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Six Sigma – A tool for breakthrough improvement in Geophysical Field Parties

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Summary

Under globalisation process of the Indian economy the competition has increased. The private companies have arrived and they are playing a vital role in the exploration of oil. The competition generates continual improvement and the continual improvement is only sufficient for survival in the industry. For creating a dominant position in the industry Six Sigma methodology can be applied in seismic data acquisition for getting faster, better and cheaper data.

Six Sigma methodology of Define, Measure, Analyse, Improve and control DMAIC can be applied

1. To reduce the defects

2. Improve the productivity

3. Reduce the cycle time

4. Improve the customer satisfaction

5. Improve the profit of the company

The product characteristics of quality, delivery and cost per unit can be improved. Quality can be improved by reducing defects, Delivery can be improved by reducing cycle time and reducing cost can decrease cost per unit. These can be achieved by improving the operational and business processes. The goal is to find what is critical to customer.

Six Sigma methodology is applied in areas where performance varies with time e.g. the number of bad shots and bad traces in seismic data acquisition varied from 5% to 18% during the period January 2005 to March 2006. The average bad shots were 10% and average bad traces were 9%. The best achieved result for bad shots were 5% and bad traces were 7%.

Two Six Sigma pilot projects namely "Reduction of bad records" and "Reduction of bad traces" were taken up in GP-85 of Geophysical Services (GS), Western Onshore, Vadodara to reduce a) bad shots from 10% to 6.5% by April 2007, b) bad traces from 9% to 7.7% by April 2007 i.e. to achieve 70% of the average value

The operational processes of supply of water, communication, drilling of hard formation were measured, analysed, improved and controlled as a result of which, bad shots reduced from 10% to 7.4%.

Similarly, the operational processes of noise control, monitoring of data and data recording time were measured, analysed, improved/changed and controlled to reduce bad channels from 9% to 6.5%.

The sustained quality improvement could be achieved as commitment from the entire organization, particularly from top -level management was extended throughout the projects.

1. Introduction

The philosophy of Six Sigma is to apply a systematic, structured approach to provide defect free processes resulting from breakthrough improvement.

The core of the Six Sigma methodology is a datadriven, systematic approach to problem solving, with a focus on customer satisfaction. Statistical tools and analysis are often useful in the process. However, it is a mistake to view the core of the Six Sigma methodology as statistics; an acceptable Six Sigma project can be started with only rudimentary statistical tools. However, the special software called "Minitab" is used in the two projects discussed in the paper.

The term "Six Sigma" refers to the ability of highly capable processes to produce output within specification. In particular, processes that operate with six sigma quality produce at defect levels below 3.4 defects per million opportunities (DPMO). Six Sigma's implicit goal is to improve all processes to that level of quality or better.

The defect levels below 3.4 defects per million opportunities (DPMO) are difficult to achieve in seismic data acquisition. The breakthrough improvements can be made in operational and business processes to acquire good quality data at low cost. In GP-85, GS of WON basin the DPMO of bad records were one lakh which were brought down to DPMO of seventy four thousand.

The Six Sigma methodology of DMAIC is applied mainly in five phases

a) Define phase – The business problem is defined by answering the questions – What, where, when and how much is the problem. The problem scope is defined by mapping the relevant process, baseline (average value) and entitlement (best achieved value) and metrics.

Objective statement shows that 70% of difference of baseline and entitlement is to be achieved by a given time. Team is defined and project is launched.

b) Measure phase - the current process is measured by analysing the historical data. The factors contributing to bad records and bad traces were firmed up in brainstorming sessions. Process Flow Diagram (PFD), I/O work sheet, Fish bone diagram, Cause and Effect matrix were prepared to filter out the insignificant factors. The fresh data is collected for future comparison

c) Analyse phase – The relationship between output and different input factors, which are causing out of OD holes or noisy traces, is established.

d) Improve phase – Processes are optimized using statistical tools.

e) Control phase – Variances in the planned and actual results are corrected before they result in defects. Pilot runs are set up to establish process capability. It is transition phase to production and thereafter process is measured continuously and finally control mechanisms are instituted.

