

Scrutinizing the Viscosity Measures of Two Formulations of Face Cream Light: An Application of Statistical Quality Control in a Cosmetic Company

**Dyan C. Gonzales-Rodriguez, Lawrence C. Alenia,
Michaela Marie M. Cruz, and Alexis C. Flores**

Industrial Engineering Department
Bulacan State University, City of Malolos, Bulacan, Philippines 3000

dyan.rodriguez@bulsu.edu.ph, alenialawrence.ie@gmail.com,
michaelacruz36@gmail.com, alxsflrs0124@gmail.com

Abstract

A cosmetic company in the Philippines is well-known for its personal care products not only in the country but also in the international market. Accentuated in this study is Face Cream Light which is a serum that transforms from cream to powder. The company have decided to change the chemical formulation of Face Cream Light since consumers of the product found out that the face cream turns out to be yellowish in the long run affecting the natural shade of the formulation. As an effect, properties of the product specifically the viscosity were greatly affected. The main purpose of this study is to comparatively analyze the viscosity measures of Face Cream Light in the year 2016, when the old formulation was used, and 2017, the new formulation is introduced. The researchers used variable control charts for the analysis which show that the data is statistically in control in 2016. Meanwhile, the data is statistically out of control in the year 2017 and 2018. The researchers recommended to review the change in chemical formulations and to frequently schedule full machine maintenance and reinforce autonomous maintenance among operators as these will unravel the problem with regards to the viscosity of the product.

Keywords

Face Cream Light, quality control, reworks, viscosity

1. Introduction

As the time advances, manufacturing companies are striving for continuous improvement in quality, efficiency, and cost reduction since increasing competition is prevalent. Henceforth, statistical process control is an effective method to drive continuous amelioration.

According to Quality One International, statistical process control is a method for monitoring, controlling and ideally, improving a process through statistical analysis. In this manner, it will guide the researchers on deciding what type of action is appropriate for trying to improve the functioning of a process. The good thing with this approach is that it is a prevention-based quality control in which by monitoring the performance of a process, trends and changes within it can be detected before it results to non- conforming product and scrap.

Moving forward, Cosmetic Company ABC is a Filipino enterprise with business interests in personal care manufacturing, marketing, and distribution in the Philippines and in the international market. It is a market leader in personal care products mainly exfoliants, skin whitening lotion, hair coloring and not to mention the different shades of face creams.

At the present time, Face Cream Light has been experiencing problem with regards to its viscosity. It does not meet the standard set by the company which is 3000 to 6000 centipoises. Although this property is reworkable, it is clearly a waste of material and machine hours. If the quality department found out that the viscousness of the cream is higher and lower than the set standards, it will be sent back to the emulsion compounding process to be fixed using the recommended proportions of material suggested by the quality inspector.

The main purpose of this study is to comparatively analyze the viscosity measures of Face Cream Light in the year 2016 and 2017 onwards. This study also intends to apply the concepts of statistical quality control in line with providing suitable recommendation in solving the problem.

1.1 Objectives

The main objective of the study is to comparatively analyze the viscosity measures of Face Cream Light in the year 2016 and 2017 onwards. The study sought to achieve the following objectives:

- To determine the significant effect of the change in chemical formulation with regards to viscosity of the product;
- To provide a comprehensive solution to lessen the number of reworks.

Quality is what people always consider when choosing certain product especially if it is about health and safety, they also took care on their appearance. People are constantly conscious about how they look like and how they appear on other people. Cosmetics, personal beauty products and hygiene are what they always seek primarily in women. Quality also took place in materials, machines and other things. For a company that produces several cosmetic products one needs a quality assurance because consumers are their main concern. This study intent to assess a certain company on how to maintain the good quality specifically with regards to the viscosity of Face Cream Light using Statistical Process Control. It also focuses on the prevailing problems that usually occur and also trigger broader problem, and find a method to unravel that problem but with consideration on the production and the present method that they are using. Furthermore, this study will be essential to Cosmetic Company ABC since the findings of this study will help to reduce the number of reworkable face creams which did not pass the set standards eliminating the waste of machine hours and materials.

