Lowering Mean Time to Recovery (MTTR) in Responding to System Downtime or Outages: An Application of Lean Six Sigma Methodology

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Abstract

The longer a software or computer system service is down, the more it costs the IT organization and the more frustrated users become. The purpose of this study is to identify the factors that are responsible for the high-resolution timekeeping capabilities in responding to System Downtime or Outages. A Lean Six Sigma DMAIC framework is often used in large software companies to improve the speed at which incidents are resolved. This framework follows the DMAIC methodology, which stands for Define, Measure, Analyze, Improve, and Control. The study discusses the potential use of the Six Sigma methodology to improve the efficiency of an IT incident management process. Qualitative and quantitative research methods were used to analyze the results obtained from the company's case study. The analysis showed that the use of both methods was beneficial. Results show the main reasons for the high MTTR are the availability of the Engineers or Specialists for functional escalation and the skill set of these individuals. This constraint gives a major factor for the delay in the acknowledgment of paging alerts, leads to subsequent reassignments of the critical ticket to another person until someone is available to go online and respond, and contributes highly to resolution time. To improve the high-accuracy time and identify the influencing factors, a cause-and-effect diagram and data analysis were performed using recorded incident tickets that were flagged as a critical or system-wide issues. The statistical analysis of the obtained results showed which factors influence the effectiveness of the process. A predictive model of the DMAIC methodology was developed to help predict the resolution time of incident tickets at a company. This model helps to quantify how other factors (such as the severity of the incident, the number of involved parties, and the amount of information available) affect the length of time it takes to resolve an incident.

Keywords
Mean Time to Recovery (MTTR), Define Measure Analyze Implement Control (DMAIC), Automated Incident Management System (AIMS), Lean Six Sigma (LSS)

1. Introduction
Six Sigma is a system of quality management practices that aims to identify and eliminate defects (items that are not part of the intended population). It has been widely adopted by businesses as an essential component of quality assurance programs. The process of reducing defects below 3.4 per million opportunities was pioneered by Bill Smith at Motorola in 1986 ((Smith & Mobley 2008). The Lean Six Sigma methodology is a data-driven process used in the design, improvement, and management of processes and systems. It helps to improve the efficiency and effectiveness of these systems by identifying and correcting problems early (Dasig 2017). In this paper, a case study of an IT company that is known for providing computer-based financial data and analysis for financial professionals requires the Technology experts' personnel or Technical Solutions Engineers (TSE) to meet the demands of clients' queries reaching out on the helpdesk for technology-related assistance. Technical Solutions Engineers (TSE) primarily cover 24/7 support in handling calls, emails, and internal tickets from the client's all around the world. One of the most crucial scopes of support that the TSE team handles is to respond to and monitor the System Wide Emergency or outage incidents or tickets. Once the ticket has been tagged in a Critical status, it means a serious issue is defined as a problem (e.g., bug or incident, not an enhancement request) that is impacting a client or trial's company workflow to the point where existing or new revenue is at risk, typically totaling at least $100,000 (USD) ASV. The goal of the

study is to improve the MTTR for IT companies, which includes the full time of an outage—from the time the system or product fails to the time, it becomes fully operational again.

The main objective of this study is to enhance the service process for IT Incident Management with the aid of Lean Six Sigma DMAIC Methodology. Moreover, this study aims to analyze existing incident management workflows to determine critical roles and activities in responding to unplanned outages in responding to system-wide outages. Moreover, below are the specific objectives that will support systematically the desired output of the study: (1) Identify the stakeholder groups, activities, and process of incident management to identify the common factors that will control the resolution time (MTTR) of a critical ticket. (2) Perform statistical data analysis of the identified causes to test their significance. (3) Create a solution design from the identified statistically significant causes and implementation plan.

2. Literature Review

The literature review of well-known sources on ITIL and incident management focuses on how modern technologies can be used to manage incidents. (Cornell 2021). According to the systematic analysis, papers from these criteria can be classified into three main categories: process, people, and tools, which are critical issues for contemporary information technology service management (Ghazizadeh 2019). There were three papers on how to automatically monitor and detect incidents in real time or on the cloud. There are three papers discussing methods for automatically detecting incidents on-demand or in the cloud. Some studies found that the most popular topic among automation enthusiasts is closing tickets. Another study looked into how machine learning can be used to help make recommendations automatically, to minimize errors. According to the literature analysis, Incident Managers' stakeholders mostly support technicians who respond to incidents. It is suggested that mathematical algorithms (such as ML algorithms) be used to optimize resource allocation throughout the day to save downtime costs.

Six Sigma concepts and techniques can be applied to many aspects of IT service management, but they are primarily focused on service quality management processes. (Radhakrishnan 2011) coined IT Service Management Process Improvement is a way to improve an organization's IT service management maturity and its Continuous Process Improvement (CPI) program. Service quality is determined by the quality of people, processes, information, and technology, as well as the maturity of service quality management systems. The management of service quality is critically dependent on effective IT processes. Radhakrishnan believes that Fishbone diagrams can help identify and analyze potential causes of service issues. He has found that they are useful tools for understanding the root causes of problems and can help to find solutions. Typically, fishbone diagrams are used to identify service issues and to better understand the flow of service requests. In this case, we are using them to understand the availability of services. The fishbone diagram is a great way to visualize the different parts of a service and how they are connected. It can help you see how the various parts work together and how they are related to one another. Fishbone diagrams and analysis can help identify and analyze potential causes for service outages. Fishbone diagrams can help to identify which areas may be causing the service to be unavailable and can help to analyze what may be causing the service to be unavailable. Service availability and service unavailability are influenced by a variety of factors.

3. Methods

To minimize the MTTR, a study followed a DMAIC framework that provided structure and guidance for developing an understanding of how the output will be designed. This framework consisted of a series of steps that helped to create a clear understanding of how the output will be constructed. For the Define phase, Historical data was recorded from the Previous Fiscal year and quarter where the number of Critical Tickets and monitoring sheets was the primary basis for Hypothesis testing. For the Measure phase, ANOVA helps determine which factors are causing the variation in the measurements or if it is statistically significant or not. For the Analysis Phase, Analysis software was used to interpret the data and transform it into charts, tables, and figures for graphical and statistical analysis.

