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SIX SIGMA APPROACH FOR REDUCING THE SLA'S RESOLUTION TIME: A CASE IN IT SERVICES ENABLED INDUSTRY

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ABSTRACT

The Six Sigma is an innovative, systematic, data-driven methodology for improving processes that reduce waste and defects/errors. The dynamic measure within Six Sigma is the number of defects and identifying the causes for variation. The variations are agile that creates uncertainty in delivering the desired outcome. Service organizations are offering services at a predetermined level stated in SLA. This paper attempts to standardize, reduce variation in offering service quality through identifying the causes of variations in the project operations by establishing specifications. The study shows the deviations among the projects teams. Analysing the time-variation in resolving the problems encountered in different projects, variation in the projects lapsed the delivery content within the SLA. Results after introducing process capabilities and online auto-triggering system enabled, variation in resolution times dropped. Team members were redeployed to other projects thus time-variations is controlled with multiple business opportunities.

Keywords: process capability; resolution time; quality function deployment; service level agreement; six sigmas, time-variation
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1. INTRODUCTION

The quality is doing the things the right way for the first time and continuing it. An individual uniquely defines it. The variation in the process mainly causes errors. The error in the process may be assignable or unassignable. Based on the levels of sigma (std. deviation) quality is defined by one sigma, two sigma's, three sigma's….. six sigma's…….nine sigma's (Brady &

Allen, 2006). The equal quality is a function of expected service levels to be maintained hence there is a need for an agreement with the client/customer. An agreement is formally known as Service Level Agreement (SLA), mutually agreed by both the parties (e.g., Goo et al., 2009). The SLA is standardized based on the action of items to be executed on the importance of the task to be performed (Wu & Buyya, 2012). As a case Priority one (P1), Priority two (P2), Priority three (P3) and Priority four (P4) that may be critical, high, medium, low for the operational efficiencies of the clients and that need to be defined in the SLA. The support team was usually known as Special Working And Tactics (SWAT) team are assigned the ticket based on the issue type and based on the importance; it will be assigned to one of the priorities. The SWAT teams have to coordinate, keep updated on the issue, create a Log records and relevant incidents, live checkmate in the banners and conduct sanity test as the process demands. This study is essential for regulating the manpower plans, optimizing the time resources and reducing the variation in the process.

2. LITERATURE REVIEW

2.1. Six Sigma

The Six Sigma is a systematic, data-driven methodology for improving processes by reducing waste and defects or errors (cf. Tjahjono, 2010). It is a well-structured continuous upgrading methodology that minimizes the process variability and removes waste in any processes (Banuelas & Antony, 2004; Thawani,2004). The process axioms are controlled and streamlined with pre-set objectives (Antony et al., 2005). Similar literature threads are available on the six-sigma application that expresses; it is a technique for improvement, performance and efficiency measures that reduce the horizontal to lean and vertical (Bunce et al., 2008). The redundant process, methods are all controlled and regulated through sigma approach which identified the variance in the process (Goh & Xie, 2004; McAdam & Evans, 2004; *cf*. Tjahjono, 2010).

Quality and six sigmas are intervened process and house of quality is a comparing matrix also called Quality Matrix that is linked to Quality Function Deployment (QFD) (e.g., Chan & Wu, 2002). The matrix gives details like customer requirements, technical descriptors. Notably, while the service level agreements are signed between two parties, there is a need for meeting clients requirements without deviation. The House of quality (HOQ) is synonymous with customer needs to be fulfilled through a systematic approach (*cf.* Basri, 2015; Fabik et al., 2013; Hauser, 1993). Synthesizing on the HOQ, the authors draw parallel's such as House of priority (HoP) focused on the methodology to do a comparative study. The comparison is based on projects and priorities.