2. Literature Review

Variation is a fact of life. It is everywhere, and it is unavoidable. Attaining consistent product quality requires understanding, monitoring, and controlling process variability. Attaining optimal product quality requires a never-ending commitment to reducing variation (Leavengood and Reeb 2015). The constantly increasing global competition that many industry sectors worldwide have been facing over the past years, associated with fast technological changes and product variety proliferation have led to a new scenario in which industries, in order to remain competitive, must continuously change, improve and implement best practice management principles, strategies and technologies. The Statistical Process Control tool and techniques can be used for the continuous quality improvement of products, processes, and services in organizations (Lepojević and Kalač 2012). In addition, full benefits of SPC tend to be realized only when the motivation is appropriate. According to Brannstrom-Stenberg & Deleryd "Organizations that have implemented statistical process control of their own free will experience advantages to a greater extent". In Japan, many companies have embraced the technique SPC with great success for tackling quality related problems such as high scrap rate, increased number of customer complaints, high rework costs, incapable processes etc. (Brannstrom-Stenberg and Deleryd 2009).

In order to reduce the variation that many companies desires and achieve the optimum goal of the company, tools like quality controlling are needed. Problems cannot be separated in every company; in fact, problems always exist. In many companies that acknowledge the SPC the disparity in quality leads them to success. Improvement, adaptation and controlling are necessary to attain the objective of the company. The capability of the organization to appraise quality problems benefits them a lot and also benefits especially the costumers.

Moving forward, the quality of a cosmetic product, in the same way as to other kind of products, is initially defined by the manufacturer that chooses the features that a product should present. On the other hand, the quality control of a product aims to verify if all of these defined features are in accordance with the standard definitions and if it will be maintained during the shelf life of the product (Shewhart 1980). Starting material quality is the most important part to ensure the cosmetic product quality are good and followed GMP regulation. According to GMP guidelines for cosmetic products include that all starting material should correspond to the agreed specification and consistently be of good quality (Savaran 2012). As a rule, when it goes about cosmetics it goes mostly about viscosity, because the liquids usually flow easily and they have no signs of elasticity (PCE Instruments 2013). Scientifically speaking,

accurately measuring viscosity, or the resistance of a liquid to flow, is an important part of quality control in the cosmetics industry. Some liquids must have a certain type of viscosity to prove effective for their designed purpose (Loeschen 2019). Likewise, in creams and lotions the stiffness or viscosity of the formulation plays an important role in (1) the proper extrusion of the product from the primary package, (2) the handling of the formulation during application, (3) the stabilization of the dispersed phase (e.g. oil, water, solids, etc.) in the primary package and (4) maintaining the homogeneous distribution of the API in the package during shelf life (BASF 2016).

Several studies have shown that viscosity should be highly considered in cosmetic products like face creams. This property affects how long the product takes to set or dry, and the time it takes to dispense the fluid into packaging. In essence, lower than the set standard for viscosity in a face cream will flow readily meaning the formulation is so watery and difficult to handle. On the contrary, it is also not recommended for face creams to have higher viscosity compared to the set standards since it would be uneasy to dispense creams into the packaging material.

3. Methods

Figure 1 shows the Input- Process- Output (IPO) model of the study wherein processing steps required to transform inputs into outputs are described. This was used to convey the overview of the methods performed on the whole study.