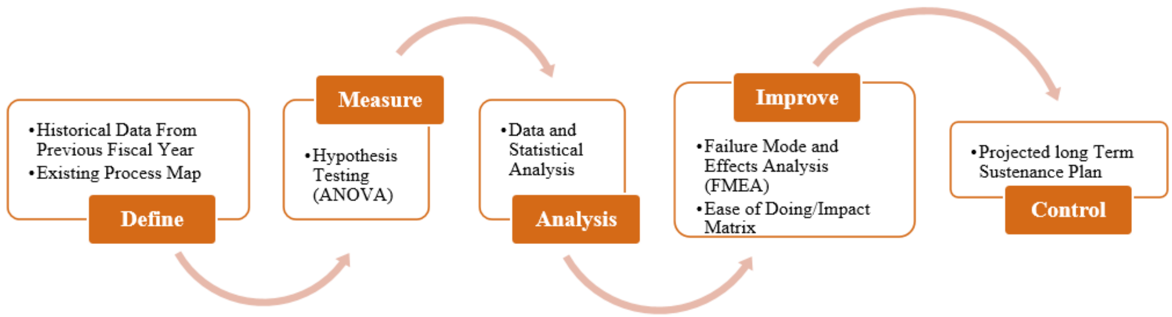

Figure 1. DMAIC Methodology

For Improve procedures, Failure Mode, and Effects Analysis (FMEA) helps to identify tasks or features that are more likely to fail and identify processes that can be improved. Moreover, the Ease of Doing/Impact matrix was used to decide and consider how much effort it will take to do something and how much potential good it might achieve for the suggested resolutions. Lastly for Control phase, it helps us figure out what needs to be done to make sure our goals are being met. Six Sigma is a data-driven methodology used in the process improvement cycle for improving the design, optimization, and continual process and design management. A sigma is a statistical measure used to quantify the variability in a process also known as Standard Deviation. Six Sigma is a data-driven and disciplined approach to measuring and improving the organization's operational performance by identifying and eliminating "defects" in manufacturing and service-related processes (Dasig 2018).

4. Data Collection

Qualitative data were collected using semi-structured interviews with stakeholders of the company that were involved in responding to and monitoring the incident management. Each interview lasted between 45 mins to 1 hour. The first set of questions established the interviewee's role and responsibilities during a system-wide downtime scenario. The second set asked the interviewee to walk the researcher through the organization's response to a "high severity" ticket that has been tagged as critical while describing the organizational structure, coordination among teams, team dynamics, routine behaviors, reporting structure, and communication protocols (Ahmad et al. 2021). Moreover, using data provided by the company, the proponent started with an overview of the company, such as its history, company objectives, and the nature of its business. For the quantitative data, the recorded historical data was recorded from the Previous Fiscal year and quarters and the number of Critical Tickets and monitoring sheets was the primary basis for Hypothesis testing.

5. Case Study (DMAIC Methodology Application)

In this study, only tickets that were categorized and alerted as Critical will undergo Data analysis as it was filed due to significant degradation of FactSet platform reliability. The historical average number of Critical ticket escalations from the recent Fiscal Year to date of FactSet was 169, which accumulated 83,998 total minutes and is equivalent to 8.28 MTTR(FY). While from the recent Fiscal quarter (April-July) we have already recorded 58 Critical tickets which have 29,121 total minutes and are equivalent to 8.37 MTTR(FQ). The management would like to control and minimize the MTTR from the recent Fiscal quarter of 8.37 MTTR(FQ) to a least low than 5. The MTTR can be computed using the formula below:

$$MTTR = Total\ hours\ of\ downtime\ /\ Number\ of\ incidents$$

5.1 Define Phase

In the Define Phase, a Project Charter was made to outline the overall process and overview and improvement of the project. It also serves as an agreement between management and the six-sigma team regarding the expected project outcome. SIPOC (Suppliers, Inputs, Process, Outputs, and Customer) shown in Figure 2 identifies all relevant elements of a process improvement project before work begins and helps to define a complex project that may not be well-scoped (Juran 2018). Further in this phase, the Problem Definition Tree branches out more details about the problem and what the customer needs. These requirements must be translated into measurable product and process requirements. (Bisk 2020).

Figure 3 shows, that 96% of Critical Tickets are Non-Class A issues, 78% of Critical Tickets affect multiple regions and 78% of Critical Tickets affect multiple types of clients (firm). This concludes that regardless of Class, Region, or location, and some clients affected by the issue, the MTTR can be controlled. Further, an interview with a cross-functional team was conducted to investigate the causes of high values of MTTR. The team comprised Engineers (Tier 1 and Tier 2), Product specialists, and Software Dev teams. The main causes and the sub-causes were as identified: (1) People - Lack of knowledge on how to fix the problem. (2) Class A service (Class A services, incident tickets depend on other services and are more challenging to fix. (3) Monitoring - Incorrect data entries and logs in ticket and Monitoring sheet. (4) Measurement - Large Calibration time and System reporting issues. (5) Escalation - Tier 2 and EOC acknowledge the Critical ticket for more than 10 mins. And a Dedicated Product Specialist or Software Dev team comes from a different region/time zone Technical Process. (6) Technical Documentation - Missing important information in SOPs or Tech Documents.

