Using Lean Six Sigma to Transform the Quality of Healthcare: A Case study from the UAE

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Meirc Training & Consulting
Anatomy of healthcare today and key figures

What is Six Sigma and what is Lean?

UAE Hospital Lean Six Sigma Case study
  • Before and after results

Take home tips- Practical and Academic
Let us talk about the Elephant in the room!
To Err is Human or is it?
As many as 1 in 4 patients are harmed whilst receiving primary and ambulatory health care.

134M adverse events occur each year in hospitals contributing to 2.6 million deaths annually due to unsafe care.

Medication errors cost an estimated 42 billion USD annually (1% of the global expenditure on health).

Prescriptions out of 3 billion filled every year are filled with error.

Have you met the Demons?

D1

D2

D3
Meet the Demons

**DELAYS:**
- ‘What is taking you so long to get my pharmacy order?’

**DEVIATIONS:**
- ‘This is not the amazing service I received last time, what is wrong?’

**DEFECTS:**
- ‘You gave me the wrong medication’
Polling Question: Implementation of Continual Improvement methodologies in healthcare
The 2 Guns I Use
Six Sigma and Lean

• Complementary Approaches – Proven Results

Lean’s Unique Emphasis

Six Sigma’s Unique Emphasis

Lean Six Sigma

Common Objectives
Six Sigma is a structured approach focusing on improving process reliability in order to eliminate the defects in products and services.

This approach was developed in 1986 by Motorola and popularized by GE.
6σ - The Three Dimensions

Lean Six Sigma: DMAIC

- **DEFINE** Define the problem.
- **MEASURE** Map out the current process.
- **ANALYZE** Identify the cause of the problem.
- **IMPROVE** Implement and verify the solution.
- **CONTROL** Maintain the solution.

**Methodology**

- Led by Senior Mgmt
- Driven by customer needs
- Enabled by quality team

**Organization**

**Tools**

- Process Map Analysis
- Upper/Lower specification limits
- Regression
- Pareto Chart

Using Lean Six Sigma to Transform the Quality of Healthcare
Lean definition

Lean is a structured approach focusing on simplifying processes by eliminating the tasks that don’t bring value for the end customer.

This approach was mostly derived from the Toyota Production System (TPS) in the beginning of the 20th century and identified as "lean" only in the 1990s.
Lean 8 types of waste (DOWNTIME)

- **Defects**: Making mistakes that cause products to fail customer requirements
- **Overproduction**: Making more than is immediately required
- **Waiting**: Waiting for the previous step in the process to complete
- **Non-utilized talent**: Not recognizing and utilizing human talent and creativity available within the workforce
- **Transport**: Unnecessary movements of products and materials
- **Inventory**: Storing parts, pieces, documentation ahead of requirements
- **Motion**: Unnecessary movements by people
- **Extra processing**: Performing any activity that is not necessary to produce a functioning product or service
Lean Six Sigma definition

**Lean**
A structured approach focusing on **simplifying processes**

**Six Sigma**
A structured approach focusing on **improving process reliability** in order to eliminate the defects in products and services

**Lean Six Sigma**
A performance improvement methodology focusing on **simplifying processes and improving process reliability**
Due to confidentiality requirements I will refer to the hospital in this case study as Hospital A.

Note: This project was submitted as part of the ASQ certificate requirements for the Lean Six Sigma Green belt and was coached by Fawzi Bawab.
Situation

• Recurrent complaints and dissatisfaction shown by patients about prolonged waiting time before being seen by physician

• 37% of the written ED patients’ complaints were related to prolonged WT. Similarly, 23% of the complaints were related to prolonged WT. A high number of patients (1,068) left the ED without being seen by a physician or complete the required care. In addition, the monthly patient satisfaction survey conducted revealed that 59% of patients surveyed, expressed their dissatisfaction with the prolonged ED waiting time.

Objectives

• Reduce WT for triage category 3, 4 and 5 and improve the percentage of patients seen within the timeframe recommended by SEHA by 25%

• Key Performance Indicators targets requiring that 90% of triage category 3 patients be seen by a physician within 30 minutes, and triage category 4 and 5 within 45 minutes of registration time, showed a trend of low compliance.