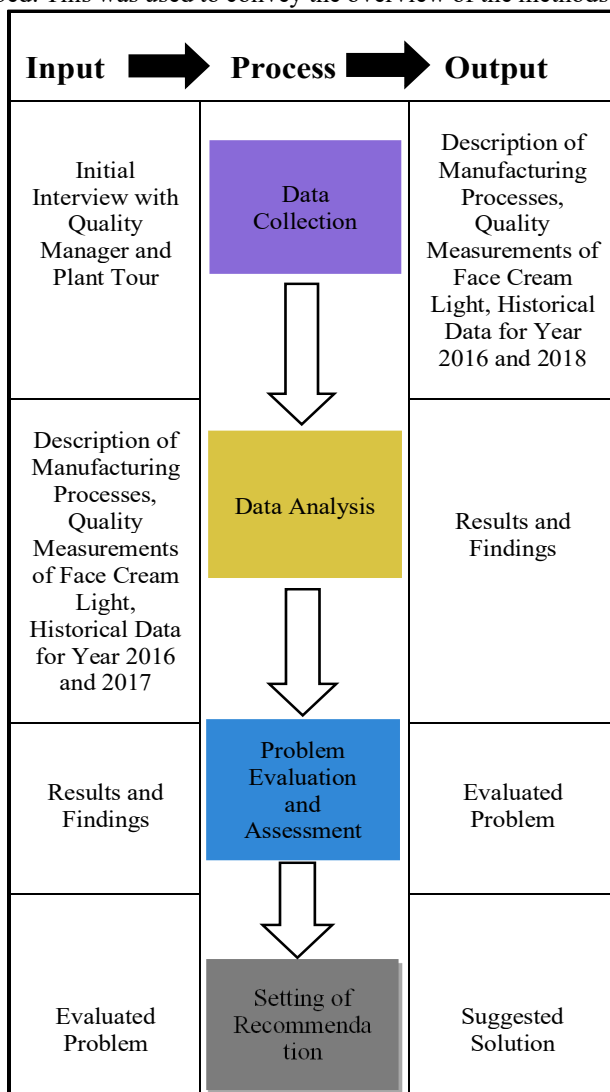


Figure 1. IPO Model of the Study

4. Data Collection

Cosmetic Company ABC provided the historical data of Face Cream Light from year 2016 to 201. Included in these data are the measures of viscosity from January to December 2016 and present year's viscosity measure till October 2018.

In line with the set quality measures of the company with regards to viscosity of Face Cream Light which is 3,000 to 6,000 centipoises; any face creams with a lower and higher viscosity compared to the set standards are considered nonconforming products that need to be reworked to meet the specifications.

The researchers along with the quality manager conducted a plant tour and a visit to the laboratory testing of Face Cream Light in able to comprehend an extensive knowledge regarding the product.

A quantitative data analysis was employed in this study. The researchers used variable control charts in able to plot the process mean, range, and standard deviation over time. In addition, variable control charts were used to track the process level and detect presence of special causes affecting the mean and in addition the process variation and detect unexpected variation.

5. Results and Discussion

5.1 Numerical Results

Cosmetic Company ABC have decided to change the chemical formulation of Face Cream Light since consumers of the product found out that the face cream turns out to be yellowish in the long run affecting the natural shade of the formulation.

In line with the change in chemical formulation, the viscosity which is an important measure of Face Cream Light has been agitated. The chemical formulation in the year 2016 had met the set quality measures of viscosity compared to the current formulation in which some batch of Face Cream Light needs to be reworked to meet the specifications (see Table 1). Rework is clearly an additional cost since it includes additional operations or to fix the product in able to meet the set standards.

Table 1. Total number of reworks done for the year 2016 and 2017

Production Year	Number of Batch Reworks done
2016	0
2017	3

5.2 Graphical Results

After the data has been gathered, the researchers summed up the results which will serve as a basis for appropriate recommendation.

In the year 2016, the mean is equal to 4353 while UCL is equal to 5725 and LCL is equal to 2981. The range is equal to 729 while UCL is equal to 2383 and LCL is equal to 0 (see Figure 2). Having point 5 out of the upper control limit of the mean chart and point 14 out of the upper control limit of the range chart indicates that the process is out of control.

In Figure 3, using the same data for 2016 a control chart of the mean and standard deviation is created. With a standard deviation of 516, UCL is equal to 1685 and LCL equal to zero, the control chart shows similar out of control point of 5 in the mean chart and point 14 in the standard deviation chart.