SUPPLIERS	INPUTS	PROCESS	OUTPUTS	CUSTOMERS
Who are the suppliers of these inputs (both internal & external)	**Identify major inputs required to run this process**	**Show the high level process steps (no more than 6) that transform the inputs to outputs**	**Identify major outputs of this process**	**List the customers who receive these outputs (both internal & external)**
Client Support Engineers	Call/Ticket Management Software		Call/ticket Logged to customer file	Cleints
		Client calls the Support Desk ↓		
Software Development Team	Enhancement Request Database		New version of Product/Software	Service Organization
		CSE/GS will try to resolve client's query ↓		
Product Specialist	Client Documentation database		MTTR	
		If not resolved, follow escalation procedure ↓		
General Support team				
		Diagnosis + Corrective Maintenance ↓		
		System Handover + close ticket		

Figure 2. SIPOC Diagram

Voice of Customer:	Faster resolution of system-wide issues				
Basis of Split					Reason to eliminate boxes
Type of Critical Issues	Non-class A services	Class A services			96% of Critical Tickets are Non-Class A issues
The region with Critical issues	Multiple regions are affected	Americas only	EMEA only	APAC only	78% of Critical Tickets affect multiple regions
Type of Clients	Multiple types of clients are affected	Large (<100 users)	Medium (50 up to 99 users)	Small (>50 users)	78% of Critical Tickets affect multiple types of clients (firm)
Updated Problem:	Reduced Mean Time to Recovery (MTTR) in Responding to System Downtime or Outages of FactSet				

Figure 3. Problem Definition Analysis

In the work sampling approach, different pieces of data from saved monitoring sheets were used at certain times, instead of always using all the data. The interval is random to determine which task or component the Engineers spend the most time on by looking at how often and how long it showed up in each random sample. Begin by breaking the task down into smaller parts and record your times as you complete them. Each step in the process of responding to Critical alerts, from acknowledging them to standing down, was analyzed to see if there were any efficiencies to be found. From the root cause analysis that was discussed, the task was observed by asking questions to the affected team who is handling and acknowledging Critical or system-wide alerts. Through interviews, possible factors were broken down to identify causing of high MTTR c. 20 respondents from a different department that handles Critical or System-wide time were asked "What factors do they think can drive high MTTR?", results show that 75 % of answers point that the main issue due to competency and knowledge in fixing the critical problem and the type of class service it belongs to, they believe it affects the resolution time. The escalation factor got the highest score of 90% which describes the acknowledgment time and availability of the relevant team to respond ASAP on the issue.

5.2 Measure Phase

To validate the measurement system, MTTR for each Critical ticket was computed automatedly in Excel. The total MTTR for each Fiscal Quarter and Fiscal Year was shown in Table 1. The metric of interest was the time to repair (MTTR) and diagnosed the issue of the ticket that was tagged as Critical. The source of data was the observation of records on when the ticket has been tagged or raised to Critical until the issue subsided or was fixed. Moreover, the source of data was the record entered into the database by the Emergency Curator Engineer (ECT1 / ECT2) in monitoring the Critical Ticket.

Table 1. MTTR Summary for the Previous Fiscal Year

Item	MTTR FQ-1	MTTR FQ-2	MTTR FQ-3	MTTR FQ-4	Total
No. of Critical Escalations	29	42	40	58	169
Critical in Minutes	11432	18211	25234	29,121	83998
MTTR (Hours)	**6.57**	**7.23**	**10.51**	**8.37**	**8.28**

The MTTR of each Critical Ticket from the previous Fiscal Quarter (FY) was used to provide the central value of a characteristic produced by the current process shown in Figure 4. Problem Analysis was derived from the possible listed categories to determine the areas of focus and get a clear and shared understanding of the issue. Moreover, the Measured MTTR value from the previous FQ was used to interpret and determine if the process is under control. As shown in Figure 5, the specification limits are LSL = 4 and USL = 8, and using the benchmark values for MTTR, the capability of the current process as shown in Figure 5 below was proven that the Baseline is Poor.

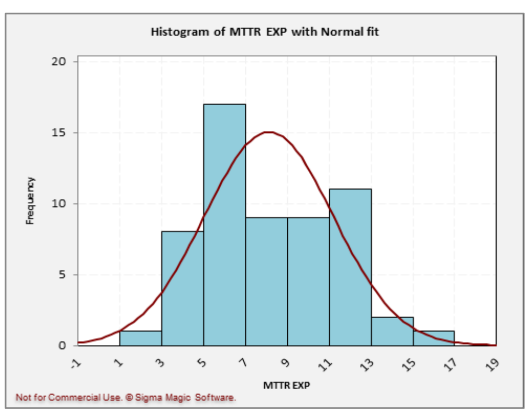

Figure 4. Histogram derived from MTTR (FY)

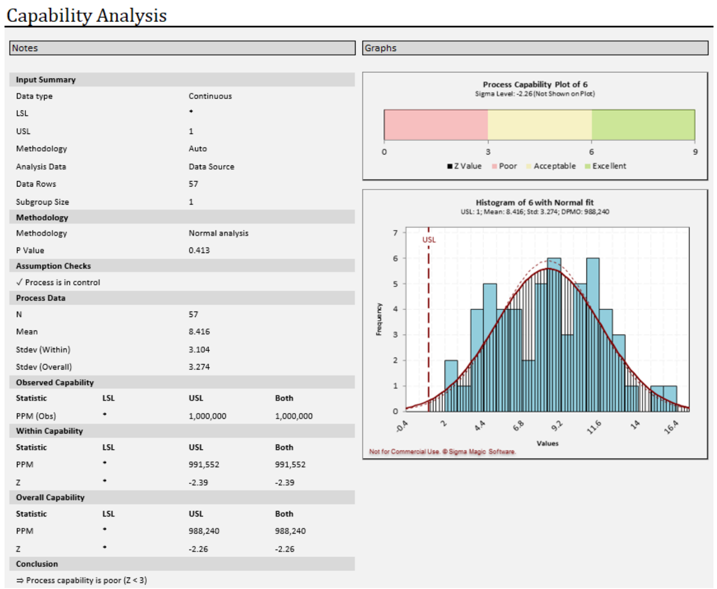

Figure 5. Existing Process Capability Analysis

4.3 Analyze Phase

From the process Map shown in Figure 6, a sequence of steps of the current as-is process was identified and a cross-functional team was formed to investigate the causes of high values of MTTR. The team comprised clients, Engineers (ECT1 and ECT2), Product specialists, Software Dev team. Figure 7 shows the cause-and-effect Diagram that identifies the potential and most likely causes of high MTTR.