Hospital A:

• 460+ bed Hospital located in the Eastern Region of the Abu Dhabi Emirate. It is a tertiary referral hospital managed by Johns Hopkins Medicine International and overseen by SEHA Corporate.
Lean Six Sigma DMAIC Methodology – Step 1

Define

Definition

Define the problem and set your improvement targets

Key Steps

1. Define your customer and their requirements
2. Define the current process
3. Define the problem
4. Define your improvement goals and ensure alignment with overall company strategy
5. Develop a plan of actions
In 2009, the Emirate of Abu Dhabi introduced the mandatory medical insurance scheme thus, giving the patients the choice to be treated at any healthcare facility. This might have contributed to the leakage of hospital A patients and consequent revenue loss.

WT improvement in ED is one of the strategic initiatives identified by the Senior Management to meet the strategic goals. Its ED is one of the busiest in the region with an average of 6,500 visits per month.

The comparison between actual and budgeted data for ED visits showed a drop of 8.8% in the volume (from 115,193 to 105,094) leading to an estimated direct loss of 5.7M AED per year and an indirect loss of about 11.4M AED per year considering that 11.3% of ED visits were admitted to the hospital.

Based on the Voice of Customer (VOC) a significant proportion of the estimated loss could be related to the prolonged waiting time.
A Capability histogram

- Process capability was very low (Z bench 0.13) producing 44.8% defects

The pain

- Only 55.2% of 3,832 adult patients (Sample data), who attended the ED, were seen within the timeframe recommended by SEHA.

The process metrics

- Performing at sigma -0.02, 0.14 and 0.65 in patients with triage category 3, 4 and 5, producing 44.4%, 35.1% and 28.9% defects respectively.

Base line Summary
Process Maps
Lean Six Sigma DMAIC Methodology – Step 2

**Definition**
Measure current state performance and brainstorm potential cause(s) of the problem

**Key Steps**
1. Measure the current process performance
2. Create assumptions for what might be causing problems
3. Create a plan to collect the data
4. Collect the data
5. Ensure your data is reliable
# Measurement Plan

## Table 3: Data Measurement Plan

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Operational Definition</th>
<th>Data Source &amp; Location</th>
<th>Sample Size</th>
<th>Who will collect Data</th>
<th>When will Data be Collected</th>
<th>Data Collection Method</th>
<th>Other Data Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 3 Waiting Time Compliance Rate</td>
<td>% of category 3 patients seen within 30 min from registration time to first contact with physician</td>
<td>HIS (Malafi), Info View Report</td>
<td>100% Adult Category 3 Patients</td>
<td>Quality Manager to run the report</td>
<td>Monthly</td>
<td>Electronic Report</td>
<td>Manual Data Collection with Patient tracer</td>
</tr>
<tr>
<td>Category 4 Waiting Time Compliance Rate</td>
<td>% of category 4 patients seen within 45 min from registration time to first contact with physician</td>
<td>HIS (Malafi), Info View Report</td>
<td>100% Adult Category 4 Patients</td>
<td>Quality Manager to run the report</td>
<td>Monthly</td>
<td>Electronic Report</td>
<td>Manual Data Collection with Patient tracer</td>
</tr>
<tr>
<td>Category 5 Waiting Time Compliance Rate</td>
<td>% of category 5 patients seen within 45 min from registration time to first contact with physician</td>
<td>HIS (Malafi), Info View Report</td>
<td>100% Adult Category 5 Patients</td>
<td>Quality Manager to run the report</td>
<td>Monthly</td>
<td>Electronic Report</td>
<td>Manual Data Collection with Patient tracer</td>
</tr>
<tr>
<td>Average Waiting Time all categories</td>
<td>Average waiting time for all and each category</td>
<td>HIS (Malafi), Info View Report</td>
<td>100% Adult Category 3, 4 and 5 Patients</td>
<td>Quality Manager to run the report</td>
<td>Monthly</td>
<td>Electronic Report</td>
<td></td>
</tr>
<tr>
<td>Patient Satisfaction with Waiting Time</td>
<td>% of patients satisfied with ED waiting Time</td>
<td>Real time hand held data collection</td>
<td>400 patients per month</td>
<td>Patient Experience</td>
<td>Monthly</td>
<td>iPad Survey tool filled by patients</td>
<td></td>
</tr>
<tr>
<td>Patient Complaints related to waiting time</td>
<td>Number of ED patients written complaints related to WT</td>
<td>Complaint Management System</td>
<td>Not Applicable</td>
<td>Patient Experience</td>
<td>Monthly</td>
<td>Manually</td>
<td></td>
</tr>
</tbody>
</table>

