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Enhancing Aluminum Recycling in Fayette County: A Six Sigma Study

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Enhancing the Competitiveness of a
Sustainable Aluminum Industry

ABSTRACT

A project initiated last summer as a part of the Sloan Foundation grant involves Fayette County, Kentucky is being used as a test lab for the implementation of the Six Sigma methodology in an attempt to understand and improve aluminum recycling rates.

The project considers each aluminum can not recycled as a “defect” and the goal is to reduce this defect level. The economic and social benefits of aluminum recycling are widespread, and this application of Six Sigma to recycling is the first methodological attempt at improving the recycling rate. Secat Inc. is working with local retailers and aluminum recycling facilities to implement the 11 steps of Six Sigma, most notably, to define a “ true “ recycling rate and to understand the process of recycling aluminum cans. This will allow Secat to understand the sources of variability and attempt to decrease the variability in the process, with the ultimate goal of increasing customer satisfaction in the form of increasing the recycling rate. This paper describes the application of six-sigma methodology to aluminum can recycling, presents preliminary findings and proposes path forward to complete the study.

Introduction

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Six Sigma is the philosophy and science of reducing costs and improving customer satisfaction through identification of sources of variability in the work process and disciplined use of data, facts, and statistical analysis to improve organizational processes. Six Sigma differs from traditional performance improvement programs in its focus on input variables. While traditional methods depend on measuring outputs and establishing control plans to shield customers from organizational defects, a Six Sigma program demands that problems be addressed at the root level, eliminating the need for unnecessary inspection and rework processes.

Six Sigma at many organizations simply means a measure of quality that strives for near perfection. Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving towards six standard deviations between the mean and the nearest specification limit) in any process -- from manufacturing to transactional and from product to service. Along with cost reduction, Six Sigma sets the stretch goal of improving quality to a level of only 3.4 defects per million opportunities. A Six Sigma defect is defined as anything outside of customer specifications.

Born at Motorola Corporation in the mid 1980's and now widely used by major corporations worldwide, Six Sigma has become “the way we do things here” in many successful companies. General Electric, one of the most successful companies implementing Six Sigma, has estimated benefits on the order of \$10 billion during the first five years of implementation. Since then, thousands of companies around the world have discovered the far-reaching benefits of Six Sigma. The benefits that can be derived from the implementation of Six Sigma are not limited solely to corporations. Six Sigma can be applied to any work process by adapting the following goals to the process in question:

- Improve Customer Satisfaction
- Increase Profitability
- Increase Productivity

For example, in recycling the customer satisfaction issue would be with the ease of the process of getting the cans to the recycling facility. The productivity issue would be the number of cans that make it to the facility. Ultimately, Six Sigma is a superb strategy that is based on natural laws and addresses leadership, tools and infrastructure issues, some of which were neglected by previous quality programs. CEOs of leading U.S. firms praise the accomplishments of their Six Sigma initiatives. Outstanding quality professionals and industrial statisticians concur and describe potential roles for

their colleagues. Engineering programs have begun to incorporate elements of Six Sigma into their curricula.

Background Information

Numerous companies supply aluminum cans to a variety of resellers in Fayette County, Kentucky. After consumption of the contents, all cans should be recycled in the ideal case. Investigation has found that a modest percentage of the cans sold in Fayette County are recycled. Increasing the recycle rate will have multiple benefits. First, the revenues and the local materials recycling facility (MRF) will be substantially improved. For every 1% increase in the recycling rate of aluminum cans revenues to the US economy will increase by 12 million dollars. This money can be used to improve our schools or other socially desirable causes. In addition, increasing this rate will reduce the fresh aluminum production requirement, which will substantially reduce energy usage at aluminum plants. In fact, it takes only 5% of the energy required to produce aluminum from raw ore to recycle an aluminum can. Also, the added benefits of a cleaner environment are paramount.

Application of Six Sigma to Aluminum Recycling

Six Sigma consists of five phases and 11 steps. The phases are scope, measure, analyze, improve, and control. Each phase and the steps required in each phase will be discussed as it applies to aluminum recycling.

Phase 1: Scope

Step 1. Articulate the problem statement:

Step one requires a good understanding of the quality issue at hand. This is essential to identifying the sources of variability inherent in the system, a key issue for quality improvement. In the context of aluminum recycling in Fayette county the problem is large amount aluminum cans per week are not recycled in Fayette County leading to revenue losses at MRF, higher energy consumption at the production facilities, and negative environmental impacts.