2.2. Process Capability:

Process capability tool that investigates the practicing and process that meet specifications in products or services (Yum & Kim, 2011). The indicator of measure identifies the shift in the process. The Process Capability Index (Cpk) is an indicator (a pure number) that measures the process deviations concerning the specification limit, relative to the natural variability from the mean (*cf.* Tapke et al., 1997). Service level agreements are again sub-categorized based on the priorities as priority 1(P1, P2, P3, P4) concerning Critical, High, Medium, Low, the customer requirement defines that and depending on the error occurred. Authors, Choi, 2005 and Halawany, 2014 have put forward that deploying the SLA and satisfying the customer by fixing the issues within preferred time. A framework to carry the SLAs to provide more service to the customer and differentiate the priorities based on the importance and delivery impact and have put forward Six Sigma in SLAs to minimize the risk in Cloud computing

(Oktadini & Surendro, 2014). To reduce the risk they reorganized the management, severity awareness and service level agreements by introducing the Virtual Private Network. Authors like Moyne et al., 2016 in their research highlights the capability of the server to hold the more data also the alerting system to predict the available capacity to hold the data. Liu et al. (2005) have proved the need for Service Level Agreements with the service provider and the client side. Also, they have worked on the problem of flow traffic that can be interacting with other flow and average of flow becomes poor. They have considered conformance deterioration flow for aggregates and individual.

In some cases, an individual flow will be negotiated with SLAs with networks concerning its end to end connection. A paper on Quality of services (QoS)-aware approach to monitoring violations of SLAs with the tool Internet of Things (IoT) (Alodib, 2016). Here SLA acts as the observation for deviation in the process of implementing the SLAs for small process and then deploying entire SLAs into a Petri net model for securities issues. Huai (2010) has put forward the study of Design Service Level Agreements in Outsourcing Contracts. Researchers, Disi & Zualkernan, 2009 have studied SIPOC (Supplier, Input, Process, Output, and Consumer) tool that summarizes the confirmation to rules are reaching the new requirements through six sigma processes, and six sigma has multiple effectiveness to improve the process/services. The primary purpose of designing service level agreements is to eliminate the gap between an outsourcing service vendor and the customer.

The primary focus of research presented here is on the variation on reaching the resolution time concerning the SLA process. Processes that provide services commonly exhibit some variation in their output. Process control is concerned with monitoring quality, while the product/service is produced. To apply Six Sigma methodologies to resolution time in SLAs and to identify the priorities, a tool such as House of priority (HoP) is adopted.

3. RESEARCH OBJECTIVES:

RO_1: To compare the resolution time-variations in different projects and to assess the time variant.

RO_2: Identifying the time variant in all projects and critically evaluating the priorities that need more responsiveness.

RO_3: To design an alarming method, that eliminates the non-value-added process.

RO_4: To maintain the uniform resolution time in the all project SLAs by deploying Six-Sigma methodology.

4. METHODOLOGY:

Methodology plays an essential component of the project that has helped to initiate the research approach and to zero it down at a strategy that contains both quantitative methods along with nominal measurement designs. This study is applied research based on the quantitative research approach that seeks a solution to balance the level of variation with the projects. The Figure 1 display the team process flow diagram that runs on the 24x7 and the process follow up steps. Any deviations/crossing the timeframe against the SLA leads to an escalation of incidences.

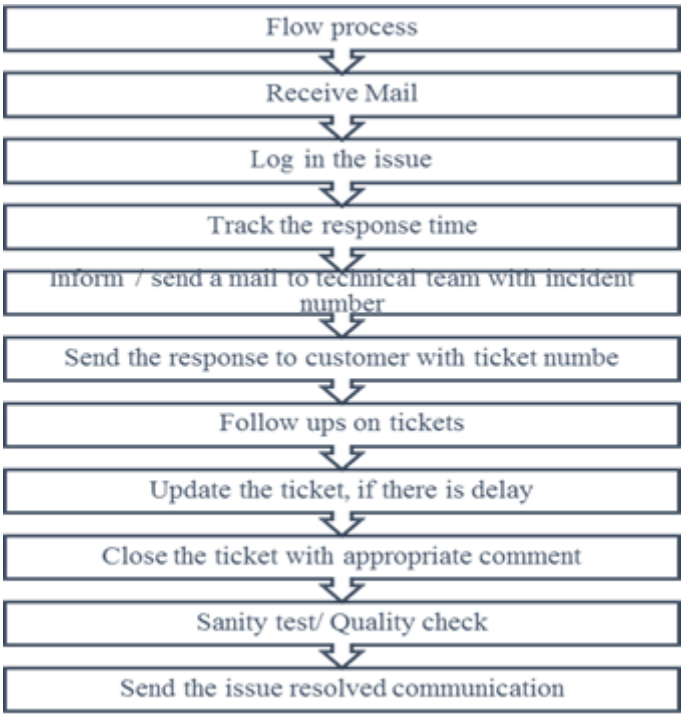

Figure 1 Workflow process and steps of incidents

Thus, priorities in the SLAs within the resolution times helps in the understanding the importance problems or the issues; this is standard footprint that is essential to reach the 100% SLAs (see Table 1). The support team is assigned the issue ticket based on the severity of the issue and the type and the client importance; it will be assigned to one of the priorities.