### How will the data be used?

1. Quarterly KPI compliance
2. Quality improvement
3. Service planning

### How should data be displayed?

1. ED Dashboard
2. SEHA Dashboard
3. ED Quality boards
Graphing

Figure 1: Number of ED visits and the average turnaround time for patients

Figure 2: Scatter plot of average WT per hour vs. the total number of ED visits

Figure 4: Descriptive statistics of WT for all adults visiting ED in January 2014 (N = 3832)

Figure 3: WT vs. number of patients admitted in the preceding hour (N = 1013, January, 2014).
Charts are worth a......

Figure 14: I-MR Control chart of WT in adult patients attending the ED (N 3832)
Number of visits

- Peaked between 08 AM and 12 noon, followed by increased WT, which persisted throughout the afternoon until midnight.
- A low rate of visits was noted between 01:00 and 06:00 AM corresponding to low WT.

Correlation between ED WT and number of ED visits

- Very low (R² 0.08) meaning that the volume of patients visiting ED accounts for less than 10% of the variation in WT and indicating that other factors should be addressed since they explain more than 90% of the variation in WT.

The process

- Was unstable and unable to support accurate predictions in the long term.
Conclusions were as follows:

- Early data suggests that a higher number of staff is required to cover the morning shift.
- Intervention aimed to solely reduce the number of patients by referring those of lower acuity to UCC is not expected to have a significant effect on the WT.
- The frequency distribution with Histogram and box plot revealed right skewed data, high variation and a large number of outliers and extremes. WT of patients in triage category 3, 4 and 5 patients was not statistically different.
- Control Charts revealed that 36% of cases were out of control and confirmed the high variation in WT that was previously noted.
Lean Six Sigma DMAIC Methodology – Step 3

**Definition**

Analyze the data and identify the root causes of waste

**Key Steps**

1. Analyze the data in details
2. Verify your assumptions in terms of what might be causing problems
3. Brainstorm solutions that might fix the problem
Figure 26: Cause and Effect Analysis

Using Lean Six Sigma to Transform the Quality of Healthcare
Root Cause Analysis

Table 6: Root Cause Analysis Rating

<table>
<thead>
<tr>
<th>Potential Root Cause</th>
<th>Quality</th>
<th>Financial</th>
<th>Customer Satisfaction</th>
<th>WT</th>
<th>Total Score</th>
<th>% Score</th>
<th>% Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortage of Drs.</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>40</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>Shortage of Nursing</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>32</td>
<td>14%</td>
<td>31%</td>
</tr>
<tr>
<td>Shortage of clinical services</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>28</td>
<td>12%</td>
<td>43%</td>
</tr>
<tr>
<td>Horizontal vs. Vertical Pt.</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>22</td>
<td>10%</td>
<td>53%</td>
</tr>
<tr>
<td>Availability of Care sets</td>
<td>3</td>
<td>1</td>
<td>8</td>
<td>8</td>
<td>20</td>
<td>9%</td>
<td>62%</td>
</tr>
<tr>
<td>Shortage of Porters</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>18</td>
<td>8%</td>
<td>70%</td>
</tr>
<tr>
<td>Availability of PRO</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>8</td>
<td>17</td>
<td>7%</td>
<td>77%</td>
</tr>
<tr>
<td>Language barrier</td>
<td>4</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>15</td>
<td>7%</td>
<td>84%</td>
</tr>
<tr>
<td>Availability of Signage</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortage of treatment rooms</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unavailability of Unit Clerks</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non empowered Security</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bed control management</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Impact Score Scale: 1-10; 1 = lowest impact and 10 = highest impact

Figure 27: Pareto Chart of the impact of causes on the process
The patient tracers and value stream mapping helped the team to understand the patient journey and highlight both value and non-value added steps.