Step 2. Define response variable:

The response variable is the variable that needs to be improved. In the case of aluminum can recycling, the response variable is the percentage of can consumed that are recycled each week.

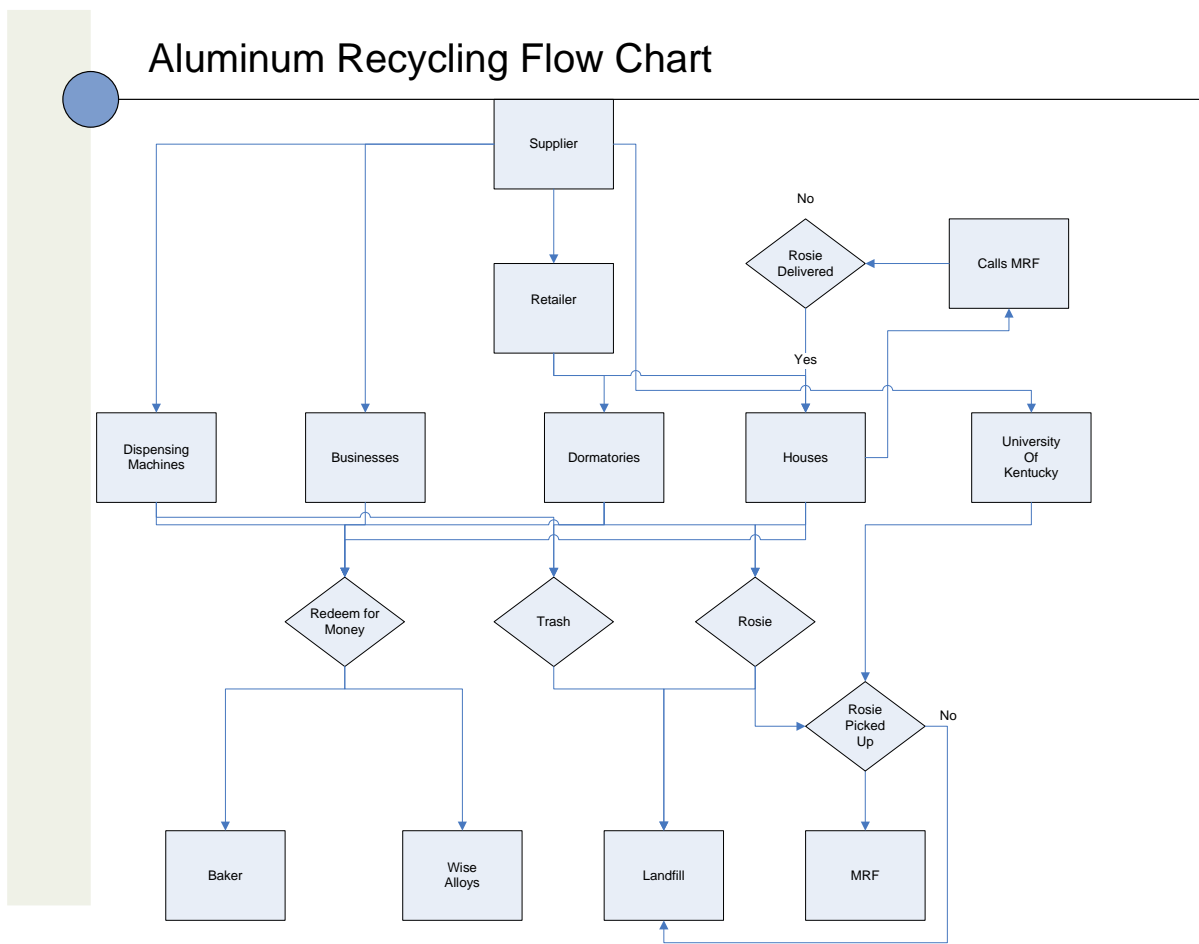
Step 3. Identify Customer CTQ (Critical-To-Quality):

The ultimate goal of Six Sigma is to improve customer satisfaction. Financial and process benefits are garnered, however, this is not the goal of the methodology. The customer in the case of aluminum recycling is the actual consumer of the beverage can. The quality issue would be a process that allows the customer to easily recycle his or her aluminum cans leading to a desired increase of 20% in the recycling rate.

Phase II. Measure

Step 4. Prepare Process Map:

In order to understand the steps inherent in the recycling process, Six Sigma requires the development of a process flow map. This is critical to defining the elements in the process that can cause variability or cause the mean to be too high or low. Secat has developed the following process map and outlining each step in the aluminum recycling process and plans to locate and correct sources of variability.



