THE LEAN SIX SIGMA QUALITY IMPROVEMENT STRATEGY IN CELL PHONE REPAIR SERVICE INDUSTRY

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I INTRODUCTION

Low labor cost in Asia, South America and lately in Eastern Europe, as well as certain agreements such as NAFTA, caused most of the manufacturing jobs to be moved from the USA and other developed countries across the World. This changed the industrial picture of the developed states. Today, industry in those countries is becoming more and more service oriented.

The rhythm of life for an average consumer became so fast and stressful that he came to appreciate any service that can help him make it through the day easier if it is:

- Providing what he needs
- Delivered on time
- Affordable

Cell phones, pagers, online banking, drive through ATMs…etc. are part of Western life for a while now. Recently GE developed a washer and dryer that would be connected to the Internet and order detergent automatically when they are running low. Of course, detergent would be delivered to the door of a consumer. Service industry becomes so profitable that GE started its own, GE Capitol Services. GECS is now contributing more than 30% to GE total income.

In the world of telecommunications, various gadgets that provide services unimaginable only several years ago are now present on the market. 3G technology in cellular communications provides fast data/voice communications, wireless Internet, e-mail exchange, live audio and video streams…etc. The price of these services must be affordable to an average consumer as well as price of the equipment. This is where electronics repair service industry comes into play.

Cheap cell phone or any other gadget is cheap for a reason. “You get what you paid for” is an old saying. Certain number of these devices fails either in the field or at the final test right before it reaches the retail store. The number of these failures is not insignificant and providers are outsourcing electronics repair companies to repair those devices. What is critical here is quality, time and price. Cell phone sitting in the warehouse for a long time waiting to be repaired is losing its value and it is not in the consumer’s hands, therefore not making profit. If the quality of repair is poor, the cell phone will have to go back to be repaired again (the second, the third time return) and by the time it is repaired the cost of the repair will be equal or even higher than the cost of manufacturing. This is why it is critical that repair companies provide high quality, defect free and on time service. One of the methods to achieve this is Lean Six Sigma.

II LEAN SIX SIGMA – WHAT IS IT?

Lean Six Sigma is a combination of two methods for the improvement of quality. Lean refers to Lean Manufacturing that concentrates on the production waste removal, while Six Sigma is a new breakthrough strategy that concentrates on the elimination of defects in every step of the process, reducing variations in the process and achieving virtually defect free product or service. The Six Sigma uses statistics to improve and control the process.

III PRODUCTION WASTE AND LEAN

Taiichi Ohno, former executive vice president of Toyota, came up with 7 wastes (“muda”) that are found in production. Waste is defined as anything that does not contribute to the creation of value for the customer. 7 Wastes per Taiichi Ohno are [1]:

- Overproduction: producing more than customer or market requires. Results in product taking up space and not making profit.
- Transportation: moving of product that does not add value (double handling, batch production, movement of parts and materials in and out of storage, poor production layout…etc.)
- Motion: movement of people that does not add value (looking for parts, reaching for schematics, looking for tools…etc)
- Waiting: idle time created when equipment, people, materials or information are not ready.
- Processing: effort that adds no value from customer’s point of view (paperwork, multiple cleaning of parts, oversight tolerances, awkward tooling design…etc.)
- Inventory: excess material or product that is stored and not immediately required by the customer (WIP-Work In Progress, parts, raw goods, finished goods).
- Defects: work that contains errors, reworks, mistakes or lacks something necessary.

Later on, Toyota identified an additional waste called Dangerous Working Practices. This is probably the most important one. Not having or not following company’s rules regarding health and safety increases chances of accidents and injuries at work therefore reducing the production, causing more down times, damaging the reputation of the company, increasing the insurance costs…etc.
Each of these non-value-adding activities contributes to poor quality of product and therefore must be eliminated. Lean Manufacturing is concentrating on elimination of these wastes.