The eight forms of waste – waiting, motion, transportation, overproduction, defects, underutilized people and inventory – slowing the patient flow were identified and kept in mind to be rectified during the development of corrective actions.

The team was able to identify 66 underlying causes and sub-causes leading to the waiting time categorized under five categories.
Lean Six Sigma DMAIC Methodology – Step 4

**Definition**

Develop solutions to address the root causes

**Key Steps**

1. Select the best solution(s)
2. Test the solution(s)
3. Deploy the solution(s)
4. Measure improvement
5. Compare results versus improvement goals
Based on the Cause & Effect analysis, an action plan was put together with the main stakeholders from ED to identify areas for improvements. Four brainstorming sessions two hours each were conducted with representations from Medical, Nursing, Patient Experience, Registration Clerks, Administration and Senior Management along with the Six Sigma team. The actions suggested were categorized under the six identified areas of concern:

- 1. Patient
- 2. Manpower
- 3. Management
- 4. Materials
- 5. Environment
- 6. Methods/Communication

For each identified cause, a corrective action was proposed by the team and was assigned a responsible person or department to implement and report status by a set timeline. Although each identified cause had a proposed corrective action, the team however felt that not all actions can be implemented immediately or that it would have adverse impact on the changes required.
Subsequently, and to have quick wins, a priority matrix was utilized to prioritize the actions required that would have a high impact and are easy to implement. The development of the priority matrix was conducted over several sessions (at least 6 hours) where each identified cause was measured against the two set criteria. The findings helped the team to stage the actions to get the best outcome desired. Both the Action Plan and Priority Matrix were presented to the Executive Team and received the required support to move forward with the actions as planned.

With reference to table 7, and to distinguish between the quick wins of the actions implemented effective immediately and the long terms ones, the status of the actions were color coded.
## Action plan

### Table 7: ED Waiting Time Improvement Action Plan

<table>
<thead>
<tr>
<th>Identified Causes</th>
<th>Required Actions</th>
<th>BY Whom</th>
<th>By When</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1. Delays are not communicated to patients | 1. Communicate expected waiting time  
   a. Allocate a big screen displaying expected waiting time  
   b. Triage nurse to inform patient about expected waiting time  
   c. Team leader updates the expected WT on the screen | Eng. **.** **.**  
   Team leader  
   Department | 31st May 2014 | Big Screen ordered, meanwhile placed small screen |
| 2. Lack of patient awareness            | 1. Share the available ED Video with community through Facebook and website  
   2. Develop a brochure displaying ED roadmap and flow expectations  
   3. Reinforce the adherence with UCC referral | ED Patient Service  
   Portfolio group | 31st of May 2014 | Pending |
| 3. Availability of Patient Flow Coordinator | 1. Assign Patient flow coordinators  
   2. Document events and discussions by Patient Flow Coordinators  
   3. Train Staff on what to document & where to document | Patient Flow Coordinators  
   Team | 31st of May 2014 | Pending |
| **Refusal to be discharged**            |                                                                                 |         |                  |                   |
| 1. Patients want to be admitted for social reasons | 1. In collaboration with other specialties to develop a protocol/guidelines addressing social admissions | Dr. **J.** Dr.  
   discuss with CMO | 1st of May 2014 | Pending |
| **Interruptions and Staff Assaults**    |                                                                                 |         |                  |                   |
| 1. Availability of PEO                  | 1. Assign a PEO 24/7  
   2. Allocation of police staff in ED | Team  
   Department | 30th of May 2014 | Completed |
| 2. Documentation of events and discussions by PEOs & Social workers | 1. Reinforce the importance of documentation in Cerberus  
   2. Train Staff on what to document & where to document | Team  
   **.** 
   **.** | April 2014 | Implemented & Ongoing |
| **Manpower**                            |                                                                                 |         |                  |                   |
| **Shortage of Staff**                   |                                                                                 |         |                  |                   |
| 1. Shortage of Nursing Staff            | 1. Calculate the required nursing FTEs as per international/SEHA benchmark  
   2. Allocate patient flow coordinators (6 FTEs) | Team  
   Flow portfolio group | 15th of May 2014 | 4 arriving in July, 6 in October, & 6 in November |
| 2. Shortage of ED physicians            | 1. Update on the status of budgeted vacancies  
   i. 6 intake GPs– Eyeball inspectors  
   ii. 14 consultants & specialists | Team  
   **.** | 31st December 2014 | For triage doctors, 2 in Feb, 2 in May & 2 in June (all arrived) |
| 3. Unavailability of Unit Clerks         | 1. Allocate positions for unit clerks (6-8 FTEs) | Dec 2014 | TBD | Pending |
| 4. Shortage of Porters                   | 1. Reassess the current porter responsibilities  
   2. Map the distribution amongst the hospital | Dee  
   **.** | Mid June 2014 | Taskforce, started assessment, trial period for the new post in July |
| 5. Unavailability of grievance counselor | 1. Assign and train current staff (PEO) to assume this responsibility | **.**  
   **.** | TBD | Pending |
| 6. Manpower utilization for category 4 & 5 | 2. Expansion of UCC to cover 16 hours per day  
   1. Staff recognition through the assignment of ED special & shift allowance/incentives  
   2. Regular ED staff gatherings  
   3. Celebrate wins and achievements | Dee  
   **.**  
   **.**  
   **.**  
   **.** | Starting April 2014 | Patients are offloaded to Family medicine clinic |
| **Staff Morale**                         |                                                                                 |         |                  |                   |
| 1. No structured staff recognition      | 1. Staff recognition through the assignment of ED special & shift allowance/incentives  
   2. Regular ED staff gatherings  
   3. Celebrate wins and achievements | **.**  
   **.**  
   **.**  
   **.**  
   **.**  
   **.**  
   **.**  
   **.**  
   **.**  
   **.** | June 2014 | Pending |
| 2. Increased number of resignations and sick calls | 1. Explore reasons for resignation through auditing the exit interviews  
   a. Sick & Exit interviews conducted with all nursing staff  
   b. Provide incentives for staff not utilizing their SL days  
   c. Exit interviews for medical staff conducted by medical executive | A & **.** **.**  
   **.**  
   **.**  
   **.** | May 2014 | a & b implemented  
   c in process |
Actions Prioritization