2. Methodology

The factors contributing to acquisition of data outside the specification limits are identified in Measure Phase using brainstorming method. These factors vary 30 to 50 in numbers. The I/O work sheet, Fish bone diagram, Cause and Effect matrix filter out insignificant factors and 8-10 factors are passed to Analyse phase. The statistical tools in Analyse and Improve phases reduce the factors to 3-6 (fig 1). These factors are removed/controlled to improve the operational / business processes.

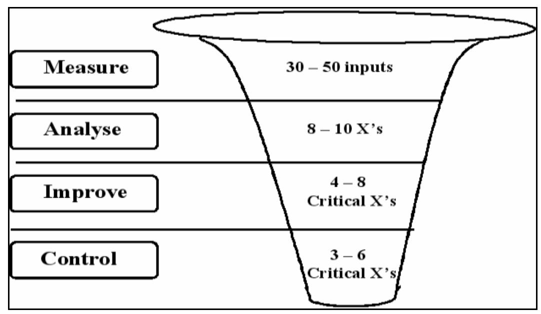

Fig 1: MAIC approach of Six Sigma and the funnel effect

2.1 Define Phase

The team was defined in this phase. The roles and responsibilities of team leader, champion, process owner, black belts, and green belts were explicitly enumerated. Team leader of the project defined the project as "Reduction of bad records" and "Reduction of bad traces". On analysis of historical data of bad records it was found that major contribution to bad records were from out of OD records therefore the project was fine-tuned as "Reduction of out of OD records". Similarly, the project "Reduction of bad records" was fine-tuned as "Reduction of noisy traces".

The timeframe for each phase was fixed. Planned time vs actual time was logged for each phase. The Define phase started in December 2006 and Control phase ended in April 2007.

The baseline i.e., the average value of out of OD records were 10% and entitlement i.e., the best-achieved practice was 5%. The difference of baseline and entitlement is 5%. Seventy percent of 5% is 3.5%. In six sigma projects seventy percent improvement is brought at first instance. Therefore, the objective statement for the first project was Reduction of out of OD shot holes from 10% to 6.5% by April 2007. Similarly, for second project objective statement was defined as reduction of DPMO of noisy traces from 90,000 to 77,000 by 31.04.07.

Macro process map were prepared for the two projects to find out the main process causing out of OD holes and noisy traces in seismic data acquisition (figs 2 & 3).

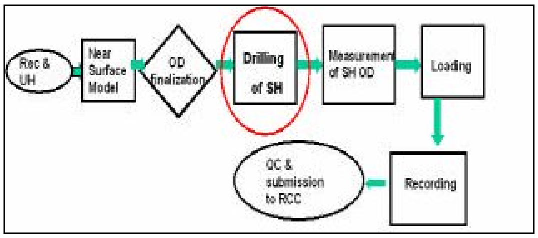

Fig 2: Macro Process Map of the project "Reduction of out of OD holes"

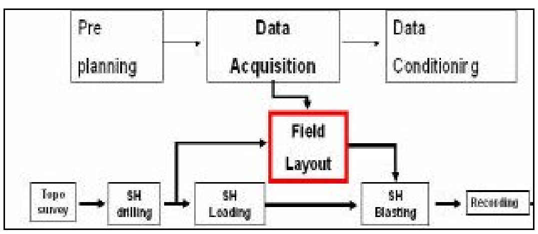

Fig 3: Macro Process Map of the project "Reduction of Noisy traces"

2.2) Measure Phase

The Process map is a team effort. During process map all team members well versed with the process should sit together to chalk out the process map. **The process owner is the guardian of the process map.** The process owner is the inheritor of the results of the project. He should have intimate knowledge of the process and all of the changes that occur throughout the project.

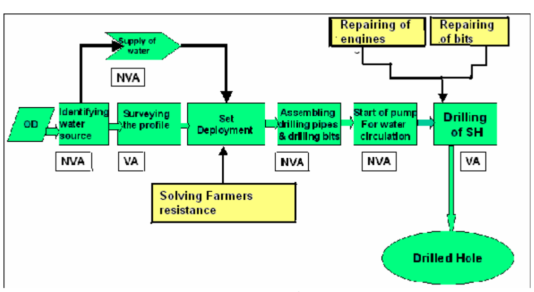

Fig 4: Detailed Process diagram of the process "Shot hole drilling"

