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LEAN SIX SIGMA PRINCIPLES

DUMITRESCU, C[onstantin] D[an]; TENT, I[onut] D[acian] & DUMITRESCU, E[ugenia] C[intia] I[vonne]

Abstract: *The purpose of the paper is to show that the combination of Lean and Six Sigma – when focused on the highest value projects, and supported by the right performance improvement infrastructure – can produce remarkable results and is the most powerful engine available today for sustained value creation. Case studies will be provided to illustrate how results are achieved. This work book closes that intuition gap with knowledge, both experimental and quantitative and shows how Lean and Six Sigma methods complement and reinforce each other. It also provides a detailed roadmap of implementation so you can start seeing significant returns in less than a year.*
Key words: *Lean, Six Sigma, Yield*

1. INTRODUCTION

Lean Six Sigma is a methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed and invested capital. The activities that cause the customerôs critical quality issues and create the longest Time Delays in any process offer the greatest opportunity for improvement in Cost, Quality and Lead Time.
Sigma (ů) is a letter in the Greek alphabet that has become the statistical symbol and metric of process variation. The sigma scale of measure is perfectly correlated to such characteristics as defects- per- million defectives, and the probability of a failure. Six is the number of sigma measured in a process, when the variation around the target is such that only 3, 4 outputs out of one million are defects under the assumption that the process average may drift over long term as much as 1.5 standard deviation.

2. HISTORY

The concept of Six Sigma was launched by Motorola in 1987. It was the result of a series of changes in the quality area starting in the late 1970s, with ambitions ten ï fold improvement drives. The top ï level management along with CEO Robert Galvin developed a concept called Six Sigma. After some internal pilot implementations, Galvin, in 1987, formulated the goal of ñachieving Six Sigma capability by 1992ò in a memo to all Motorola employers (Bhote, 1989). The results in terms of reduction in process variation were on-track and cost savings totaled US$ 13 billion and improvement in labor productivity achieved 204% increase over the period 1987-1997(Losianowycz, 1999).
In the wake of successes at Motorala, some leading electronic companies such as IBM, DEC and Texas Instruments launched Six Sigma programs in the early 90s. However, it was not until 1995 when GE and Allied Signal launched Six Sigma as strategic initiatives that a rapid dissemination took place in non electronic industries all over the world (Hendricks and Kelbaugh, 1998). In early 1997, the Samsung and LG Groups in Korea began to introduce Six Sigma within their companies. The results were amazingly good in those companies. For instance, Samsung SDI, which is a company under the Samsung Group, reported that the cost savings by Six Sigma project totaled US$ 150 millon (Samsung SDI, 2000a). At a present time, the number of large companies applying Six Sigma is growing exponentially, with a strong vertical deployment intro many small and medium size enterprises as well.
The Six Sigma concept is extremely powerful in improving the quality and speed of all types of ñtransactionalò processes, including sales and marketing, quotations?pricing/order processing, product development, hotel check-in, mortgage applications, financial/administrative, and human resourses. Transactional processes must also be improved in manufacturing companies, as they are enablers of the manufacturing process itself. In fact many companies are finding that there is tremendous value creation opportunity in attacking these processes simply because they have been overlooked in the past.

3. FIRST TIME YIELD METHOD

This method is used to determine the quality level of a single process. It aims at a process with no repairs/ rework (fig.1).
Yield describes the portion of good products and is an indicator that is monitored on each process level including defective parts (rejects) like ñreworkò (parts that must be reworked) or ñscrapò (unusable parts).
Types of Yield Indicators (for Quality of single Processes)
First time yield aims the purpose at a process with no repairs/rework; rolled throughput yield is understood as the product of FTYs of all Process Steps and another is normalized yield and is the geometric mean value of the whole Process.
Yield, explanation in thefigure number 2.