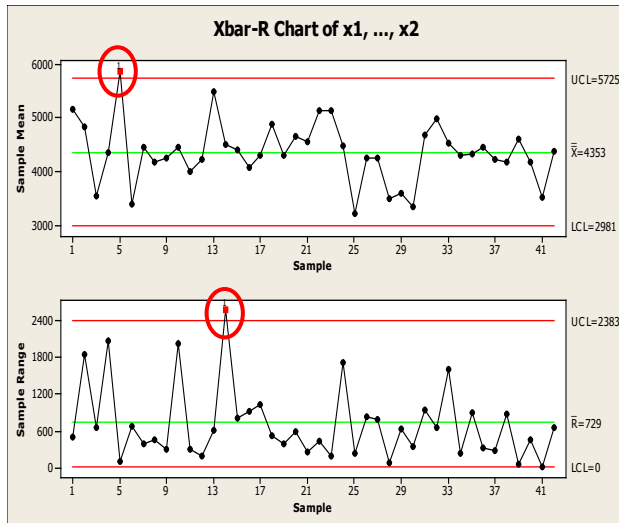


Figure 2. Control Chart of Mean and Range for the year 2016

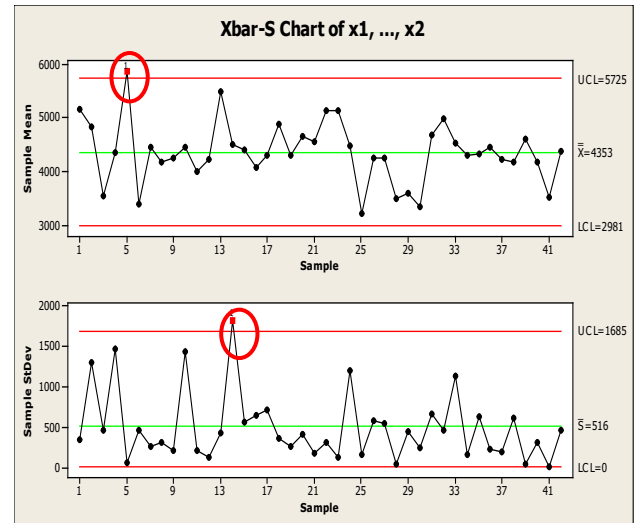


Figure 3. Control Chart of Mean and Standard Deviation for the year 2016

The out of control points are verified to be caused by the delay in transferring the mixture of face cream. The signals were said to be unintentionally ignored because the warning signals in the machine design is small. This error is considered as an assignable cause. When an assignable cause has been detected by the control chart, resulting in a sustained process shift, then there is evidence of the process shift and it is appropriate to define a new control region for the process.

The process presents to be statistically in control after revision (see Figures 4 and 5) wherein points 5 and 14 are removed from the data.