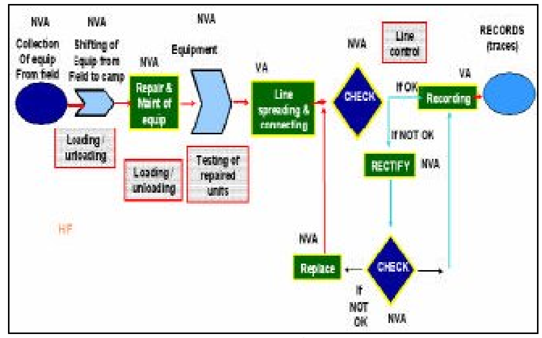

Fig 5: Detailed Process diagram of the process "Field Layout"

Detailed process maps / Process Flow diagrams (PFD) of shot hole drilling and Field lay out were prepared (figs 4 & 5) to know the various sub-processes under it and to list the inputs, equipments and outputs of each sub process. The value addition to the final product is also listed at each sub process. The hidden factories (activities which consume time and resources and are not endorsed by management) shown in figure by yellow colour in fig 4 are identified. The brainstorming was done at camp and 25 factors were listed for out of OD records.

During the measure phase eleven factors for "Reduction of out of OD holes" were left after filtering. Similarly, nine factors were left for "Reduction of noisy traces".

2.3 Analyse, Improve and Control Phases

For the project "Reduction of out of OD holes" statistical tools were applied on the input factors to see the statistical significance. Only four factors were found to be statistically significant. A relationship between output (out of OD holes) and four input factors were defined under Improve phase. The Y (output) = X's (input factors) is

$$Y\ (OOD) = 1.866 + 0.297\ Sk + 0.853\ WL - 0.861\ WS$$

The various abbreviations used in arriving at the equations are :

OOD (Out of OD), HF (Hard formation), Sk (Skill), WL (Water loss), WS (Water supply (less)).

Similarly, the relationship between output (noisy traces) and six significant input factors were defined. For the project "Reduction of out of OD holes" The Y (output) = X's (input factors) relationship is

$$Y\ (DPMO) = -245 + 45.6\ village + 35.5\ road + 46.0\ track + 24.9\ Drill + 39.2\ TW + 31.4\ Works + 39.6\ Random$$

TW – Tube well

The LEAN Six Sigma was applied to improvise the seismic lab. The details are

Sorting: The equipments like ground electronics, geophone, accessories, spares etc were sorted on the basis of type, utility and frequency of use.

Storing: The sorted equipments were neatly stored in their labeled boxes. The boxes were arranged as per frequency of usage. All unnecessary or unwanted items were returned to stores of the party. Good and bad equipment were placed on opposite walls to avoid mixing.

Shining: Boxes were painted and labeled. Sources of dust and soiling were identified and removed. Work floor, tables etc were cleaned every morning and vening. Wire cuttings and other wastes were kept in marked bins.

Standardizing: All the workers of the lab and field visiting the lab were trained. They started keeping the equipments at designated places.

Sustaining: The party maintained Lean Seismic lab applying 5S (sorting, storing, shining, standardizing and sustaining) from 1st January 2007.

Statistical Process Control (SPC) method was applied in the Control Phase. Run charts were made for the data generated on input factors for the project "Reduction of out ofOD holes" e.g., less supply of water, low skill, hard formation etc. Similarly, the run charts were prepared for the input factors of the project "Reduction of noisy traces".

The run chart is simply time series plot. They show cycles, trends, sense of stability and provide some predictability.

The processes for the two projects initially mapped are shown in figs 4 & 5. The improved processes and the process capabilities before and after improvements are shown in figs 6 - 11.

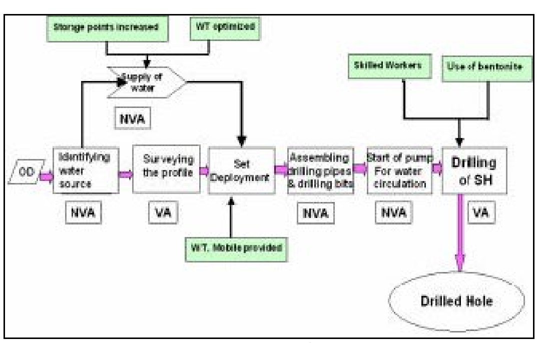

Fig 6: Improved Process diagram of the process "Shot hole drilling"