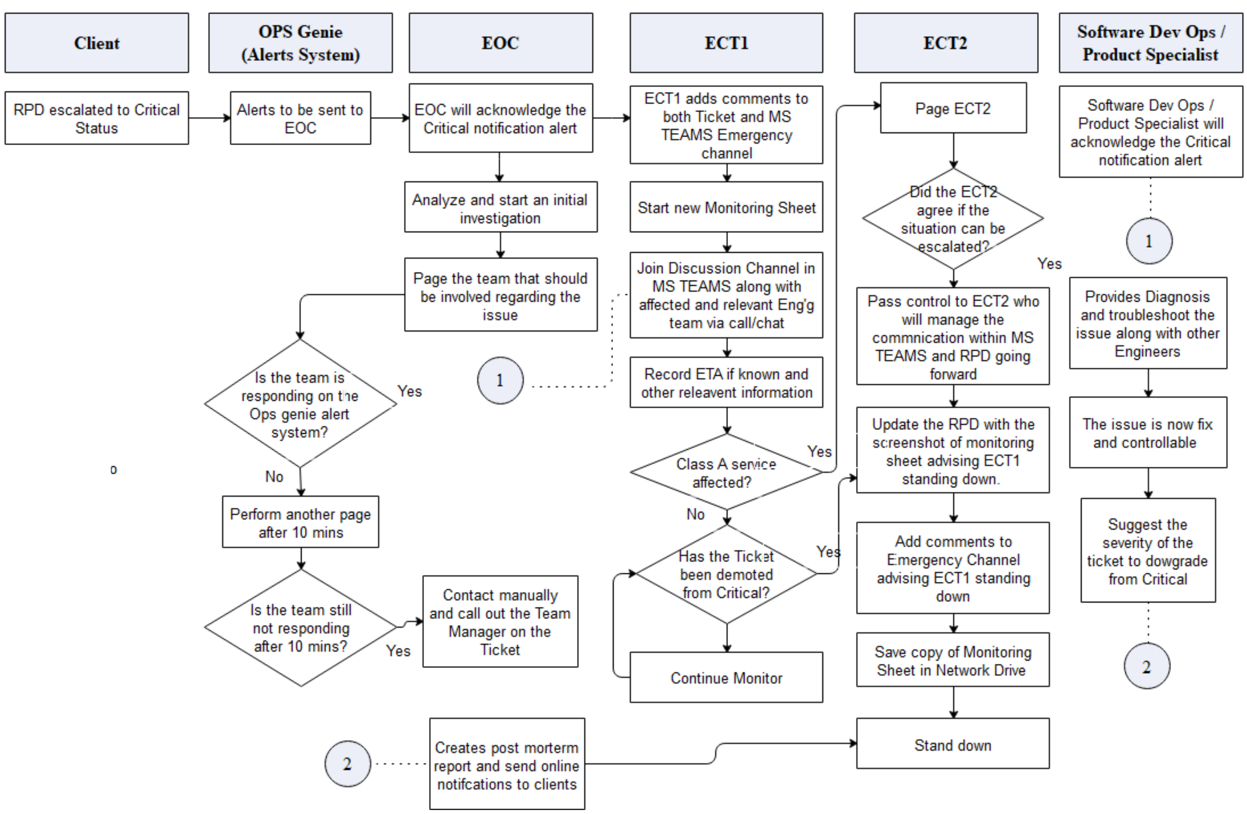

Figure 6. As Is Process Map

Cause & Effect Diagram

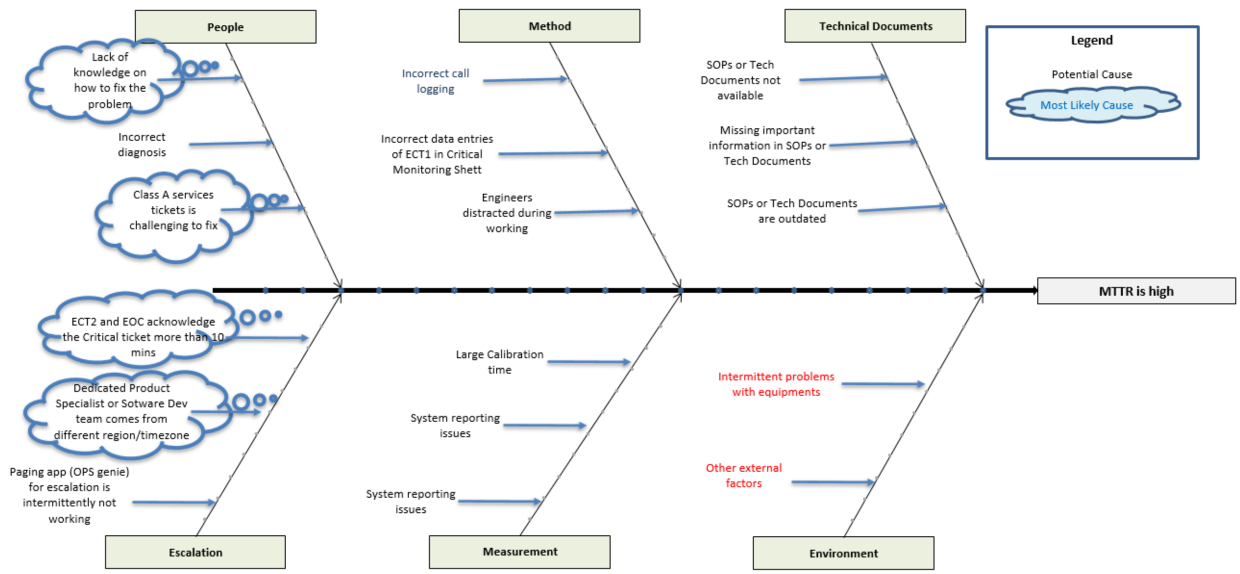

Figure 7. Fish Bone Diagram

5.3 Analyze Phase

Based on the root cause analysis, data were collected to validate the most likely potential causes –hypothesis tests were performed to determine if these causes are statistically significant and practically important to address the issue of high MTTR. Data shown in this section was based on the 58 documented Critical Monitoring sheets from the last Fiscal Quarter (FQ).