Table 1 Resolution time based on priorities

Priority	Response SLA	Target res. time	Maximum res. time
P1	15 min.	< 2 b. hrs*.	< 4 b. hrs.
P2	30 min.	< 4 b. hrs.	< 8 b. hrs.
P3	4 b. hrs.	< 8 b. hrs.	< 16 b. hrs.
P4	8 b. hrs.	<16 b. hrs.	<60 b. hrs.

The standard footprint that is necessary to reach the 100% SLAs. Time is fixed based on the priorities and issues. The crucial issues are prioritized under the P1 or critical to resolving and on similar grounds few are listed (see Table 2). The data are objectively coded, and project scheduled are referenced to investigate further.

Quantitative research focuses on an objective, consistent numeric data, and the information is given in detail so that it takes into the converging the process in the project. The data gathered from the document using the structured process and the data are based on an extensive number of sample sizes that depends on multiple projects. The data contained is repetitive causes/errors, given its significant variation in reaching the resolution time. Data is collected considering all the aspects of the research study. Data collected based on the priorities with four different projects that already templated in the results and investigate causal relationships. The numerical data for variables error, time and priorities are collected from the secondary sources by company specified tool. This tool will give the complete

information that includes time, type of error, category falling, owner name, and problem and solution characteristics.

Table 2 Error falling under categories

P1 ***Critical***			***P2*** ***High***		***P3*** ***Moderate***					***P4*** ***Low***
App Performance	Front-end Cosmetic	Environment	Content	Front-end responsive	Server Down	Content	Access related	Component	3rd party problem	Caching	Non-Content

The tickets are prioritized/characterized based on the data collection through quantitative approach, further it is subdivided based on the priorities as P1, P2, P3, and P4 construed on relative importance Critical, High, Medium, Low. Then the process graph is developed on the root of monitoring the work completed and the time taken to resolve (resolution time) the issues and is measured using statistically by mean, median, mode, standard deviation. The advanced graphical tool like the control charts is drawn with specification limits, to show the process capability indicators in the graph.

5. PROCESS CAPABILITY INDEX (CPK)

The Cpk is an index (a pure number) that measures how the closeness of the process that is running within specification limits. Any parameters falling out of the sigma limits are considered as unable to meet the specification (www.isixsigma.com; Novaes et al., 2016).

Based on the secondary quantitative data, the information on four priorities and four projects - Project-A, Project-B, Project-C and Project-D, the reference tickets numbers concerning the Services Level Agreement are collected. The general resolution times for P1, P2, P3, P4, respectively are four hours, eight hours, sixteen hours and sixty hours that are agreed by both the parties to reach 100% SLA. On comparing the four priorities and the four projects, there is a difference between the resolution times across the entire project for the same priority. Hence, it is necessary to the specification limit for run all the projects.

Finding the mean value by using the mean calculation the tolerance limits of the priorities, with this it is assumed that the maximum and minimum tolerance limit of the projects also that can be used for process capability check whether the resolution time is within the given time frame concerning the service level agreement.

The priority three maximum resolution time is 16 hrs (980 minutes) and defines the tickets are breaching the SLA and process are deviating. The percentage of the priorities, numbers of tickets falling in the different category in the given period (Table 3) and resolution time is reaching out of the specified limit is recorded and observed.

Table 3 Project-A Minimum and Maximum resolution time

Time / Priority	Min. time (min.)	Max. Time (min.)	Avg. Res. time (min.)	Priorities (%)
P1	11.5	17.3	19.37	1%
P2	17.3	97	56.5	5%
P3	210	980	492.7	54%
P4	23	750	190.4	40%

Based on the consumption of the resolution time for project A, it was found 54% stands for priority three; it means priority three is spent some time among all the priorities and the 40% by the priority four which is the moderate priorities follow low prioritized issues. Priority one that is critical is standing at 1%, and priority two or high priority tickets are at 5%. From this moderate, priority three issues are frequently occurring in number also maximum time is consumed for the priority three (Figure 2). For only medium priority P3, a process capability graph is plotted for analyzing and checking the consolidated deviation The C_{pk} measures the process the process capability to run within the specification limit related to the natural variability of the process.