For example, consumers must call and request a Rosie (recycling bin) and in some cases, that Rosie is never delivered. Also, in some cases the full Rosie is never picked up. In addition, those consumers living apartments have no easy access to recycling facilities. Consumers can take their cans to the local MRF or to Good Foods Coop, however, this requires considerable motivation on the part of the consumer. One large source of variability is the decision of the consumer to recycle in the first place. We are working with various academics to understand the motivation behind recycling, and government officials to put programs in place to increase recycling behavior.

Step 5. Validate Measurement Systems:

If the measurement systems used to determine defects in a process are inconsistent or flawed, implementing and measuring improvement will be unachievable. In the case of aluminum recycling, the measurement systems requiring validation are:

- Consistent definition of what is meant by weekly; a week is taken to be 7 days – Monday through Sunday.
- Data on incoming Aluminum procured from the various resellers.
- Precision of recycled Aluminum weight measurements and that of data at MRF. Based on current estimates from the aluminum association, we are using the figure of 33 aluminum cans per pound.

Step 6. Collect data on response variable:

Collecting data on the response variable is necessary to establish a baseline. For aluminum recycling the data necessary are the following:

- Weekly data on incoming aluminum cans and the recycled aluminum cans (lb/week) are collected for ten randomly selected weeks.
- Recycling rates in Fayette County are estimated via stratified sampling.
- The local recycling facilities provided weekly data on Aluminum cans recycled for the same ten weeks.

Step 7. Establish the Baseline:

The baseline in this case is the “true” recycling rate. Historic estimates have relied on broad assumptions such as consumption of 380 aluminum cans per person annually. Thanks to resources provided by the Sloan Foundation, we are in the process of developing a much more precise estimate, a key element of Six Sigma. The local recycling facilities have provided us with the amount that is being recycled. We are working with local retailers, bars, restaurants, etc. to determine the actual amount sold. We have employed a statistician to provide us with stratified random sample of these establishments, and have determined the UPC codes of products sold in aluminum cans. While the rigorous determination of the true recycling rate is in progress, initial estimate is 39% based upon Anheuser Busch and Kroger data. After establishing the rate, we will work to correct these sources of variability and attempt to increase

recycling rates. The data shown graphically below are used to compute the mean weight percent aluminum cans recycled weekly and its standard deviation. Six Sigma should increase the mean and reduce the standard deviation.

Phase III. Analyze

Steps 8 & 9 Collect and Analyze Data:

Analyzing the data in the case of aluminum recycling requires defining why there is a gap between incoming and recycled aluminum cans and methods by which the gap can be reduced for an improvement in the aluminum recycling rate. The gap arises because there are numerous missing steps in the process map. The approach to follow is to scrutinize the process map and introduce the many missing steps.

Phase IV. Improve

Step 10. Remove Causes of Variability:

The missing steps on the process map are responsible for much of the variability in the response variable, weight percent of Aluminum cans recycled weekly. Some of the missing steps such as delivery and pick up of the Rosies have already been identified. Inputs from a large number of people in Fayette County will be solicited on the missing steps and the map further modified.

We are also working with other locations that are interested in increasing recycling rates to determine best practices such as the new aluminum recycling project sponsored by Bowling Green Technical College (BGTC), Logan Aluminum, ARCO Aluminum, and Novelis. This project would address two of the sources of variability outlined above, that of motivating people to recycle to begin with, and giving those without access to curbside pickup a convenient place to drop off their aluminum cans. The project has placed recycling bins in all of the elementary school in Bowling Green and the schools are allowed to keep the revenues from cans collected. Those without easy access to recycling can simply send their cans on the school bus with their child. In addition, the motivation to recycle will increase due to the benefits reaped by the school the child is attending. This revision in the process map will likely increase the mean level of recycling.

Conclusions and Future Work Plan

We have identified the preliminary process map and have an initial estimate of the true recycling rate. We have also made initial recommendations of steps that will improve the process map such as ensuring Rosies are delivered when requested, and replication of the Warren County project to address the ease of recycling issue for apartment dweller and businesses. Going forward, we plan to do the following five items:

- Determine true recycling rate using rigorous statistical techniques.
- Further revise process map based upon new data and input from a large number of sources in Fayette County.
- Implement step of Warren County project in Fayette County to enhance recycling rate and carefully document this process to enhance transferability.
- Ensure sustainability of improvements.
- Recommend strategies for wider replication.