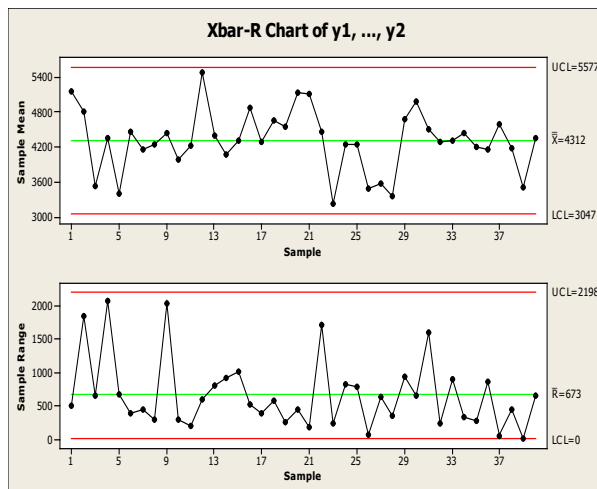


Figure 4. Revised Control Chart of Mean and Range for the year 2016

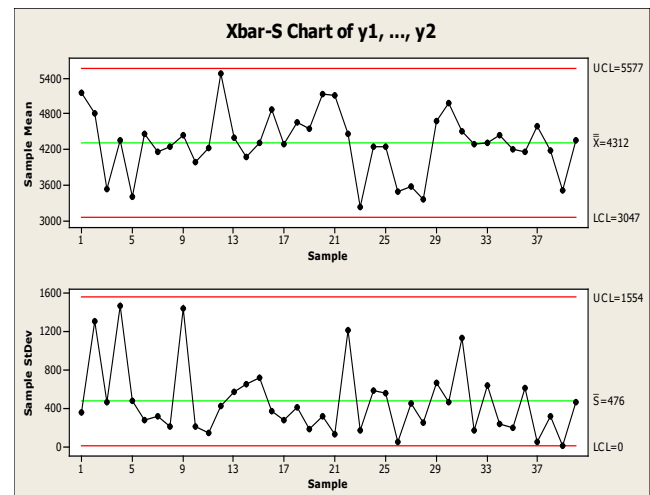


Figure 5. Revised Control Chart of Mean and Standard Deviation for the year 2016

The data measure of viscosity for the year 2017 will also be analyzed to comparatively assess the effect of changing the chemical formulation. In the control chart, the mean for the mean chart is equal to 5191 while UCL is equal to 6833 and LCL is equal to 3549. The mean for the range chart is equal to 873; UCL is equal to 2852 and LCL equal to zero. (see Figure 6) Having points 15, 20, go beyond the lower control limit and points 30, 42, exceeds the upper control limit for the mean chart and point 41 exceeds the upper control limit of the range chart which indicates that the process is out of control.

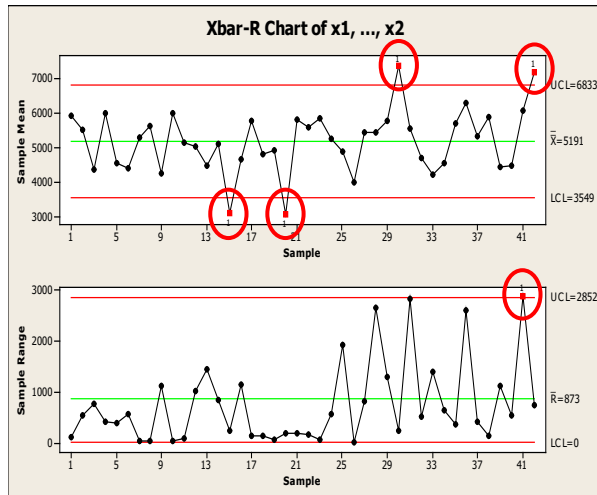


Figure 6. Control Chart of Mean and Range from the year 2017

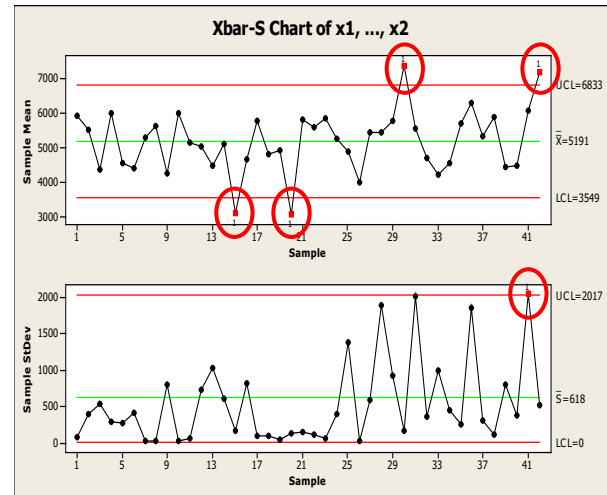


Figure 7. Control Chart of Mean and Standard Deviation for the year 2017 to 2018

Using the same data for the viscosity measure of face cream from year 2017, the control chart for the mean and standard deviation is constructed (see Figure 7). The mean for the standard deviation chart is equal to 618, the UCL is equal to 2017 and LCL is zero. The same points 15 and 20 go beyond the lower control limit while points 30 and 42 exceed the upper control limit of the mean chart. Point 41 exceeds the upper control limit of the standard deviation chart. The result of these control charts shows that the process is statistically out of control.

The error that caused these out of control points is traced and determined. From year 2017, due to the change in chemical formulation, the mixture sticks at the bottom of the vessel and clogs the tubes. The scheduled maintenance turns out to be infrequent due to the thick characteristic of the face cream compared to the composition of the face cream for the previous year. Points 15 and 20 that go beyond the lower control limit are found to be due to the delay in transferring the mixture. This is similarly because of the warning signals in the design of the machine. Therefore, revisions will be done due to the presence of assignable cause in points 15 and 20.