IV SIX SIGMA

The Six Sigma strategy was first developed in Motorola by Bob Galvin and Bill Smith. Later it was accepted by other giants such as GE, Allied Signals, Ford…etc.

There are many ways to explain Six Sigma. Six Sigma can be considered a vision, a goal, a strategy, a mission; however, it does not matter what’s it called, what matters is that it works.

Simply, the Six Sigma is customer focused, data driven strategy that has the reduction of variation and elimination of defects for a goal. The Defect is defined as anything that does not meet customer’s requirements. It does not matter how small and insignificant defect might look like, it is still one defect too many. The goal of Six Sigma is to reduce the number of defects to 3.4 per million of opportunities. An opportunity is defined as anything that can go wrong in the process. Therefore, Six Sigma goal is 99.9996% quality. Company or production line that operates at 6-sigma level has no need for final quality check and out of box audit at the end of the line. The product can go straight to shipping department after it has been produced.

What is Sigma? Sigma is a Greek letter that is used in statistic to define standard deviation of population. This is a measure of how much something deviates from the mean value. In the case of Six Sigma the mean value is “perfection”, which means totally satisfied customer. Any deviation from ideal is considered a defect and has to be removed.

Statistically, production processes have normal distribution. For example, if we measure the number of shipped units or number of processed applications…etc., it will be distributed normally around certain mean value (see figure 1).

Greater the deviation, the bell shaped curve will be flatter and wider. This means that large number of measurements is not distributed around the mean. The goal is to set desired control limits and reduce the variation so that most of the values are around mean. At 6 sigma 99.99966% of the values will be between \( \mu - 6\sigma \) and \( \mu + 6\sigma \), which means 3.4 values out of million will have the value outside of specified interval. These are the defects.

Mathematically, the goal is to get the individual measurement, \( x \), as close as possible to mean, \( \mu \), ideally equal to mean.

V SIX SIGMA IMPLEMENTATION

There are 6 phases in implementing Six Sigma, four of which are establishing Six Sigma and the last two are realization of Six Sigma. Phases one thru four are:

1. Establishing management commitment
2. Information gathering
3. Training
4. Developing monitoring system

This is an initial portion of implementation. The fifth and the sixth phase are:

5. Selection of a process to be improved and
6. Conduction of DMAIC project

The sixth phase we will discuss in more details. The main improvement tool used in Six Sigma is DMAIC. This stands for [2]:

- Define: define the problem and what the customer require
- Measure: measure the defects and process operation
- Analyze: analyze the data and find the causes of the problem
- Improve: improve the process and remove the problem causes
- Control: control the process to make sure defects do not recur

DMAIC is carried out as a project by the Six Sigma team. The teamwork and upper management support are crucial in implementing Six Sigma.

After one project is concluded the next one starts. This cycle is called continuous improvement and it is one of the core objectives of Six Sigma.

VI CASE STUDY-CELL PHONE REPAIR FACILITY

This is an example project from one of the Midwest cell phone repair companies. The Six Sigma team was used to improve the process on one of the repair lines.

Description of a problem: Customer’s requirement from the repair line was 5000 processed units for 5 days (5 day TAT – Turn Around Time). The customer agreed to cover expenses for a BER (Beyond Economical Repair) and RTM (Return To Manufacturer) rate. BER units are units that have physical damage and do not get repaired. RTM are units that cannot be repaired on the site and have to be returned to the manufacturer. The team was failing to meet customer’s demand and it was falling behind, creating the backlog of units. Also MCPU (Material Cost Per Unit) was too high. The pricing for the project was done in a form of a flat rate per unit and the parts were not consigned. The pricing is done based on the level of repair: Level 3, Level 2, No Fault Found, S/W update/alignment, BER and RTM. Certain
number of RTMs was returned as non-legitimate RTMs and the company had to pay for their repair.

