Minimizing Wastage by Improving Process Capability: Study in Toothpaste Manufacturing Section

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ABSTRACT

Fast Moving Consumer Goods (FMCG) sector provides high quality products for their customers. Therefore they always try to please their customers while achieving the profits. Thus, the identification of the potential capabilities to produce their products more accurately is an important for the organization.

In this research, the toothpaste manufacturing sector was identified to analyze the capability of the process. As the production process deals with larger control limits in fillings, tooth paste tubes contain more paste than the amount indicated in the package. In such a situation, companies have to identify whether the process is capable enough to reduce the controlling limits or not. This can be done by identifying existing control limits and their behaviors. The variations of the process were identified to analyze the capability. Through the methodology, the researcher identified several processes as capable and the processes which need to be further improved.

Solutions to minimize these variations in the production process are identified and these solutions are basically mentioned as managerial point of view. Feasibility study was carried out for all possible solutions to identify most appropriate solution. Improve the communication through mixing and production department was identified as best solution for this scenario.

KEYWORDS: Control Limits, Process Capability, Waste Minimization, Manufacturing

INTRODUCTION

Consumer goods manufacturing companies always try to satisfy their customers by providing products what customer wants. One quality consideration factor in this process is a weight of the product. Companies usually maintain a policy of providing the weight mentioned in every product label. To meet that requirement, Companies usually do not provide less weight than the mentioned value. In other words, they always give more to the customers which is known as "give away". Even thought this is a plus point for the customer, it makes losses to the company.

Even in the production, company is unable to meet the targeted output at the end. Moreover, it creates several problems to the entire process.

Usually, the company considers amount of raw material allocated for the production process to set the production plans. But, due to the giveaway and other related factors, companies face lot of difficulties to meet these targets. As these companies involve with mass production, there can be several reasons in the production processes for these changes.

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Therefore company needs to find the root causes for these variations in the production output. But without knowing the causes, they are unable to streamline the production process and to fill accurate volume of paste for the value mentioned in the label.

Mainly, Production Department suffers from these variations which directly cause for quality problems. Therefore Quality Department also expects to identify and implement the necessary steps to minimize unnecessary fillings.

This study is mainly focused on the production of personal care products in FMCG sector due to the management interest and the high market share. After an investigation and discussions with the relevant authorities, toothpaste filling and packing section was selected apart from personal care product categories.

Research Objective

Main objective of this study is to minimize the wastage by improving the process capability in the toothpaste manufacturing section. Further, this aims to identify wastage minimizing strategies for a personal care manufacturing company through an extensive investigation.

LITERATURE REVIEW

What is Waste?

Waste is any activity that does not produce value, value in the "eyes" of the customer. There are seven types of wastages in a production process according to the Japanese 5s approach. Toyota uses this approach to minimize wastages and they were able to achieve their targets successfully (James, 1992).

1. Waste from overproduction
2. Waste from waiting times
3. Waste from transportation and handling
4. Waste related to useless and excess inventories
5. Waste in production process
6. Useless motions
7. Waste from scrap and defects

Above mentioned wastage types can be a cause for several problems (Six Sigma Training Consulting, 2009). They are; reduced productivity, large reach / walk distances, longer lead times, excess handling, reduced quality, people / machines waiting, high energy cost and inappropriate use of resources.

Wastage can be generated from any manufacturing process. Therefore, it has become one of main problems for many industries and most of the time; companies try to minimize it at the end of the pipe. In other words, companies try it at the destination not at the source. But, it can be minimized by identifying the pollutions at the development stages (James, 1992). The hierarchical decision procedure can be used for this synthesis as Douglas has discussed in his research.

Flexibility is an essential factor for any type of organization to gain profits and to satisfy their customers while minimizing the cost of production. The capacity flexibility consists of three indices. They are quality, cost and scheduling. By enhancing quality control in manufacturing process, capacity flexibility can be enhanced. And also the integrated control strategy between prevention control and Six Sigma management help organization to obtained high quality, low cost and high speed manufacturing processes to achieve the targets (Hui Wang, 2007).