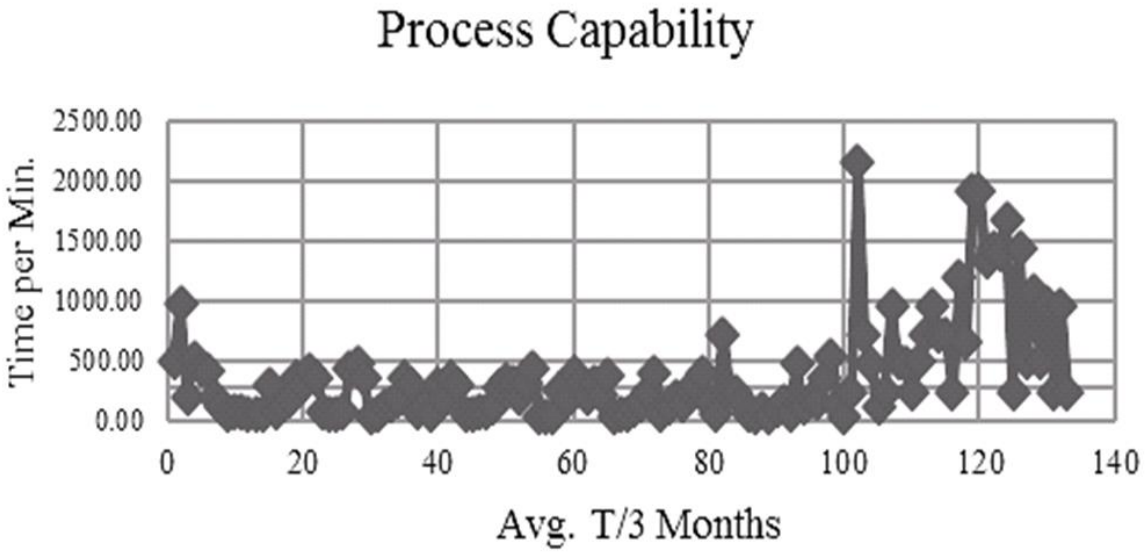

Figure 2 Process Capabilities illustration for three months for priority three

Based on the all medium priority of projects P3, also this indicates the upper and lower specification limit along with the average resolution time. It is evident that the maximum permissible time for resolution is exceeding the stated SLA resolution time. The focus of in-depth analysis is concentrated on priority three and justification for selecting P3 a quality deployment function tool is enabled, and it follows.

5.1. House of Priority

The House of Priority (HoP) is a focused methodology to do the comparative analysis. The tool to transform the quantitative parameters of qualitative results. It mainly emphases on the critical needs and the priorities, the priorities are taken on the bases of customer requirements.

The House of priority approach is an excellent communication tool for decision making (Chan & Wu, 2002).

The evaluation is based on the 10-pointer scale, and the results are grounded on the weights and occurrence of issues on all the four projects and four priorities (Figure 3). Thus, the findings obtained at the bottom of the house of quality.