Figure 28: Action plan priority matrix

[Diagram showing a matrix with actions prioritized based on impact and easiness]
Since the employment of Triage physician in ED was identified as a quick win solution and in order to evaluate the benefit of its implementation. Two physicians were assigned in the triage area to assess patients, assist in assigning triage category, initiate an order care set or triage out patients with lower triage acuity to urgent care service.

Waiting Time data retrieved from the HIS for one of the assigned physicians was analyzed to show significant improvement in the WT in all categories where 94% of category 3 patients were seen in 30 min and 100% of category 4 & 5 were seen in 45 min.
Lean Six Sigma DMAIC Methodology – Step 5

**Definition**

Monitor and continuously improve

**Key Steps**

1. Ensure the process is being managed and monitored properly
2. Continuously improve the process
3. Share and celebrate your success
4. Apply new knowledge to other processes in your organization
The plan of actions, priority matrix and pilot results were presented to the main stakeholders and Senior Management granting approval and financial support. A decision was made to implement the high impact, easy to implement actions including the following:

1. Expedite the process of recruiting five additional triage physicians for 24 hours coverage
2. Complete the development and implementation of diagnosis specific order care sets
3. Reverse the decision of closing the STAT Laboratory in the ED
4. Expansion of ED
5. Expansion of UCC Services
6. Assignment of PEOs for 24 hours coverage

In addition the Six Sigma team decided to quantify the improved process capability, implement the process control, develop a control plan and close the project.
Before and After

Figure 31: Process capability six pack of WT after improving the process (June 2014). Box and Cox transformation was used to normalize the data.
Overall, the goal of 25% reduction in defects was accomplished as the DPMO decreased by 63% within 6 months.

Short term sigma increased from 0.13 to 0.97. Further improvement is expected with the full implementation of corrective actions and the support of Senior Management.

Estimated savings approached AED 11M ($3M) per year.
**Results**

SEHA recommends maintaining the WT within the recommended guidelines in 90% of cases thus tolerating 10% defects. The improved process exceeded SEHA tolerance limits by 6.5% only. This compares favorably to baseline data where the limits were exceeded by 34.8% (improvement of 81%). Thus, the Six Sigma goal of 25% improvement has been met.