Statistical Quality Control (SQC)

Statistical Quality Control (SQC) is a term which can be used to make quality decisions. Specific statistical tools are available to make right decision for the quality problems. This can be divided into three categories, such as

1. Descriptive Statistics:
This is used to describe the quality characteristics and relationships. Under this mean, standard deviation, range and the distribution of the data can be found.
Variation of a process can be occurred due to material, workers, machines, tools and other several factors (Hitoshi Kume, 1985). The causes of the variation can be divided into two;

- Common causes of Variation
  The process may have variations but it cannot be adjusted.
- Assignable causes of Variation
  These are the causes which can be eliminated. This can be done through the training or changing materials.

2. Statistical Process Control (SPC) :
Using the descriptive statistic, an idea about the process can be obtained. Results can be converted into useful information by using the SPC methods. Amount of variation and its status; whether common or normal, are determined by the SPC. The production process is analyzed by using various types of control charts and make sure whether the process is in a state of control or not. $\overline{X}$ - R charts which can be used to monitor changes in the mean of the process and dispersion or variability of the process was used for this (Hitoshi Kume, 1985).

3. Capability Indexes
Potential Capability (Cp) is the simplest and most straightforward indicator of process capability. It is defined as the ratio of the specification range to the process range; using ± 3 sigma limits
When,

$Cp < 1.0$	Poor Process
$Cp = 1.0$	Process is Okay
$1.3 < Cp < 1.5$	Process is Good
$Cp = 2$	Excellent Process

Using the Cp index the smartness of the process curve can be identified while identifying the positioning of Curve from Cpk which can be used to measure the potential process capability.

METHODOLOGY

This research is an applied research which can be used to find solutions for the currently existing problems. The research was conducted according to the procedure given below by analyzing the process capability.
After recognizing the research problem, published literatures were reviewed to get improve the knowledge related to research area. Then required primary and secondary data sets were identified. Primary Data were collected through the interviews, observations, questionnaires. And the Secondary Data were gathered from Annual reports, past records, journals etc.

There were two filling machines namely: Wimco and Norden in the filling section and 40g, 70g, 120g and 170g were the Stock Keeping Units (SKU) produced in this manufacturing process. Therefore, required data were collected for all four categories.
For these SKUs, sample of five tubes were selected from each corrugated box. The samples of ten tubes were fed into the process at once to obtain an idea about the ongoing process.

By using statistical software, collected data were analyzed and variations were identified. Based on the analysis results, the root causes were identified. Then, the details were summarized to find alternative solutions for these identified root causes. Further, solutions' feasibility was studied to identify most appropriate ones for the organization.

DATA COLLECTION AND ANALYSIS

The net filled weight was calculated by subtracting the weight from the filled weight. The net filled weights were used to analyze the capability of filling machine. Following figure shows the summary of collected data for 40g SKU which used Wimco machine for filling.

Table 1: Data Collection of 40g SKU

SKU 40g					
Date	Time	Box No.	Number	Weight	Filled Weight
2/8/10	12.20pm	2162	1	4.27	44.92
			2	3.91	44.61
			3	4.23	44.88
			4	4.22	44.99
			5	4.30	44.94
		2156	1	4.05	44.68
			2	4.00	44.62

Under the measurements before and after filling weights of the tubes were found. The code number of the corrugated box was indicated as the box number. The boxes were selected at random and the tubes which were taken from one corrugated box ware indicated by the number.

According to the collected data, the control charts were obtained as follows. Through these charts, behaviors of the process can be identified.

Data Analysis of 40g SKU

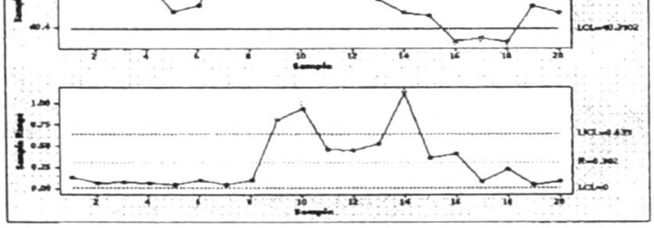

Figure 1: Control Chart for 40g SKU

For the 40g SKU, the center line on the X chart is at 40.5644, and only five points are outside the control limits. The process is falling within the specification limits, because 75% of data lie inside the control limits. From 20 data points, five points fall outside the control limits, implying a stable process. The center line on R chart, 0.302, is acceptable considering maximum allowable variation is +/- 0.5g.