**Definition:**
1. The five days TAT is not met.
2. MCPU is too high, $14.3, resulting in reduced profit margin per unit and contributing to the overall loss.
3. Number of units returned from manufacturers as non-legitimate RTMs caused the customer to question the ability of the company to repair difficult problems.

**Measurements**
Historical data collected from the production reports over 2 months period and the line layout are used as a starting point for the analysis. Following control charts represent data collected relevant to the problems stated above.

**Analysis:**
Based on collected results following can be concluded:
- Number of touched units oscillate between 900 and 1230. The days when the number of touched units was high were the days when the team worked overtime to meet the customer demand. Overtime contributes to increased cost per unit and since the techs are working 10 hours per day, their concentration is lower in the second half of the day, which affects the quality of the product (see figures 2, 3 and 4).
- The oscillations in the number of touched and shipped units are too high (see figures 2 and 3).
- The yield is too low and it is decreasing. This means that the number of rejected units from final inspection is increasing. The breakdown of failures is presented on the figure 6. Top 5 failures are debris under the lens, scratched housing, scratched lens, vibrator/speaker inoperative and scratched LCD. These failures are mechanical failures, which means that the techs are not paying enough of attention to details and do not perform proper inspection before sending the unit down the line. These rejected units must be returned to repair, which increases the chance of some other components being damaged in the process. This results in increased MCPU.
- Double handling. The units that are repaired by L3 techs are touched again by L2 techs for cosmetics repair. This also increases the possibility of additional damage to the unit and raises MCPU.
- This number of RTM units is too high. This means that techs are not trained or qualified to repair certain L3 repairs. They try to repair the unit and when they cannot they choose RTM as an option. Those phones come back from OEMs (Original Equipment Manufacturer) as non-legitimate failures and company has to pay for their repair, which adds to MCPU.
- The line layout is not optimal (see figure 7).
Improvement:

- The first step is to eliminate double handling of units. The repair process is changed so that L3 techs perform complete repair of the unit.
- Triage station is eliminated. RF test station will perform RF test and functionality test.
- Software update, clearing and loopback stations are combined into one station. This change eliminated another two positions.
- L2 and L3 techs are issued parts kits every morning and held responsible for every part they change. They had to match every replaced part with the defective one. This change added more time to prepare kits but resulted in savings in material and reduction of MCPU to $10.2.
- In order to reduce the number of final quality failures, an experienced L2 tech is assigned to final quality inspection to perform a quick fix of top 5 failures. The data about failures is still recorded and each tech is held responsible for the failures.
- Retraining of all personnel for the cosmetics criteria and retraining of L3 techs on the theory of operation of the digital transceiver.
- To reduce the number of RTMs, all RTMs are checked by an engineering tech who validates RTM. Engineering tech is a part of the engineering department.

Overall results:

- Elimination of 3 positions: savings of $90,000 per year (see figure 8).
- Reduction of MCPU from $14.3 to $10.2.
- Reduction of RTMs for over 50%.
- Increase of the number of shipped units for 4.2% on average, which brought the total of shipped units per day to 1002 on average therefore satisfying customer’s requirement.
- Keeping the average number of touched units the same without working overtime.
- Removal of 3 stations that resulted in floor space savings of 100 square feet.

VI CONCLUSION

One of the main six sigma principles is that everyone in the process is responsible for quality. Therefore, every engineer should become familiar with this method. Regardless of working place, every engineer is part of the process and every process always can be improved. In this case study lean six sigma application brought quick results to the company; however, even after the improvement this process will be due for another change and engineers must be ready to address the issues and act accordingly.

LITERATURE


Abstract: Modern day economy and fast changing technology dictate that companies that are in the cell phone repair industry constantly change the way they manage business and improve the quality they offer to customers. With the orientation towards providing services this is even more critical for the companies from the USA and Europe. The quality of the product and time to customer has never been more important. The Lean Six Sigma is the way to implement quality improvement and control in every step of the process and provide virtually defect free product. The quick introduction to this method along with a real life example is presented in this article.

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