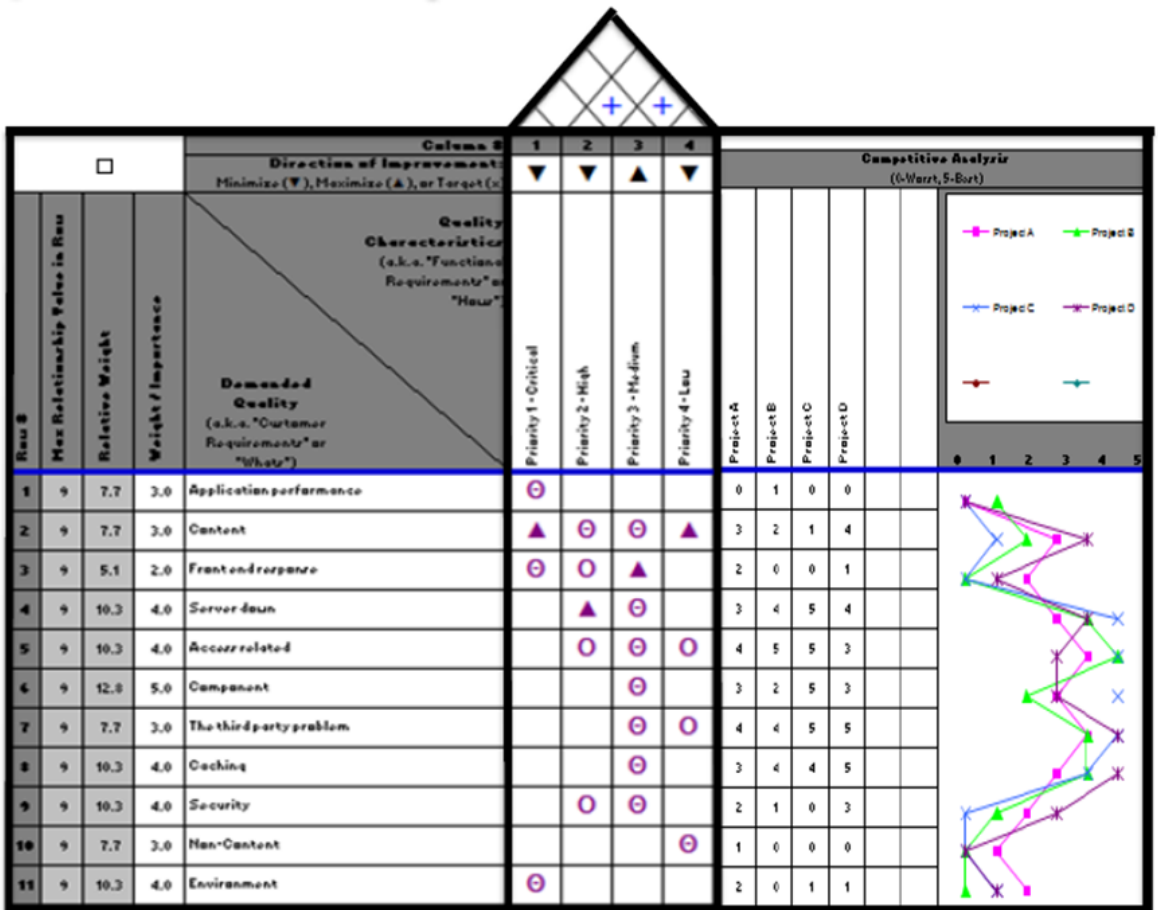

Figure 3 House of Priority plot for projects

A comparative analysis gives the graphical relation of highest occurrence of errors in a particular time frame. A comparative analysis is made by considering all four projects (Project A, Project B, Project C, and Project D. The correlation matrix prepared with the five pointers scale that highlights, number of errors that are occurring at a time in all the projects. Similarly, the number of tickets occurrence at a time is considered for tackling further analysis (Table 4).

Table 4 House of quality legends used

Legends	Meaning	Rank
⊝	Strong Relationship	9
O	Moderate	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
−	Negative Correlation	
▼	Strong Negative Correlation	
▼	The objective is to Minimize	
▲	The objective is to Maximize	
x	The objective is to Hit Target	

The results define the weight/importance, and the weighted average is defined based on the importance of the trouble and relative rating of the errors; the relative error will be considered based on their importance. For example, an application error is stood with the weight of three, whereas the overall weight of the error that impact is three for the entire process and again it is falling high, moderate, or low priority. It is most likely to fall in the high priority, that is pre-defined in Table 4. The cross weights of the legends driven point and the impact rating give the weight/importance. The HoP used to summarize and consider the highest occurring error of the priority, and the results carried out for analyzing the process variation. Using deployed quantitative data in the HoP, it helped to carry out the P3 to analyzed further.

6. RESULTS AND DISCUSSION

The analyzed data is tabulated as results so that interpretation of results with a discussion gives way for answering the research questions enquired, a hypothesis formulated, and the literature reviewed. Results of this study are the outcomes of the analysis that justifies the value added to this research.

6.1. Analysis of the prioritized data:

Three-months data were collected to envelop the reference QFD model; a pie chart is developed to know the pattern of the time consumption for various priorities (P1, P2, P3, and P4). It is evident from pie-chart also the priority three occupies 39% of space when compared to other priority two, four and priority one. It is insufficient to conclude priorities based on pie-chart, so frequencies graphs such as Pareto analysis are used to as a quality tool helps to display the results in the graphical representation with this of charts it enables to identify more occurrence (frequency) level. Based on the weighted scores on the Pareto analysis it is clear from the charts that the seven quantities consumed more time and defects of priority three (80% of cumulative) with the total time consumption of 49579 minutes. When all the four priorities, the sum of individual priorities, and the results are plotted using a Pareto approach

for the analysis; weighted average gives priority three has high error frequency along with the more time consuming and thus the rationale for this research (Lawshe, 1975) (see Figure 4). Further in-depth data collection and analysis was carried out with priority three based on the results justified by the quality function deployment, pie chart, and Pareto analysis.