Reduction in the percentage of the written ED patients' complaints related to prolonged waiting time from 37% to 23%. Similar results were obtained through the M initiative which revealed reduction in complaints related to prolonged WT from 23% to 10% before and after improvement respectively.

Number of patients who left ED without being seen decreased from an average of 89 per month to 41.

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**Regulations**

**Guidelines**

**COMPLAINTS**
## Control Measures

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Target</th>
<th>Process Owner</th>
<th>Frequency</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 3, 4 &amp; 5 WT</td>
<td>Improve process capability by 25% in 6 months</td>
<td>ED Team with support from Six Sigma team</td>
<td>Monthly</td>
<td>PIC &amp; E Team</td>
</tr>
<tr>
<td>1. Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Variability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Z bench</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Control chart</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of Patient satisfied with ED WT</td>
<td>90%</td>
<td>ED Team</td>
<td>Monthly</td>
<td>PIC &amp; E Team</td>
</tr>
<tr>
<td>Number of written complaints related to ED WT</td>
<td>≈0</td>
<td>ED Team</td>
<td>Monthly</td>
<td>PIC &amp; E Team</td>
</tr>
<tr>
<td>Percentage of patients leaving without being seen</td>
<td>≈0%</td>
<td>ED Team</td>
<td>Monthly</td>
<td>PIC &amp; E Team</td>
</tr>
</tbody>
</table>
LSS Tools Used During the Project

<table>
<thead>
<tr>
<th>Phase</th>
<th>Tool</th>
<th>Description</th>
<th>Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define Phase</td>
<td>Stakeholder Analysis</td>
<td>The team gathered and analyzed qualitative information about main process owners</td>
<td>To determine whose interests should be taken into account when developing and implementing plan of actions</td>
</tr>
<tr>
<td></td>
<td>Process Swim Lane Flowchart</td>
<td>The sequence of events from patients’ arrival until discharge were graphed</td>
<td>To identify the inputs, outputs, activity steps and decision points in the process for each patient as they progressed through their journey in ED from admission to discharge, graph cycle time for the important steps of the process and specify their value from the customer perspective</td>
</tr>
<tr>
<td></td>
<td>SIPOC</td>
<td>A template for defining a process, before mapping, measuring or improving it</td>
<td>To get a high-level understanding of the scope of the process and determine the boundaries to work on</td>
</tr>
<tr>
<td>Measure Phase</td>
<td>Data Measurement Plan</td>
<td>Is a plan to determine what data to collect, how it will be collected and reported</td>
<td>To remind the team members what they want to accomplish</td>
</tr>
<tr>
<td></td>
<td>Combined Line Graph &amp; Bar Chart</td>
<td>The number of patients admitted to ED each hour and their respective WT were plotted in parallel on a timeline chart and bar graph</td>
<td>Screening tool reflecting the relation between the number of patients admitted each hour and their WT</td>
</tr>
<tr>
<td></td>
<td>Scatter Plot</td>
<td>ED WT was plotted against the number of admissions in each hour of the day and the correlation coefficient was measured</td>
<td>To analyze the association between the WT and the number of admission to ED</td>
</tr>
<tr>
<td></td>
<td>Histogram and Box Plot</td>
<td>The frequency distribution of ED WT was analyzed</td>
<td>To locate the center of the data mean and median and visualize the spread of data (variability)</td>
</tr>
<tr>
<td>Analyze Phase</td>
<td>Control Chart</td>
<td>I-MR Control chart of WT for all patients &amp; for different subgroups based on the triage category &amp; the time of admission to ED</td>
<td>To look for common cause and special cause variations and check the process stability and behavior</td>
</tr>
<tr>
<td></td>
<td>Capability Histogram</td>
<td>Data was first tested for stability &amp; normality. Data distribution identification &amp; transformation were done when required to select an optimal distribution &amp; measure sigma level and DPMO</td>
<td>To assess if the process is able to meet the voice of customer (specifications limits set by SERA)</td>
</tr>
<tr>
<td></td>
<td>Value Stream Map</td>
<td>Following patients’ tracer (following randomly selected patients as they progressed through their journey in ED from admission to discharge), graph the cycle time for the important steps of the process and specify their value from the customer perspective</td>
<td>To assess the value added time of each step in the process that was traced and identify the activities causing non-value added time that can potentially be improved</td>
</tr>
<tr>
<td></td>
<td>Cause &amp; Effect Analysis</td>
<td>Joint brainstorming sessions facilitated by the Six Sigma team leader and key stakeholders to graph causes of long WT in a structured Fishbone Diagram</td>
<td>To identify all possible causes of the long WT and categorize systematically</td>
</tr>
<tr>
<td></td>
<td>Root Cause Analysis Rating</td>
<td>The matrix used to assess each potential root cause over impact dimensions and develop a score</td>
<td>To help rank the potential root causes with the most impact on the symptom</td>
</tr>
<tr>
<td></td>
<td>Pareto</td>
<td>A technique used for decision making based on the Pareto Principle, known as the 80/20 rule.</td>
<td>To analyze what problems need attention first because the taller bars on the chart, which represent frequency, clearly illustrate which variables have the greatest cumulative effect on a given system</td>
</tr>
<tr>
<td>Improve phase</td>
<td>Action Plan</td>
<td>Table describing recommended actions, the allocated responsibilities and the timeline for implementation</td>
<td>To follow on the action plan and ensure its implementation</td>
</tr>
<tr>
<td></td>
<td>Priority Matrix</td>
<td>Joint brainstorming sessions of the Six Sigma team and main stakeholders to plot the recommended actions in a priority matrix graph</td>
<td>A subjective method to prioritize the actions for implementation based on the easiness to implement and impact on WT improvement</td>
</tr>
<tr>
<td></td>
<td>Control Phase</td>
<td>This included an I-MR chart with Anderson test of normality, a scatter plot, a capability histogram and a summary statistics</td>
<td>To assess the pre-requisites of capability analysis (normality and stability) and measure the capability of the process</td>
</tr>
<tr>
<td></td>
<td>Capability Six Pack with Cox &amp; Box Transformation</td>
<td>Individual Control Chart for June 2014 with a historical control from January 2014</td>
<td>To assess the process behavior after improvement (lower mean WT, less variability, more stability)</td>
</tr>
</tbody>
</table>
Take Aways for success in future projects