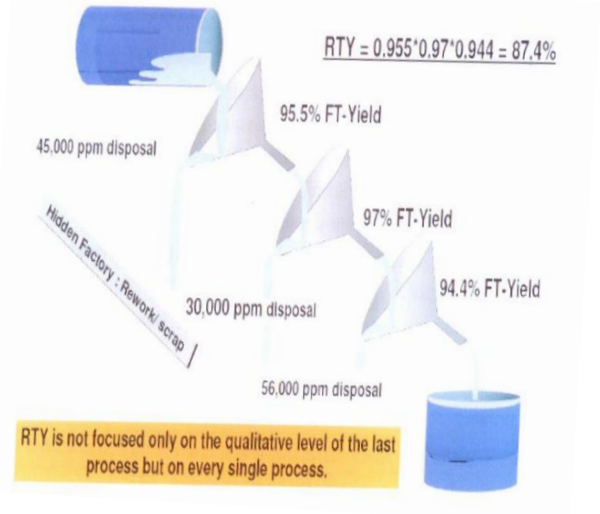

Fig. 1. Normalized Yield

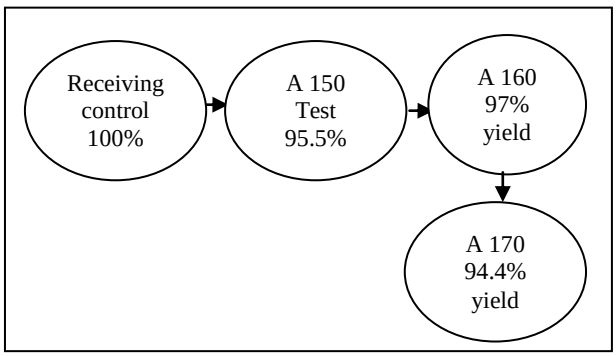

Fig. 2. Yield

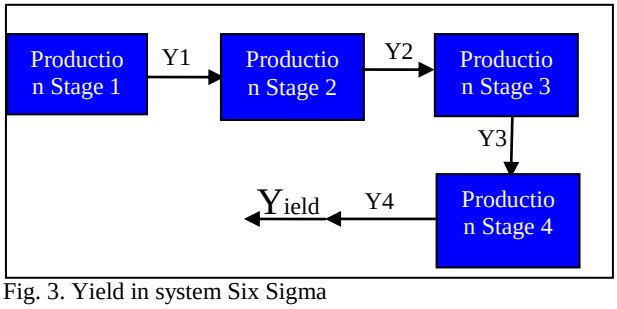

Fig. 3. Yield in system Six Sigma

RTY=1.00 x 0.955 x 0.970 x 0.944
= 0.874=87.4% (1)

$$Y_{NOR}=\sqrt[4]{RTY}=0.874^{1/4}=0.967=96.7\% \quad (2)$$

Displaying yield in Six Sigma system:

RTYield= Y1 x Y2 x Y3 x Y4 (3)

Yield is defined as a profitability that is used to fulfill customerôs requirement and expectations (fig. 3). Examples: cost per procedure; turn frequency; rework; waiting times.

4. DEFINITION OF DEFECTS PER UNIT

DPU is defined as number of errors that was detected at the inspection point per number of units that passed the inspection point.
DPO is number of errors per opportunities and is an universal quality measurement that considers possible errors and had as definition number of errors that was detected at the inspection point x 1.000.000 per number of opportunities x units.
An example of Lean Six Sigma application:
A person goes to work
One person lives approximately 10 minutes driving time from his work. He attends Six Sigma training. He knows that in Six Sigma there is a lot related to figures. That is why during the last weeks he measured how many minutes the way takes.
Results (fig. 4):

Week 1		Week 2		Week 3	
Day :	Min :	Day :	Min :	Day :	Min :
1	10	1	10	1	10
2	18	2	9	2	10
3	16	3	16	3	9
4	11	4	11	4	10
5	10	5	10	5	11

Fig. 4. Table with results for 3 week

What can we do with these data?
To calculate the average for the days:

$\overline{X}$ = 1/15 * (10+9+11+10+ é é é . + 9+ 10+ 11)= 11 min.(4)
To calculate the average for a week:

$\overline{X}_1$=1/5(10+9+11+10+10) = 10 min
$\overline{X}_2$=1/5(10+18+16+11+10)=13 min
$\overline{X}_3$=1/5(10+10+9+10+11)=10 min

- X is the average of a group of data

Differences between the data
Range(R)=(the highest value ï the lowest value)
R=18-9=9 min (the total range)
R=11-9=2 min (range of the first week)
R=18-10=8 min (range of the second week)
R=11-9=2 min (range of the third week)
Variance:

$$S^2=\frac{1}{n-1}\sum_{i=1}^{n}(x_i-\bar{x})^2 \quad (5)$$

S^2- is the variance of data group
For 1 week:

$$S_1^2=\frac{1}{5-1}\sum_{i=1}^{5}(x_i-10)^2=0,5$$

$$S_2^2=\frac{1}{5-1}\sum_{i=1}^{5}(x_i-13)^2=14$$

$$S_3^2=\frac{1}{5-1}\sum_{i=1}^{5}(x_i-10)^2=0,5$$

For all 3 weeks is important:

$$S^2=\frac{1}{n-1}\sum_{i=1}^{15}(x_i-11)^2=6,43\text{min}$$

5. CONCLUSION

The paper has shown is to show that the combination of Lean and Six Sigma can produce remarkable results and is the most powerful engine available today for sustained value creation. Case studies have been provided to illustrate how results are achieved.Some people have described Lean Six Sigma as ñdoing quality quicklyò, which may seem counterï intuitive at first. Intuition tells us that faster we go, the more mistakes we make. If that were the case, trying to speed up a process would only result in lower quality. But Lean Six Sigma works not by speeding up the workers or the machines, but by *reducing unneeded wait time* between valueadd steps.

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