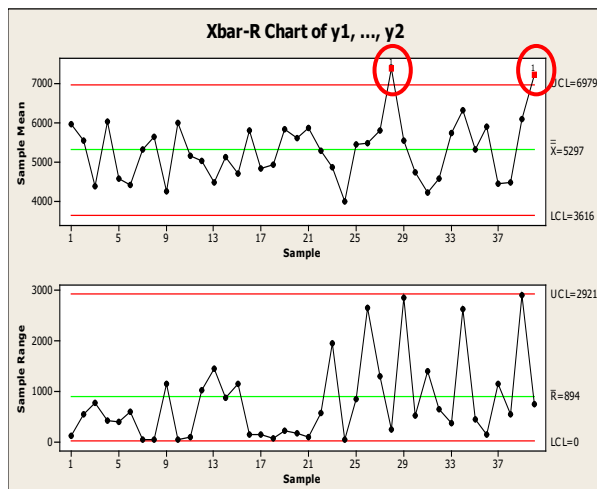


Figure 8. Revised Control Chart of Mean and Range from the year 2017

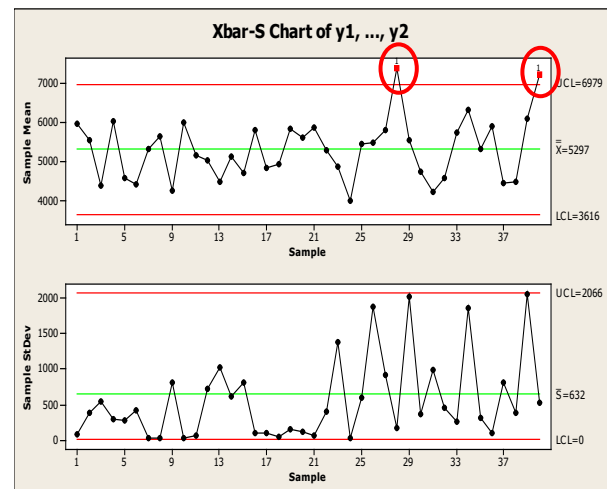


Figure 9. Revised Control Chart of Mean and Standard Deviation from the year 2017

In the revised control chart for both mean and range (see Figure 8), and mean and standard deviation (see Figure 9), points 28 and 40 exceeds the upper control limit of the mean chart. Though, even after revision the process from the year 2017 shows to be statistically out of control.

For the year 2016, the control charts for mean, range and standard deviation are statistically out of control due to assignable causes, but then after revision, the process became statistically in control. On the contrary, from the year 2017, the control charts for mean, range and standard deviation are statistically out of control and remains to be even after revision (see Table 2).

Table 2. Summary of the Control Chart Interpretation

	2016	2017
Mean	Out of control	Out of control
Range	Out of control	Out of control
Std. Deviation	Out of control	Out of control
Revisions are done		
Mean	In control	Out of control
Range	In control	Out of control
Std. Deviation	In control	Out of control

The control charts from the data shows that there is a problem within the process of producing Face Cream Light for the year 2017 compared to 2016. Cosmetic Company ABC stated that for the year 2017 they have replaced Chemical X with Chemical Y due to customer complaints.

5.3 Proposed Improvements

As the data presents the problems encountered with regards to the change of Chemical X to Chemical Y, the researchers recommend that Cosmetic Company ABC review further the complaints specified by the consumers. In terms of viscosity, the usage of Chemical X in the year 2016 provides less reworks than with the replacement to Chemical Y in the year 2017.

The researchers suggest that a thorough research must be done regarding the emendation done in the chemical formulation as these greatly affect the viscosity of the product.

Since Cosmetic Company ABC changed its chemical formulation, the researchers recommend to frequently schedule full machine maintenance since the researchers found out that the use of Chemical X in the year 2016 leave only a few residues down the suction tube compared to the use of Chemical Y in which generous amount of unprocessed materials are stocked in the suction tubes. Although the company has its own schedule of machine maintenance, it would not be enough since the past months, some batches of face creams has been affected in which sporadic reworks appeared.

5.4 Validation

In addition, the researchers recommend reinforcing autonomous maintenance. In this type of maintenance, machine operators will be taking care of small maintenance jobs.