5.3.1 MTTR in Experience and Skill Level of Engineers/Specialist

Data on MTTR with experienced and inexperienced Product Specialists and Software Dev is shown in Table 2. From the 58 critical tickets, the team that mainly helps fixed the issue was divided into three groups:

- Less Exp (hired less than 1 year ago)
- Mid Exp (hired more than 2 years up to 3 years)
- Senior Exp (hired more than 3.1 years ago)

Table 2. MTTR Exp

Exp Level	No. of Tickets	Ave MTTR (hours)
Senior Exp	43%	6.25
Mid Exp	38%	8.77
Less Exp	19%	11.08

From the data gathered, the Analysis results are shown in Figure 8 shows the data is **Statistically Significant!**

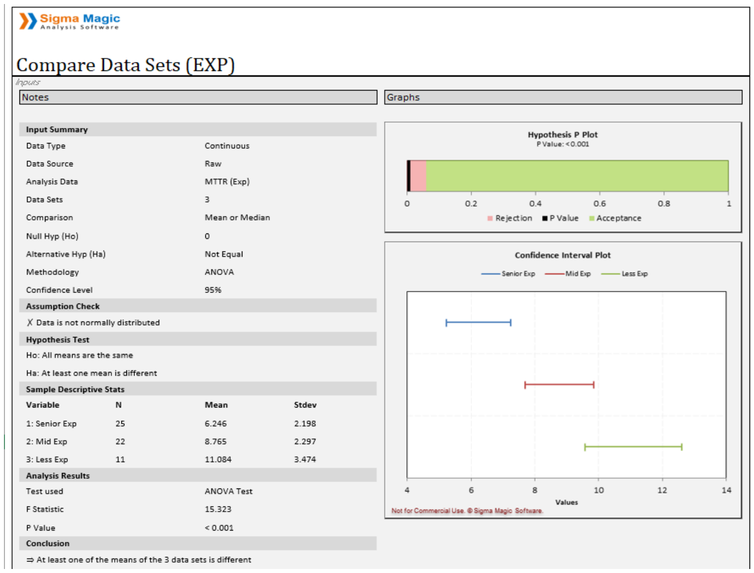

Figure 8. Anova (MTTR Exp)

5.3.2 MTTR Class A Services

Data on MTTR if Class A services were affected by the Critical Ticket is shown in Table 3. From the 58 critical tickets, two types of classes were categorized:

- Class A (Immediate escalation required to ECT2)
- Non-Class A (Follow Normal Critical Monitoring Procedure)

Table 3. MTTR Class

Class	No. of Tickets	Ave MTTR (hours)
Class A	12%	6.57
Non-Class A	88%	8.35

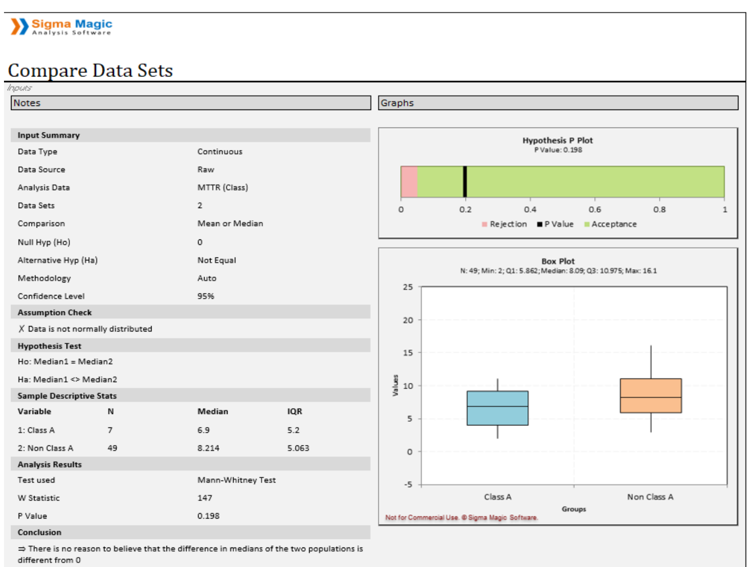

Figure 9. Anova (MTTR Class)

From the data gathered, the Analysis results shown in Figure 9, shows the data is **Statistically NOT Significant!**

5.3.3 MTTR in Acknowledging the Paging Alerts

Data on MTTR if the assigned EOC and ECT2 were able to acknowledge the Critical Ticket on time, data shown in Table 4.

Less than 10 mins acknowledging in Op's genie App and Microsoft teams are acceptable for EOC and ECT2 to respond. However, there are some cases there will be no assigned EOC or ECT2 can join despite of paging request, manually paging of other available Engineers will be implemented.

- On-time (>10 mins acknowledgment)
- Delay (<10 mins acknowledgment)
- No Res (No response)

Table 4. MTTR Ack

Acknowledge	No. of Tickets	Ave MTTR (Hours)
On-time	64%	6.59
Delay	31%	10.42
No Res	5%	13.18

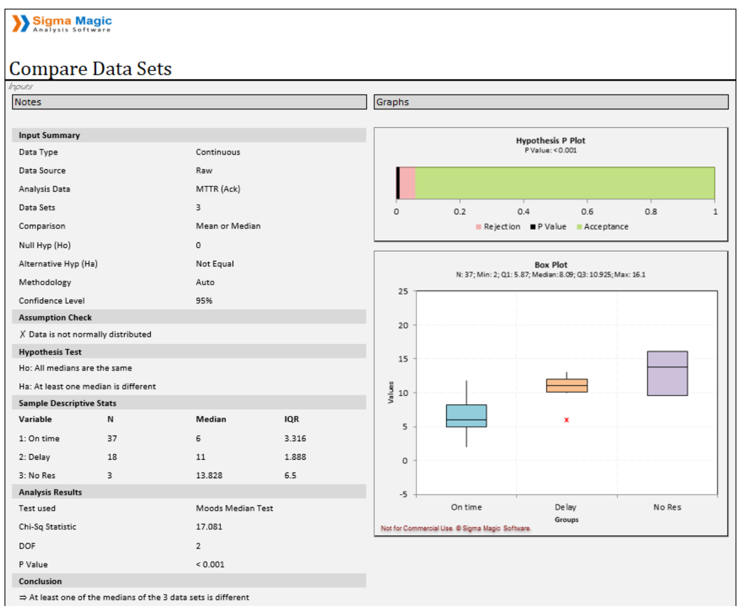

Figure 10. MTTR Ack

From the data gathered, the Analysis results are shown in Figure 10, shows the data is **Statistically Significant!**