Data Analysis of 70g SKU

For 70g SKU, the center line of X chart is at 70.4964 and implying that the process is not falling within the specification limits. But 16 points fall outside the control limits, implying an unstable process. The center line on the R chart, 0.1185, is acceptable considering +0.5g.

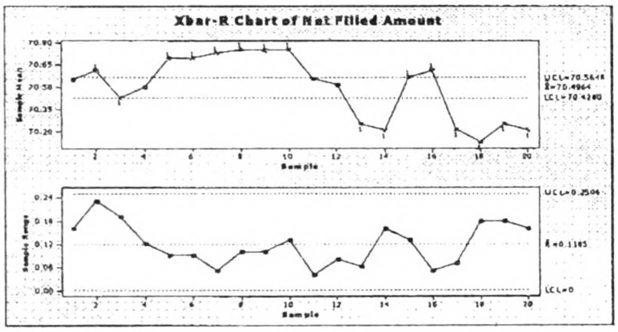

Figure 2: Control Chart for 70g SKU

Data Analysis of 120g SKU

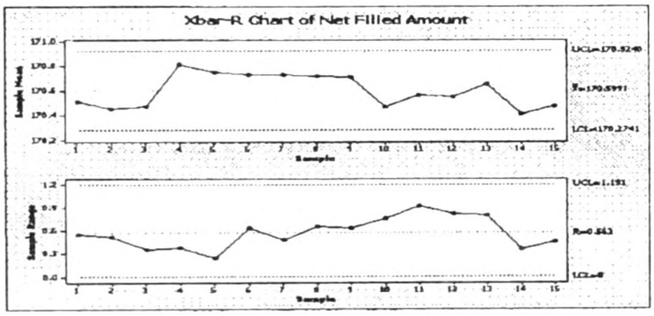

Figure 3: Control Chart for 120g SKU

For 120g SKU, the center line of X chart is at 120.728, implying the process is falling within the specification limits. Only four points fall outside the limits, implying this is a stable process. The center line of R chart, 0.3179, is acceptable.

Data Analysis of 170g SKU

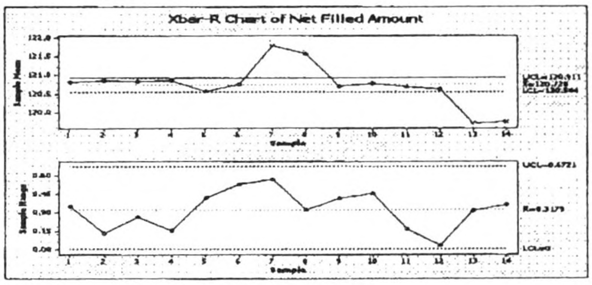

Figure 4: Control Chart for 170g SKU

For 170g SKU, the center line on the X chart is at 170.5991, implying that the process is falling within the specification limits. All points fall inside the control limits, implying this is a stable process. The center line on R chart, 0.563, is not acceptable considering the maximum allowable variation is +0.5g.

For the selected four SKUs, relevant descriptive statistics were obtained and the details were shown in Table 1.

Table 1: SKUs Descriptive Statistics

Variable	Mean	SE Mean	St. Dev	Median
40 SKU	40.564	0.0213	0.213	40.555
70 SKU	70.496	0.0215	0.215	70.545
120 SKU	120.73	0.0652	0.545	120.76
170 SKU	170.60	0.0295	0.255	170.57

Capability Study

Calculated capability index values for all four SKUs are shown in Table 2.

Table 2: Capability Indices for the SKUs

SKU	C_p	C_{pk}	P_p	P_{pk}
40g	1.19	1.04	0.88	0.77
70g	1.48	1.47	0.77	0.77
120g	1.18	0.62	1.05	0.55
170g	0.68	0.55	0.65	0.52

For 40g SKU:

The 1<Cp< 1.3 implying the process is more than okay for the production; marginally acceptable. It means Wimco machine has a marginal process capability for filling 40g SKU. Ppk<1 implying that, this is not meeting the specification limits well.