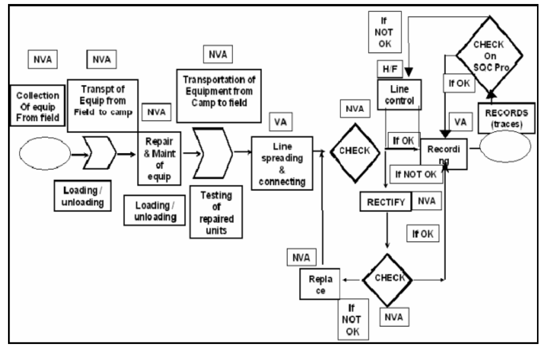

Fig 7: Improved Process diagram of the process "Field Layout"

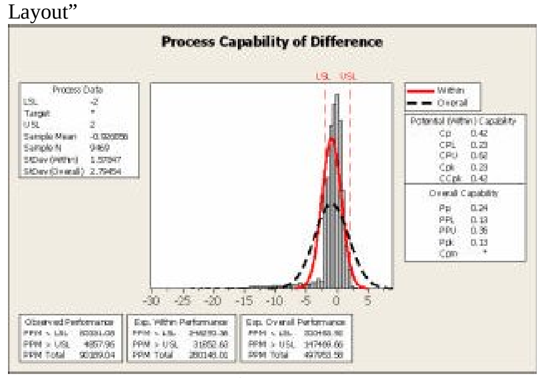

Fig 8: Process capability of the process "Shot hole drilling"

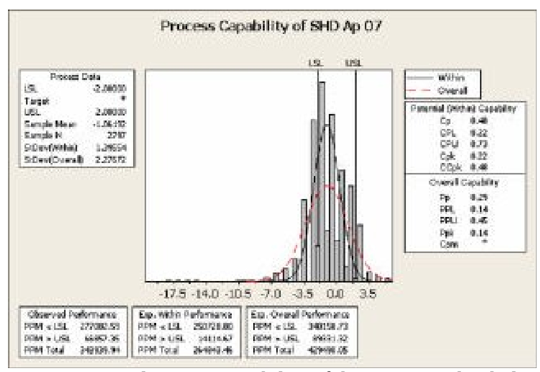

Fig 9: Improved Process capability of the process "Shot hole drilling"

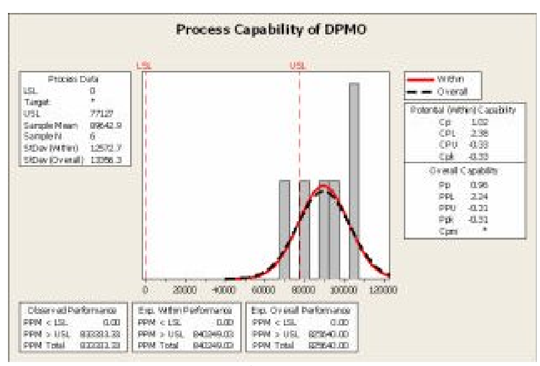

Fig 10: Process capability of the process "Field Layout"

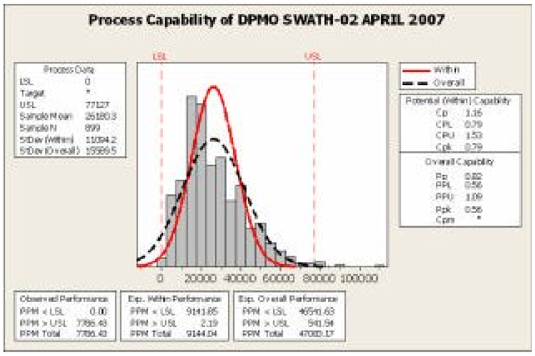

Fig 11: Improved Process capability of the process "Field Layout"

4. Conclusion:

The operational processes of supply of water, communication, drilling of hard formation were measured, analysed, improved and controlled as a result of which, the out of OD records were reduced to 7.4% during the period 1st April 07 to 26th April 07. It further reduced to 4.6 % in next 10 days. Similarly, the operational processes of noise control, monitoring of data and data recording time were measured, analysed, improved/changed and controlled to reduce noisy traces from 9% to 6.5%.

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