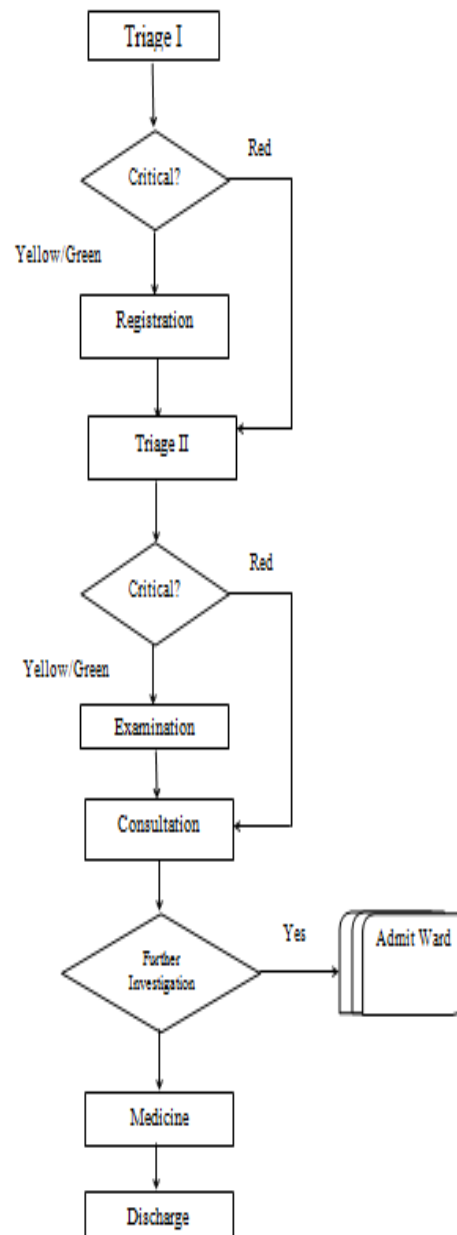
The measure phase is about understanding the current process, how the process is measured, and performance improvement. A process flow chart are developed to understand the process and to gain consensus for the overall scope of the project as shown in Figure 2.

The triage red patients are immediately sent for second triage for vital signs examination such as blood pressure and heart rate checkup. While for the triage yellow and triage green patients they have to complete a mini registration whereby they have to provide their particular and chief complaint before attending their secondary triage.

After secondary triage patients are once again classified to three stages as per first triage. Triage yellow and green patients go for examination and investigation by MA such as x-ray and blood test follow by consultation with doctor. Meanwhile, triage red patient go directly for consultation with doctor.

Lastly, the process in ED ends with doctor decides whether patient needs further investigation or not. If

needed, will be admitted to ward while patient that do not need further investigation will be discharged after receive medicine from pharmacy.



**Figure 2: Process Flow Chart**

From the flow chart above, the process which involves waiting time in ED will be measured. However, the time can be dragged longer during school holidays and public holiday. The standard estimated time for the ED process are shown below:

1. Registration after first triage (30 minutes)
2. Waiting time to get vital signs and early treatment (secondary triage) by paramedics (1 hour)
3. Treatment and investigation (x-ray/blood test/ medication) (4 hour)
4. Waiting time to see doctor (3 hours)
5. Patients admitted to ward (1 hour)

## Analyze

Analyze phase is a step that looks into the possible sources of the variation that cause the defect. To identify the root causes in Analyze phase, a Fishbone diagram was constructed to identify the major causes and sub causes of this study.

Fishbone diagrams are also known as cause-and-effect diagrams, are about organizing possible causes behind a given problems. The following Fishbone Diagram example as shown in Figure 3 looks at possible causes of long waiting time in ED.

The first major problem is the registration. Registration process at the triage takes time when there is not enough staff to register. In addition, communication failure exists if the patient walk in to ED but they are not able to convey their problem properly.

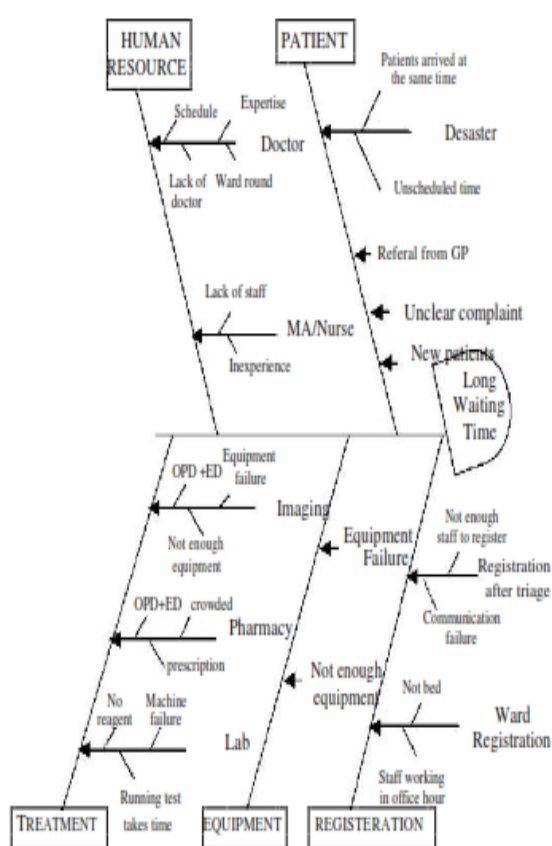


Figure 3: Fishbone Diagram

Second problem comes from the patient themselves. New patients arriving at the same time and unscheduled time are the main problems that will drag to long waiting time. Referrals from general practitioner (GP) are sometimes not necessary to go to ED. In addition, disaster will drag very long time in the ED. Equipment failure will drag really long time to be fixed. Not enough equipment will disturb the waiting flow.