- Engagement of key stakeholders
- Support of Senior Management
- Team collaboration
- Commitment and Clear rules of engagement
- Utilization of systematic approach and quality tools
- Continuous and close follow up
Benefits of LSS in healthcare

Defects → Non Value Activity → Costs → Leads To

Patient Satisfaction
Patient Safety & Quality
Efficiency and Effectiveness
Reputation & Financials
Bonus Take Away: A Suggested Model to Implement LSS: Findings from Fawzi Bawab PhD research

Bawab, F (2019) The Effects of Lean Six Sigma Critical Success Factors on Organizational Performance: A mixed-methods study on United Arab Emirates Hospitals, Heriot-Watt University
<table>
<thead>
<tr>
<th>Categories (Theme)</th>
<th>CSF</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic</td>
<td>Top Management Commitment</td>
<td>STMC</td>
</tr>
<tr>
<td></td>
<td>Management of cultural change</td>
<td>SMCC</td>
</tr>
<tr>
<td></td>
<td>Aligning LSS projects to business objectives</td>
<td>SABO</td>
</tr>
<tr>
<td></td>
<td>Understanding LSS methodology</td>
<td>SULM</td>
</tr>
<tr>
<td></td>
<td>Availability of resources (financial, time)</td>
<td>SAOR</td>
</tr>
<tr>
<td>Tactical</td>
<td>Linking LSS to employees</td>
<td>TLLE</td>
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<td></td>
<td>Incentive programme</td>
<td>TIPR</td>
</tr>
<tr>
<td></td>
<td>Training and education</td>
<td>TTED</td>
</tr>
<tr>
<td></td>
<td>Usage of problem-solving and Statistical thinking and tools</td>
<td>TUPS</td>
</tr>
<tr>
<td>Operational</td>
<td>Established Lean Six Sigma dashboard</td>
<td>OESD</td>
</tr>
<tr>
<td></td>
<td>Linking LSS to suppliers</td>
<td>OLLS</td>
</tr>
<tr>
<td></td>
<td>Project Prioritisation selection, management, and tracking</td>
<td>OPPS</td>
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<tr>
<td></td>
<td>Linking LSS to customers</td>
<td>OLLLC</td>
</tr>
<tr>
<td>Patient outcomes</td>
<td>Patient satisfaction</td>
<td>HPAS</td>
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<tr>
<td></td>
<td>Service lead time</td>
<td>HSLT</td>
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<td>Staff and work system outcomes</td>
<td>Satisfaction</td>
<td>HEMS</td>
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<tr>
<td></td>
<td>Turnover</td>
<td>HEMT</td>
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<td>Hospital efficiency and effectiveness outcomes</td>
<td>Productivity increase</td>
<td>HPRI</td>
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<tr>
<td></td>
<td>Number of service defects and errors decrease</td>
<td>HNSD</td>
</tr>
<tr>
<td>Flexibility performance outcomes</td>
<td>Waste reduction</td>
<td>HWARHICP</td>
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<tr>
<td></td>
<td>Increase in competitive profile</td>
<td></td>
</tr>
</tbody>
</table>
It’s all about Value...