Table 3. Cost Analysis for Machine Maintenance

	2016	2017
Technician (cleaning and disinfection)	Php 1, 790.00	Php 1, 790.00
Actual No. of Machine Maintenance in a Month	1	1

No. of Months	9	9
Total Cost	Php 16,110.00	Php 16,110.00

Table 3 shows the cost that will be spent in a total of 9 months with regards to the cleaning and disinfection of the emulsion compounding machine. The table only shows the costs involved in the machine maintenance when there are no other defective problems found in the machine.

Table 4. Cost Analysis for Recommended Machine Maintenance for the year 2017 and 2018

Technician (cleaning and disinfection)	Php 1, 790.00
Proposed No. of Machine Maintenance in a Month	2
No. of Months	9
Total Cost	Php 32,220.00

In a study conducted by Levi, maintaining a full cleaning schedule for machine is the easiest way to keep its efficiency as not to affect the machine's performance of doing the specific task. He stated that the ideal schedule of full cleaning maintenance is twice a month but for other cases where the machine needs comprehensive maintenance, successive maintenance is necessary.

Since the company had sporadic reworks the past few months, costs has been associated with the rework process done including the raw materials needed to fix the products who does not conform with the set standards of 3000 to 6000 centipoises.

Table 5 shows the comparison of the income that the company may earn. The proposed machine maintenance for the year 2017 gives a return greater than what the actual process earns. Cosmetic Company ABC would have been able to save the cost associated with the rework process given the chance that preventive measure was done to avoid problems regarding the property of the product specifically with viscosity.

Table 5. Benefit Analysis for the Year 2017

	Actual	Proposed
Total Profit	Php 3,780,000	Php 3,780,000
Deduct Total Cost of Reworks	44,557	0
Deduct Total Cost of Rejects	22,279	0
Deduct Total Cost of Machine Maintenance	16,110	32,220
Total Income	3,697,054	3,747,780
Difference	Php 50,726.00	

All points being considered, this recommendation would be a preventive measure to avoid unexpected situations wherein the viscosity of Face Cream Light would be flustered.

6. Conclusion

The research was conducted to suffice the goal of the study. By reviewing and analyzing the data gathered in Cosmetic Company ABC, the researchers distinguished the significant effects of the change in chemical formulation with regards to the viscosity of Face Cream Light. After variable control charts were employed, the researchers found out that in the year 2016, the data is statistically in control. On the other hand, the chart explained that the data is statistically out of control from the year 2017.

The researchers recommended to that a thorough research must be done including laboratory testing of raw materials as these greatly affects the viscosity of the product. In addition, the researchers also suggested to frequently schedule

full machine maintenance and to reinforce autonomous maintenance leaving the small maintenance jobs to the machine operator. In the long run, reworks will be reduced and the data will be statistically in control.

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Biographies

Dyan C. Gonzales-Rodriguez is an Assistant Professor IV, and College Research and Development Unit Head of the College of Engineering at Bulacan State University, Philippines. She is in the academe since 2011. She finished her Bachelor of Science degree in Industrial Engineering at Bulacan State University in 2009 and her Master of Science degree at the University of the Philippines in 2017. She is conferred as a Professional Industrial Engineer by the Philippine Institute of Industrial Engineers and an ASEAN (Association of Southeast Asian Nations) Engineer by the ASEAN Federation of Engineering Organizations. She had presented several researches in different conferences sponsored by Asia Pacific Industrial Engineering and Management Society, Korean Convergence Society, and Daehan Society of Industrial Management since 2014. She is an active member of Philippine Institute of Industrial Engineers, Institute of Industrial and Systems Engineering, and International Association of Engineers.

Lawrence C. Alenia, Michaela Marie M. Cruz, and Alexis C. Flores They are senior students of BS Industrial Engineering at Bulacan State University by the time this research was conducted. They were the research assistants of Engr. Gonzales-Rodriguez for a couple of years. During these times, these students showed so much interests in systems improvement in different companies in the Philippines where they had conducted most of their researches. These students also won in different student research competitions in the Philippines.