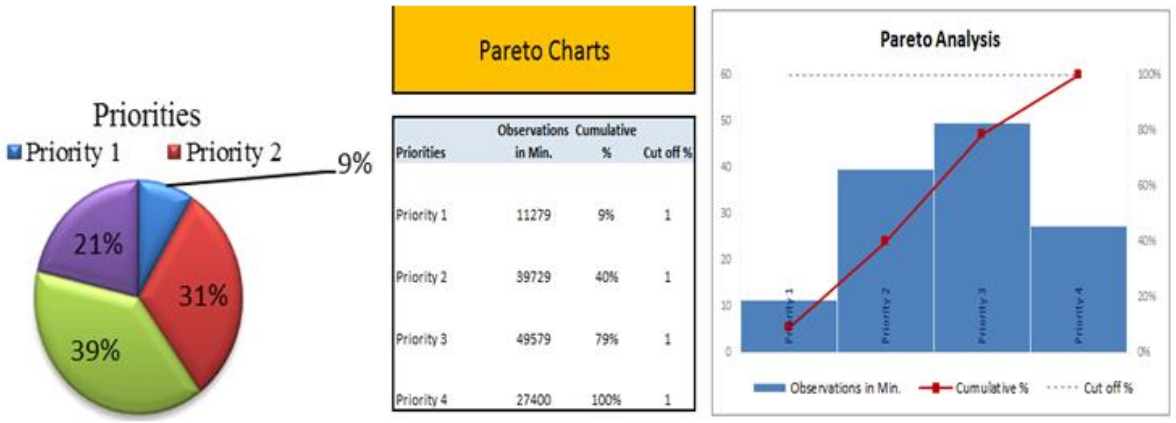

Figure 4 Priority wise time consumed

The process was identified and triggered an action such as email alerting systems was designed to monitor the process.

6.2. Email Alert System (Alarm to monitor the resolution time)

As there was a deviation in reaching service level agreement, there was a requirement to auto trigger/alerting before the issue reaches resolution time defined by the service level agreement.

Alerts will be repetitive every 15 min. Hence, tier 1 team need to monitor the alert mail; if it is not solved in three alerts it triggers after consuming 85% SLA time then it sends out an email to the respective technical team and to close the issue within the given time frame. Hence this Tier 1 team able to achieve 100% SLAs without breaching time frame. This tool/alert mail system added quality and productivity to work.

Data collected after implementation of the dangerous/alert email system. Total three months data is collected after implementing the alert email system. Based on the data there is a significant difference before and after implementing the alarming system.

6.3. Process control in the resolution time for four projects

Collating all the four projects resolution time on a moderate priority for four projects and consolidating the priority three that is plotted with the process capability specification gives a clear picture of the process variations (Figure 5).

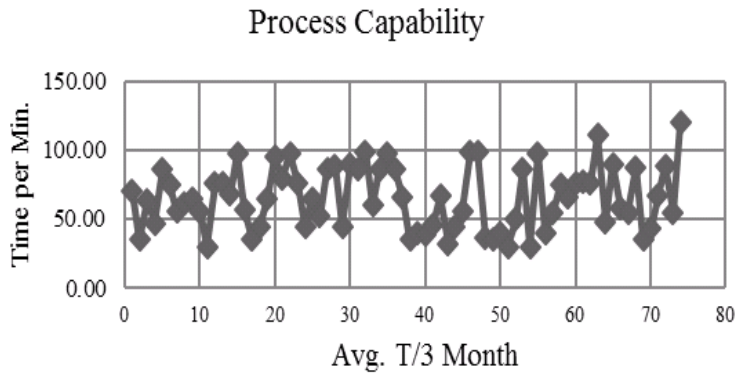

Figure 5 Process Capability Chart for Priority Three Collated

To validate the process consistency after the implementation of the email alert again three months data was compiled and plotted (Figure 5), with the plotted a graph of all the projects with priority three only. It is evident that the email altering system must have made team members to execute the work before the scheduled time well within the SLA. Thus, there is a significant difference in reaching SLA and they're not even a single issue was missed, and all issues were sorted well within the resolution time as stated in SLA.