5.3.4 MTTR in Availability of Engineers/Specialists to Respond to Paging Alerts

Data on MTTR if the dedicated Product Specialist or Software Dev team is from a different time zone or Region and might be unable to respond ASAP, data shown in the Table below. From the 58 critical tickets, below are the data:

Table 5. MTTR TZ

Acknowledge	No. of Tickets	Ave MTTR (Hours)
1st Attempt	67%	6.65
2nd attempt	28%	10.54
The manager wascalled out	5%	14.31

Figure 11. MTTR TZ

From the data gathered, the Analysis results shown in Figure 11– (MTTR TZ) show the data is **Statistically Significant!**

5.3.5 Data and Statistical Analysis

For the Data and Statistical Analysis, three out of 4 causes show significance and each of them computed the number of hours Impact and the size:

**No of Hours Impact = MTTR (7 and above) x No. of Tickets*
**Size of Impact =Total No. of Critical Tickets that has an MTTR above 7 / Total No. of Critical Tickets*

Table 6. Size and Impact of High MTTR

No.	Cause	Significant	Size	Impact
1	Experience and Skill Level of Engineers/Specialists	Yes	57%	157.38 Hrs.
2	Class A service is affected	No		
3	EOC and Tier 2 Acknowledgement	Yes	36%	113.56 Hrs.
4	Availability of Engineers/Specialists to Respond to Paging Alerts	Yes	33%	105.76 Hrs.

Table 6 reveals that the lack of knowledge and experience level of Engineers and Specialists could result in more time in identifying the root cause of the critical issue to fix or providing an ETA to the resolution to the clients. This is mainly caused by the lack of supervision of senior team members who are not available to consult online. On the other hand, the problem in the escalation of Critical tickets to dedicated Engineers/Specialist to Respond to Paging Alerts become evident as the major cause of high MTTR. Aside from unavailability, there is no current rotational shifting for 24/7 coverage of each team to respond to System-wide emergencies or critical issues.

Table 7. Ease of Doing/Impact Matrix

#	*Description*	*Impact on the Problem (40%)*	*Ease to implement (30%)*	*Risk (30%)*	*Score*	*Rank*
1	*Refresher Training for all Engineering team Responders*	*10*	*9*	*8*	*9.1*	*1*
2	*Product Specialist and Software Dev team to publish solutions to a central database*	*5*	*7*	*7*	*6.2*	
3	*Share tips for routine Diagnosis*	*7*	*9*	*5*	*7.0*	
4	*Buddy System to share knowledge and best practices*	*7*	*7*	*8*	*7.3*	
5	*Create rotational shifts for the Product Specialist and Software Dev team for 24/7 availability*	*10*	*2*	*5*	*6.1*	
6	*Manage vacation and absenteeism so that someone will be available*	*10*	*7*	*8*	*8.5*	*2*
7	*Maintain SOP records of required parts by type of call*	*2*	*3*	*1*	*2.0*	
8	*Train other resources to fill gaps*	*9*	*8*	*8*	*8.4*	*3*

5.4 Improve Phase

For strategic prioritization ease of doing/impact matrix was created in finding the most impactful ideas that require the least amount of effort. The developed matrix shown in Table 7 was the product of the brainstormed actions across the involved team in responding to system-wide critical alerts. The activities were evaluated and rated in turn on how much they will impact the goal on a scale of one to ten, with one being not much and ten being a lot. Then three criteria with corresponding weights were used to measure the impact, ease, and risk of implementation. Based on the results 3 out of 8 got the highest scores which means those items are needed to be set as a high priority for implementation.

5.4.1 Failure Modes and Effects Analysis

The following solutions were considered in Table 8, and all the inputs were based on inputs from the involved team, also the possible failure modes for the selected solutions and take actions to reduce the risk were highlighted. The RPN is calculated by multiplying the three scoring columns: Severity (S), Occurrence (O), and Detection (D). RPN = Severity x Occurrence x Detection. Table 8 below shows that the severity/criticality, probability of occurrence, and probability of detection scores are from 1 to 10. A score of 1 is low risk, and a score of 10 is high risk. In this study, we consider the RPN score higher than 200 to be considered in high risk that requires an immediate corrective action.

Table 8. FMEA

#	*Structural Element*	*Failure Modes (FM)*	*Failure Effects (FE)*	*S*	*Failure Cause (FC)*	*O*	*Prevention Control (PC)*	*D*	*RPN*
1	*Refresher Training for all Engineering team Responders*	*Training is ineffective*	*No impact on MTTR*	*7*	*No independent review of materials*	*6*	*Assess the developed materials by SMEs or Senior level team members*	*10*	*420*
2	*Refresher Training for all Engineering team Responders*	*Training is not attended by the employees*	*Variability is MTTR by employees*	*5*	*Not required to attend*	*5*	*Maintain logs and link to the year-end performance appraisal process*	*10*	*250*
3	*Refresher Training for all Engineering team Responders*	*New employees are not covered*	*Variability is MTTR by employees*	*5*	*No process to cover new employees*	*4*	*Put it as part of the new employee orientation program*	*10*	*200*
4	*Manage vacation and absenteeism so that someone will be available*	*Emergency Leave or Sick leave*	*A dedicated Product Specialist and Software Developer will be not available*	*7*	*No backup assigned People to respond on the paging system*	*7*	*Create a schedule for Critical ticket responders that will cover 24/7 coverage, with the primary and secondary assignees*	*10*	*490*
5	*Manage vacation and absenteeism so that someone will be available*	*Staffing issue*	*A dedicated Product Specialist and Software Developer will be not available*	*7*	*Unmanaged leaves Policies*	*8*	*Revisit the company and employee manual and implement a strict Leave of Absence Policy*	*10*	*560*
6	*Train other resources to fill ECT2 gaps*	*No other resources could be found*	*ECT2 is not available*	*4*	*No Development Plan*	*3*		*10*	*120*
7	*Train other resources to fill ECT2 gaps*	*Other resources are not at the level that they can be trained*	*ECT2 is not available*	*4*	*No Development Plan*	*2*		*10*	*80*