Waiting for treatment contribute the most waiting time in the process. Investigation in lab will be disturbed if there are not enough reagent and machine failure. Also, running some tests also takes time. Imaging modality

such as x-ray takes time when there are not enough equipment and equipment failure. In addition, patients from outpatient department also come to the imaging department to do x-ray.

For patient that can be discharged, waiting at the pharmacy also takes time because of the crowdedness and not enough staff to prescribe.

The last factor for long waiting time is the human resource. For the doctors, their scheduled is really tight especially for districts hospital. They have to do ward rounds in the hospitals.

There are no specialists in district hospital; therefore long time is needed if the patient's problem is complicated.

## Improvement

Improvement phase involves the improvement that has to be developed to fix the problem. Designing and running pilot test can be done here. The ultimate goal is to see if the ideas will solve the problem.

The Failure Modes and Effects Analysis (FMEA) are the primary tools for risk assessment. FMEA assist to reduce defect, fast action and countermeasures based on JIT approach. The outputs would yield a list of defects to be improved. Here we can detect which process that effect the most for the waiting time in ED.

The first component is the Process input, then the Failure Mode – “what can go wrong with the input?” the Potential Failure Effects – “what is the effect on the output?” Then, assigning a Severity Level score (1-10, where 10 is the score representing a very likely occurrence) for each Potential Cause.

The Occurrence score (1-10, with a score 10) representing the case where the detection of the cause or failure would never occur. Finally, a Risk Priority Number (RPN) is calculated by multiplying Severity, Occurrence and Detection scores together for each Process Input row<sup>11</sup>.

From Table 1, it is found that the biggest RPN is physician consultation with patient. This means, the longest waiting time occur in this stage because complicated disease takes long time to be diagnosed. Furthermore, critical cases requiring further extended investigation drag very long waiting time.

The FMEA helps to define which process should be improved the most. For Improvement phase, some improvement has been done in the ED such as:

1. Sending staff for more courses related to emergency
2. Train paramedical staff to do all processes except for doctor's task
3. Incompetent doctor will be monitored by well-trained doctor until they became really efficient.
4. Address the equipment problems by dealing with the inventory department.

**Table 1: FMEA**

Process Step	Potential Failure	Failure Effects	Sev	Causes	O c c	Current Control	D e t	RP N
Registration after triage	Crowding of patient at registration counter	Delay in process	6	Not enough staff to register, too many patient, too many red case	7	Paramedic assist PPK	2	84
Vital Sign by nurse	Equipment failure	Delay in Process	7	Inexperient staff, lack of staff, season machine	7	MA assist, find new machine	1	56
Secondary triage by MA	Unspecific patient complaint	Delay in process	6	Patient communication failure, patient don't want to wait in OPD	5	Paramedic doing primary triage help	1	30
Physician examination	Slow in making diagnosis	Delay in service	8	Inexperience doctor, complicated disease, need further extended investigation	8	Consultation with senior MO, specialist consultant via phone	2	128
Physician consult with patient	Not enough information to make diagnosis	Delay in service	6	Lab takes time to complete test, many different test ordered together, not enough reagent	6	Grouping of similar test to run for many samples, 3 radiographer on duty, sample sent to GH	1	36
Discharge	Late discharge	Delay in process	7	Late in getting medication, late registration in Hosp registration book.	7	Pharmacist and MA can make registration instead of office staff.	2	98

**Control**

The final phase is the control phase. The control phase is where control charts and other monitoring tools are used to track the solution of the problem are designed in order to ensure long term success of the solution. A quality coordinator was appointed to the ED department to control the waiting time process in ED.

**Table 2: Gantt chart**

No	Description	Dur (hr)	1	2	3	4	5	6	7	8
1.	Registration at the triage	0.5	*							
2.	Registration after first triage	0.5	*							
3.	Waiting to get Vital sign / secondary triage	1		↔						
4.	Receive treatment	4					←	→		
5.	Waiting to see doctor	3				←	→			
6.	Admitted to ward	1								↔

In this study, Gantt chart is built to keep the improvement in control as shown in Table 2. Gantt chart assists to plan the allocation of resources needed to complete the project. The processes with the maximum durations are shown. Waiting time for patients could not be more than the durations stated in the Gantt chart in order to ensure the flow runs effectively.

**Recommendation**

For further research, it is suggested to study the relationship between lean six sigma practice (LP) and Supply Chain Innovation (SCI) in ED department for Malaysian Healthcare Industries.

**CONCLUSION**

In order to successfully integrate the new process, the medical staff must believe in the solution and be capable of the continual monitoring of the process to ensure that improvement are maintained. Therefore, this study assists hospital managers and policy maker to find the best quality management to achieve their best performance in managing the waiting time in ED.



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