All the four projects were manipulated with the manager's interventions; all the project priorities were equally moving in the graph thus the clients were satisfied with the service level agreement. They are having oversight project, A, B, C, D process in resolving the issue (included only priority three issues). Y-axis represents the minute vs. some tickets graph, where 75 tickets are in the bucket for three quarters.

Resolution time is falling in between the time frame of 30 minutes to 120 minutes. Thirty minutes is taking minimum time to resolve the issue and 120 min maximum time to resolve the issue that gives an average of 65 minutes approximately.

7. RESULTS VALIDATION

Statistical quality tool to manipulate and analyzed the data to get the results by deploying the quantitative data. This tool can handle a large number of data and can perform all the analyses covered as a text. Independent T-test also knew as two samples t-test, this sample test determines that whether there is any statistically significant difference is resulted in independent two groups. Priority three data is deployed for before and after implementation of all the projects (Project A, B, C, D) to SPSS tool as the independent t-test.

Null Hypothesis (H_0)

There is no significant difference in the process of implementing six sigma methodologies (concerning the P3 data before and after)

Alternate Hypothesis (H_a)

There is a significant difference in the process of implementing six sigma methodologies (concerning the P3 data before and after)

The t-test was carried out and based on before and after priority data. Priority 3 is tabulated in one column where this is containing the resolution time of priority three before and after. Before and after, before and after data are coded with the numbers. Moreover, further data will be analyzed. Based on the analysis of before and after data results are as follows (Table 5).

Table 5 Independent sample t-test results

Group Statistics					
Resolution time of Priority 3		N	Mean	S. D	S E M
	Before	133	372.78	413.7	35.8
	After	86	66.07	22.6	2.5

N-Number of the sample; S. D-Standard deviation; SEM-Standard Error of Mean

The *p*-Value is less than 0.05 (Assumed 0.0001), Null hypothesis (H_0) is rejected at 95% confidence while alternative hypothesis H_a is accepted. Thus, providing statistical evidence, there is a significant difference in the P3 data before and after the implementation of six sigma methodologies.

7.1. Establishing the Process capability

The mean calculated from the data variation in processing the task – in our case for the priority 3 (moderate priority), mean (SD) is 66.070 (22.65) mins. Upper/Lower specification limit for the process is calculated using USL (LSL) using mean ± 6σ, the USL obtained is 201.9 mins (rounded to 202 min) and LSL to be established at (- 69.9 mins). Literature evidence support in case the LSL is contrary, it may be assumed to be zero. Moreover, the process time cannot take non-negative quantity.

When the results were plotted on a graph with tickets timings completion, it was seen that the processing times were all well within the given tolerance limit. The upper specification limit is at 202 minutes with an average of 66 minutes and followed by a lower tolerance limit as zero minutes. To proactively regulate the process within six-sigma limits process delaying and shortcut-action that needs to be fixed an alert system was initiated (El-Haik, 2005).

Maximum tolerance limit (USL) as per six-sigma decided is 202 minutes, based on the service level agreement and resource availability, to maintain the less variation in process time a triggering time is fixed at 25% buffer time (that again a determinate of USL). To speed up the process an email alert shoot at 75% for the first cycle then second will be 80%, and the last alert will be at 85% of time consumption (Figure 6).