5.4.2 Improved Process

The refresher training and managing of vacation and absenteeism create a huge impact to improve the overall process. Based on the new 10-day MTTR that was computed from September 22 – September 30 in Table 9, the average MTTR drops to 5.03. Previous MTTR from the past Fiscal Quarters shown in Table 10 compares all previous MTTR values. From FQ1-FQ4 average MTTR is all above 6, while the recent measure is doing not exceed 6.

Table 9. FQ's 10-day MTTR comparison

	Period	No Critical Tickets	AVE MTTR
FQ 1	Oct 5 -14	9	7.90
FQ 2	Jan 4 -13	12	6.50
FQ 3	April 5 -14	11	8.10
FQ 4	July 5 -14,	7	6.25
	Sept 22 - 30	**11**	**5.03**

Table 10. MTTR from September 22 to 30

Date	Day		No Critical Tickets	No. of Hours	MTTR
22-Sep-22	Monday	Weekdays	1	9.5	9.5
23-Sep-22	Tuesday	Weekdays	2	5.5	2.75
24-Sep-22	Wednesday	Weekdays	2	4.5	2.25
25-Sep-22	Thursday	Weekdays	1	11	11
26-Sep-22	Friday	Weekdays	2	6.5	3.25
27-Sep-22	Saturday	Weekend	1	2.5	2.5
28-Sep-22	Sunday	Weekend	0	0	0
29-Sep-22	Monday	Weekdays	1	1.5	1.5
30-Sep-22	Tuesday	Weekdays	1	12.5	12.5
			Total No. Tickets	**Total No. of Hours**	**Ave MTTR**
			11	**53.5**	**5.03**

5.4.3 Forecasted MTTR

To further validate the applied six sigma on the process, a forecasting method was formulated and it gives the possible average MTTR for the coming Fiscal Quarter period from October to December, shown in Table 11. An Exponential smoothing method was used with a dumped factor of 0.3 given the data is smoothed (or averaged) from one period to the next. Results show the forecasted MTTR values, the average MTTR for October to December gives the overall possible MTTR of 4.7102. This is 1.55 lower than the Fiscal Quarter and the desirable value was met as the MTTR is lower than 5.

5.5 Control Phase

To successfully achieve a goal in the long-term run, we must be able to measure progress. MTTR is the average time it takes for a tool or process to recover from any failure. The long-term sustenance plan below shows ground rules for using MTTR wisely from a long-term plan perspective shown in Table 12.

Table 11. Forecasted MTTR (Oct- Dec)

Date	*MTTR*	*Date*	*MTTR*	*Date*	*MTTR*
1-Oct	*4.775*	*1-Nov*	*4.427713*	*1-Dec*	*4.90874*
2-Oct	*3.0075*	*2-Nov*	*5.547036*	*2-Dec*	*4.034449*
3-Oct	*8.60225*	*3-Nov*	*5.20697*	*3-Dec*	*3.800708*
4-Oct	*4.855675*	*4-Nov*	*5.778088*	*4-Dec*	*4.199844*
5-Oct	*3.206703*	*5-Nov*	*5.851005*	*5-Dec*	*4.633585*
6-Oct	*0.962011*	*6-Nov*	*5.188389*	*6-Dec*	*5.057502*
7-Oct	*1.338603*	*7-Nov*	*3.87936*	*7-Dec*	*5.39449*
8-Oct	*9.151581*	*8-Nov*	*2.760007*	*8-Dec*	*5.454478*
9-Oct	*6.087974*	*9-Nov*	*3.927401*	*9-Dec*	*5.072461*
10-Oct	*3.931642*	*10-Nov*	*5.061145*	*10-Dec*	*4.345852*
11-Oct	*7.201068*	*11-Nov*	*5.163223*	*11-Dec*	*3.964251*
12-Oct	*5.559293*	*12-Nov*	*5.593629*	*12-Dec*	*4.129166*
13-Oct	*3.91248*	*13-Nov*	*5.773792*	*13-Dec*	*4.482259*
14-Oct	*1.847151*	*14-Nov*	*5.36401*	*14-Dec*	*4.884929*
15-Oct	*1.491168*	*15-Nov*	*4.324755*	*15-Dec*	*5.241622*
16-Oct	*6.853457*	*16-Nov*	*3.229431*	*16-Dec*	*5.390621*
17-Oct	*6.317619*	*17-Nov*	*3.71801*	*17-Dec*	*5.167909*
18-Oct	*4.647435*	*18-Nov*	*4.658205*	*18-Dec*	*4.592469*
19-Oct	*6.434978*	*19-Nov*	*5.011717*	*19-Dec*	*4.152717*

20-Oct	*5.821998*	*20-Nov*	*5.419055*	*20-Dec*	*4.136231*
21-Oct	*4.485335*	*21-Nov*	*5.667371*	*21-Dec*	*4.378451*
22-Oct	*2.638607*	*22-Nov*	*5.455018*	*22-Dec*	*4.732986*
23-Oct	*1.835399*	*23-Nov*	*4.663834*	*23-Dec*	*5.089031*
24-Oct	*5.34804*	*24-Nov*	*3.659752*	*24-Dec*	*5.300144*
25-Oct	*6.026745*	*25-Nov*	*3.700533*	*25-Dec*	*5.20758*
26-Oct	*5.061228*	*26-Nov*	*4.370903*	*26-Dec*	*4.777003*
27-Oct	*6.022853*	*27-Nov*	*4.819473*	*27-Dec*	*4.340002*
28-Oct	*5.882255*	*28-Nov*	*5.239181*	*28-Dec*	*4.197363*
29-Oct	*4.904411*	*29-Nov*	*5.538914*	*29-Dec*	*4.324124*
30-Oct	*3.318348*	*30-Nov*	*5.480187*	*30-Dec*	*4.610327*
31-Oct	*2.280284*			*31-Dec*	*4.94542*
AVE MTTR	*4.639003*	*AVE MTTR*	*4.815937*	*AVE MTTR*	*4.6757*
Forecasted MTTR for FQ (Oct- Dec) = 4.7102					