For 70g SKU:

The 1.3<Cp< 1.5 implying the process is good. Therefore process is performing well. It means Norden machine has a good process capability for 70g SKU. Pp=Ppk means the process continues on target.

For 120g SKU:

The 1<Cp< 1.3 implying the process is more than okay for the production; marginally acceptable. It means Norden machine has a marginal process capability for filling 120g SKU. Thus, Ppk<1 implying that this is not meeting the specification limits well.

For 170g SKU:

The Cp<1 implying the process has poor capability. But Cpk~Ppk imply, it as a stable process. But Ppk<1 implying that this is not meeting the specification limits as well If it is equal to the Pp, then this stable process can be conducted on target.

Root Causes for the Variation

Root causes for the variations were identified through the discussions with the relevant persons and investigating the regular processes in this toothpaste manufacturing section. Causes were identified under the categories of Man, Material, Methods and Machinery.

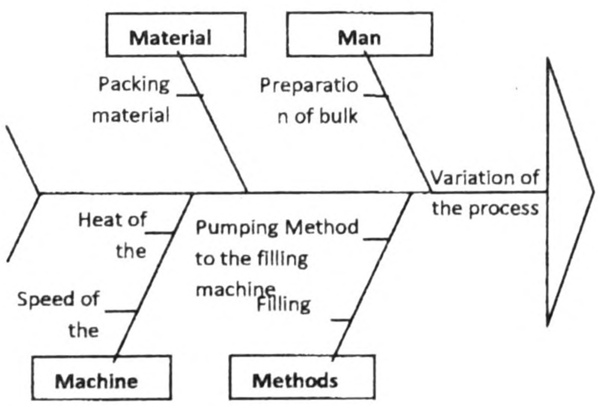

Figure 5: Root Causes for the Variation

To minimize above identified root causes, probable solutions were identified.

Option 1: The Human errors should be minimized

Due to the changes in the density, weight can be varied. By reducing human errors in mixing, this can be minimized.

Option 2: Improve the communication through mixing and production department

If a batch is in a minimum level, it is necessary to inform to the line supervisor, to stop production. If not, whole paste included packages are classified as waste.

Option 3: Implement new machine which have enough capability.

High speed new machine can be replaced to get accurate performances in fillings. By implementing new machine, interruptions can be minimized and capability can be enhanced to produce quality products with less time duration.

Option 4: Change the existing techniques which use to the filling.

New techniques which comply with the requirements of the production department can be introduced with the help of the engineering department.

Feasibility study was carried out to check the implementation feasibility of given solutions. Summary of this study has been listed below.

Table 3: Feasibility Study

Options	Economical	Schedule	Operational
First	✓		✓
Second	✓	✓	✓
Third		✓	
Fourth		✓	✓

DISCUSSION AND CONCLUSION

Through this research, existing control limits for the different SKUs of the Wimco and the Norden machine were identified.

Variations and root causes were identified and the probable actions were taken into account to avoid or to reduce those errors. According to the analysis of each SKU:

- 40g SKU filling process indicated marginal acceptance capability. It means capable process but need to improve. There were some problems with the upper controlling limit since it does not meet the specifications.
- For 70g tubes, the Norden machine has its capability for production on target. This was identified as a capable as most of the data vary at target.
- The 120g SKU filling process has shown capable process, but it needs further improvement.
- The 170g SKU is stable process of the Norden machine. Filing process continues with constant fillings, but specification limits are not met by process.

According to the research findings, the process should be improved to meet the specifications. There can be technical solutions like speed adjustment or adding new equipments to the machine. Managerial points of view, the causes were the human errors and communication problems. In any toothpaste manufacturing process, there can be variations. By focusing on research findings, best feasible solution was identified. It is a technical solution or a managerial decision.

Not only for the toothpaste manufacturing process but also for any other manufacturing process, these findings are important. Communication problems and human errors are more common to any production process. There can be variations according to the employee skill levels, but each and every person's involvement will be highly affected for the production processes. In general, this model can be used to identify capabilities of any production processes.

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