“The central goal in health care must be value for patients, not access, volume, convenience or cost containment”.

“Health care systems need to be redesigned so that they dramatically improve patient value”.

Professor Michael E. Porter Harvard Business School
Thank you!
Education: Dr. Fawzi Bawab is a partner with Meirc. He holds a bachelor of science in civil engineering and an M.Sc. in industrial engineering with an emphasis on total quality management from University of Jordan. He also holds a postgraduate certificate in Business research methods and a doctor of philosophy (PhD) in Lean Six Sigma from Edinburgh Business School at Heriot Watt University in the UK. Fawzi is a registered professional engineer (P.E.) with the engineering association in Jordan. He is also a senior member of the American Society for Quality (ASQ), the American Institute of Industrial Engineers (IIE) and the American Society for Engineering Management (ASEM). Among the certifications he holds are: certified quality lead assessor with IRCA of England, certified TS16949 automotive assessor, approved ASQ Lean Six Sigma trainer and ASQ certified manager of quality and organizational excellence. Fawzi is a certified Six Sigma Master Black Belt (CSSMBB) and a Kaplan-Norton strategy and KPI qualified practitioner. Fawzi is a certified training practitioner (CTP) from the Institute of Performance and Learning, Canada.

Experience: Prior to joining Meirc, Fawzi held several managerial positions in Canada and the Middle East. He was the training director and a consultant with British Standards Institution (BSI)- Americas based out of Ottawa, Canada. He also was the regional business manager with BSI based in Dubai, UAE. Before that, he was the training director with KPMG Quality Registrar in North America. Fawzi also worked with IBM as the quality manager/specialist for IBM locations in the Gulf region. Earlier in his career, he worked as a quality consultant with Talal Abu Ghazleh consulting firm in Dubai. Fawzi also worked for a leading insurance company in Jordan as an assistant marketing manager and quality coordinator.

Expertise: Fawzi has more than 29 year worth of top management experience in various companies in areas of quality, strategy planning and organizational improvement. At Meirc Training and Consulting, he has been supporting and coaching organizations in achieving their business objectives through training and consulting for business process improvement. His areas of competence include delivery of top-rated public and customized private in-house training in all areas of corporate quality systems. These include: Six Sigma (black belt, green belt, champion), Lean, customer service, ISO, strategic quality planning, Total Quality Management (TQM), process improvement, leadership, Statistical Process Control (SPC), performance management and strategic management. Fawzi has trained and coached thousands of participants in different fields. He is also a frequent keynote speaker at professional conferences and meetings. Fawzi can be reached at fbawab@Meirc.com
Fawzi Bawab Aka The Quality Guy

B.Sc. Civil Engineering
M.Sc. Industrial Engineering

Over 29 Years Experience

PhD – Edinburgh Business School - Heriot-Watt

Lean Six Sigma, ISO

Business Process Improvement

Quality management systems

KPIs and Balanced Scorecards

Leadership & Strategic planning

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