Table 12. Long Term Sustenance Plan

Task Name	Purpose	Owner
Quality Monitoring	The data flowing through the application, server, and infrastructure must be monitored closely to ensure that it arrives at its destination on time and with no errors.	Senior Engineer, Team Leads, Manager, Infrastructure team
	When assessing a solution, keep in mind how it's being applied and how to resolve an incident as quickly as possible.	Senior Engineers, Team Leads, and Manager
Take advantage of AIOps capabilities to detect incidents, diagnose them, and resolve them faster.	AIOps are AI applications that help to automate tasks and processes in IT operations. These applications use artificial intelligence (AI) and machine learning to analyze data generated by software systems to predict possible problems, determine the root causes, and drive automation to fix them.	Senior Engineers, Team Leads, Managers,
	Preventing problems from happening in the first place is a key part of good production or customer service.	
	Intelligent alerting and escalation allow incidents to be automatically routed to the people or teams best equipped to respond.	
Create Centralize SOPs related to handling, troubleshooting, and Monitoring System-wide incidents or tickets	Write it all down and use these notes to create "runbooks" — documentation that tells emergency services exactly what to do when a specific problem arises.	Senior Engineers, EOCs, Senior Product Specialists, and Senior Software Dev Ops
	Use runbooks to collect your team's "tribal knowledge" about a given incident-response scenario in one document. In addition to helping, reduce MTTR, runbooks are useful for training new team members, and they're especially helpful when important members of the team leave the organization.	
Random reviewing and follow-up on previous Critical tickets	What can be done to prevent this from happening again in the future?	Senior Engineers, EOCs, Senior Product Specialists,

to understand how and why they occurred		and Senior Software Dev Ops

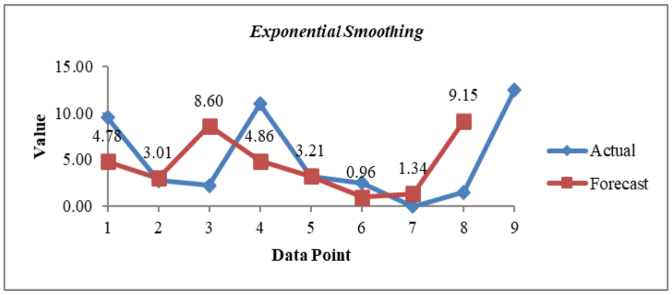

Figure 12. Exponential Smoothing

5. Summary and Conclusion

Six Sigma DMAIC methodology has been successful in improving the overall process to reduce the MTTR. This methodology focuses on continuous improvement and strives for continuous improvement. This continuous improvement leads to a shorter MTTR, which in turn leads to a more efficient and effective process. One important point to note in this case is that simple solutions were successful in achieving the desired results, without any additional cost or investment required from the company. The Ease of Doing/Impact Matrix table shows the ease of performing different actions and the impact those actions have. It is a helpful tool for decision-makers who want to know which actions are easiest and most effective. Having clearly defined roles and responsibilities is key to managing incident response and reducing MTTR in this study. The EOC is responsible for managing incidents and adapting and improving the process as necessary. ECT1 is a single point of contact for end users reporting service outages. This group is responsible for classifying incidents and routing them to the appropriate second-line support personnel if the first-line support is unable to resolve the incident. They also monitor repair activities and update users on the incident status. ECT2 technicians typically have more advanced knowledge than first-line support staff. This is because ECT2 technicians have undergone additional training in the field. First-line support staff, on the other hand, are typically less experienced than ECT2 technicians. Therefore, frontline support personnel may be enlisted to help with incidents that first-line support can't resolve. And the Product Specialist and Software Dev Support responders are the main ones responsible for interacting with third-party software or hardware vendors to help quickly restore normal service.

From the Statical Data Analysis, it was proven that the selected factors can diminish the hours in resolving system-wide incidents tickets and their impact are significantly relevant in lowering the MTTR. Further, through formulated Ease of Doing/Impact Matrix and Failure Modes and Effects Analysis, we can assure that the implementation plan will be successful as highlights the prioritizing of actions, and risks, and develops countermeasures. Refresher training can help prevent one of the most dangerous incident-response risks: situations in which only one person knows a particular system or technology. Overall, the long-term sustenance plan in lowering the MTTR for this study is to continuously improve the quality monitoring, Leverage AIOps capabilities, Create Centralize SOPs, and Random reviewing and follow-up on previous Critical tickets, this will contribute to maintaining lowering the MTTR and creates best-in-class incident response process of the company. The forecast gives the overall possible MTTR of 4.7102. This is 1.55 lower than the Fiscal Quarter and the desirable value was met as the MTTR is lower than 5.

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Biography

Arnold I. Aguilar has been in the IT industry for almost 5 years, he works as a Technology Solutions Engineer in a Financial Data company located in Taguig City, Manila. He is primarily responsible for coordinating technical services and development to provide solutions to clients' problems. This included providing problem analysis and driving a timeline and maintaining high customer satisfaction while involved and responding to critical tickets. He obtained his bachelor's degree in Computer Engineering at San Sebastian College – Recoletos de Cavite in the year 2015. And currently, he is pursuing his Master's in Engineering in Industrial Engineering at De La Salle University – Manila. His research interest includes Operations Management, Service Quality Improvement, and Lean Six Sigma Methodology Management.