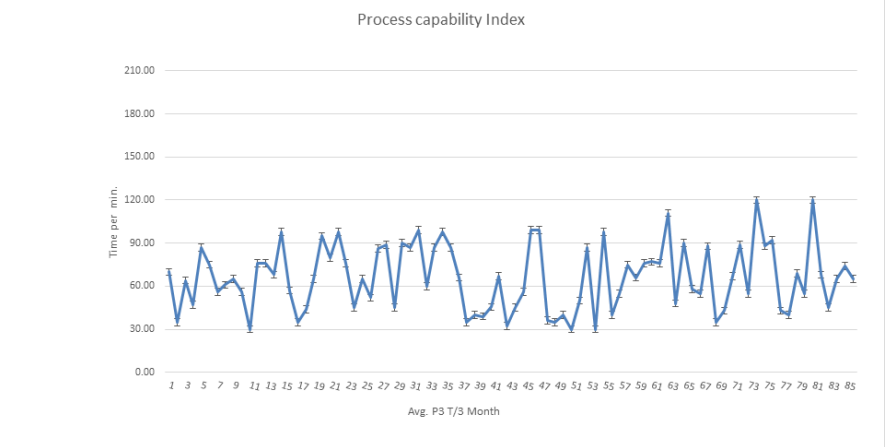

Figure 6 Process Capability Index chart after implementation

The delivery is not deviating from the process without missing the SLAs. Also, process interfering with the manager in to call an escalation of the issue in reaching out the SLAs is eliminated. Reduced the time and effort by managers, this considered to be a value added to the process/cutting off the additional process. The team members will stop the tickets at the Tier1 level and resolve in high time by monitoring the alert emails.

Six Sigma methodologies helped to reduce the long process and give the time saving and value addition to the existing process. After implementing, there is very less chance of breaching the SLAs because of backups of the ticket, now Tier1 team members have the control, and they will monitor the real-time as per SLAs (Casola et al., 2016).

The primary research was focused on the variation on reaching the resolution time concerning SLAs process. There is a need to reduce the resolution-time-variation in all the projects. The purpose is to reduce the time-variations in the SLAs and to implement the Six-Sigma to maintain the SLAs resolution time uniformity in all projects (Cervone, 2008; Galup et al., 2009).

The data gathered using a structured process document and the data are based on an extensive number of sample sizes that depends on multiple projects. Data collected based on the priorities with four different projects that are in the secondary sources and investigate causal relationships. A study carried out one priority across all the projects; this is because to converge the study for anyone priority. The identified only priority is deployed with data into HoP and results are concluded that priority three that needed more attention. As there were few tickets are overshooting and unable to reach the SLAs (Muller & Hart, 2016). So, implemented the Alerted E-mail system that triggers the email, three times before breaching SLAs (Alarming system). After implementing alert E-mail system, again collected three months data and calculated the Mean and Sigma value also established the specification limit with the help of Mean and sigma value. Results plotted the graph where all the tickets are falling within the given tolerance limit. Alarming time is fixed at 25% (Depends on USL) buffer. Hence alert emails will shoot at 75% for the first then second will be 80%, and the last alert will be at 85% of time consumption. After implementing Six-Sigma methodologies, all the tickets are in control limit and reaching 100% SLA. Finally based on the above results and this study the reasons and benefits are explained in detail in the conclusion chapter along with the limitations of this study.

8. CONCLUSION

Six-Sigma, House of priority are the primary quality tool which helps to achieve a higher level of quality (Besterfield et al., 2012). The statistical approach to Six Sigma describes the quantitative way of evaluating the process performance. Maintaining equality in all the projects is crucial within the company. It is informal if there is a variation between the projects to reach the Service Level Agreement. There will be a higher level escalation in case of missing the SLAs. It is essential to implement the alert E-mailing system which helps to avoid the additional effort by the managers. Outcomes of implementing the Six-Sigma methodologies resulted in reducing the unwanted additional process of reaching escalation to managers; this is a valuable addition to process and productivity. Implementing Six-Sigma methodologies also helped manage the uniformity in resolution time across all the projects (Ahmad & Abawajy, 2014). This study understood only for the ticketing system which includes Service Level Agreements, which has taken care of project level and not for ticket level. The study has also not considered factors like human errors and contingent things behind the ticket information. There was no control over the issues raised in the tickets to solve the problem and the reason for fluctuation in resolution time. This study was covered in a single location in Bangalore.

8.1. Scope for further study

The type of study is a first attempt to incorporate the process capability index and define the Sigma level. Along with the standard Service Level Agreement fixing the specification limits gives more stabilized and normality to the process. A significant advantage of this study goes to clients, where they can expect a high quality of delivery and very minimal missing (breaching of SLAs) of the tickets to reach the client with the specified time frame. Teams have to be very meticulous about the quality regarding achieving the target limit only then the team can plan the work more precisely. It is suggested to design a Special Weapons and Tactics(SWAT) team to get as much work done at the quickest possible time, typically on a small, delicate task. The team members are trained in evolutionary and iterative software problem fixing processes adopting agility approach. A company implementing this input of the study can target to achieve high efficiency and quality of deliveries along with the less variation in the SLAs. In the process, the company seeks better business opportunities and high level of customer satisfaction.

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