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Statistical Process Control (SPC) as a tool for Measuring Customer Dissatisfaction Level and Service Process Improvement

Muhammed Zakir Hossain [1] & Sayaka Zaman [2]

Abstract- **The purpose of this paper is to identify assignable causes of the problem in the service process and eliminating them using Statistical Process Control (SPC) to achieve some improvement in the process quality. Closed-ended questionnaire is utilized to find out the vital causes that may lead to customer´s dissatisfaction, to do that 110 target customers asked through a questionnaire to choose one of the five options that expected may produce customer dissatisfaction then analyzed all the collected data by using some improvement tools such as, data collection, histogram, Pareto chart, cause and effect diagram, and control chart. Systematically review the literature and using the SPC tools it is concluded that SPC is a versatile tool which can help to measure customer dissatisfactions and service process improvement.**

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I. Introduction

In today's world, it is evident that whenever the needs to improvement also need to change, but always not all change results in an improvement (Berwick, 1996). The key to identifying beneficial change is measurement. The vital components of measurement include: (1) determining (problem) and defining (process) key indicators; (2) collecting an appropriate amount of data; and (3) analyzing and interpreting these data (Benneyan et. Al., 2003). This paper focuses on to solve a Statistical Process Control (SPC) problem by defining problem and process, exploring output data from this process, proposing ways to present the data and reflection. But more focusing on the analysis and interpretation of data as we know SPC technique can help both researchers and practitioners of quality improvement to determine whether changes in processes are making a real difference in outcomes.

a) Purpose And Execution

To fulfill the aim of the paper researchers selected the Shwapno, which is the top retail brand in Bangladesh, customer´s dissatisfaction as a problem, and the customer´s waiting time on queue as a process to analyze, and then they explored two types of data, one to find out the main reasons for customer´s dissatisfaction, and another to analyze the waiting time process. Then they analyzed all the data by using some improvement tools such as data collection, histogram, Pareto chart, cause and effect diagram, and control chart.

b) Limitations

Researchers had some difficulties in determining the suitable process to analyze, which can be affordable for them with no previous practical experience, and which can be doable by using the improvements tools that they were asked to use. The most important limitation was that they needed to simulate some data because they were not able to make any change to the real process. The achievement of the paper represented a challenge for them because of its application to a real process.

c) Theory of Statistical Process Control (SPC)

It has been recommended that SPC can conveniently be connected to wellbeing (Smith, 1989), conveyance frameworks (Zurier, 1989), social insurance the executives (Demos and Demos, 1989), transportation frameworks and administration enterprises all in all (Mundy et al.,1986). There are various precedents demonstrating the advantages of SPC and why it ought to be actualized openly as a component of an association's quality strategy. Watson (1998) gives a magnificent talk on this part of SPC.

Why do we need SPC?

According to Mason, B., & Antony, J. (2000), the following are the typical benefits that can be gained from the application of SPC:.

- Reduction in squandered endeavors and expenses;
- Process improvement, more prominent yield;
- Better consistency of procedure yield;
- Improved operator in development: when to and when not to make a move;
- A unsurprising procedure can be accomplished;
- A regular language on execution of procedure for various individuals crosswise over divisions;
- SPC graphs help recognize unique from normal reasons for variety;
- Variation decrease;

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- Reputation for top notch items/administration and there by diminish client grievances;
- Healthy piece of the overall industry or improved productivity/viability;
- Reduced quality expenses;
- Reduced requirement for checking/ investigation/ testing endeavors;
- More productive administration, and better comprehension of procedure;.
- Reduction in time-spent putting out fires quality issues.

To control any process need to measure the variation to this process, and it is significant to identify the causes of variation. There are two kinds of causes, assignable causes which contribute so much to the variation and can be identified and eliminated, and produce assignable variation. Common causes which each contribute just a little to the variation, but together can contribute significantly, and they produce what it is called random variation (Bergman & Klefsjö, 2003). Researchers will be on the assignable causes on variation because they are more controllable, and by eliminating these causes or some of them researchers might achieve some improvement on the process quality.

To be able to accomplish research objective it was helpful to adopt the improvement cycle which contains the following stages (Bergman & Klefsjö, 2003):

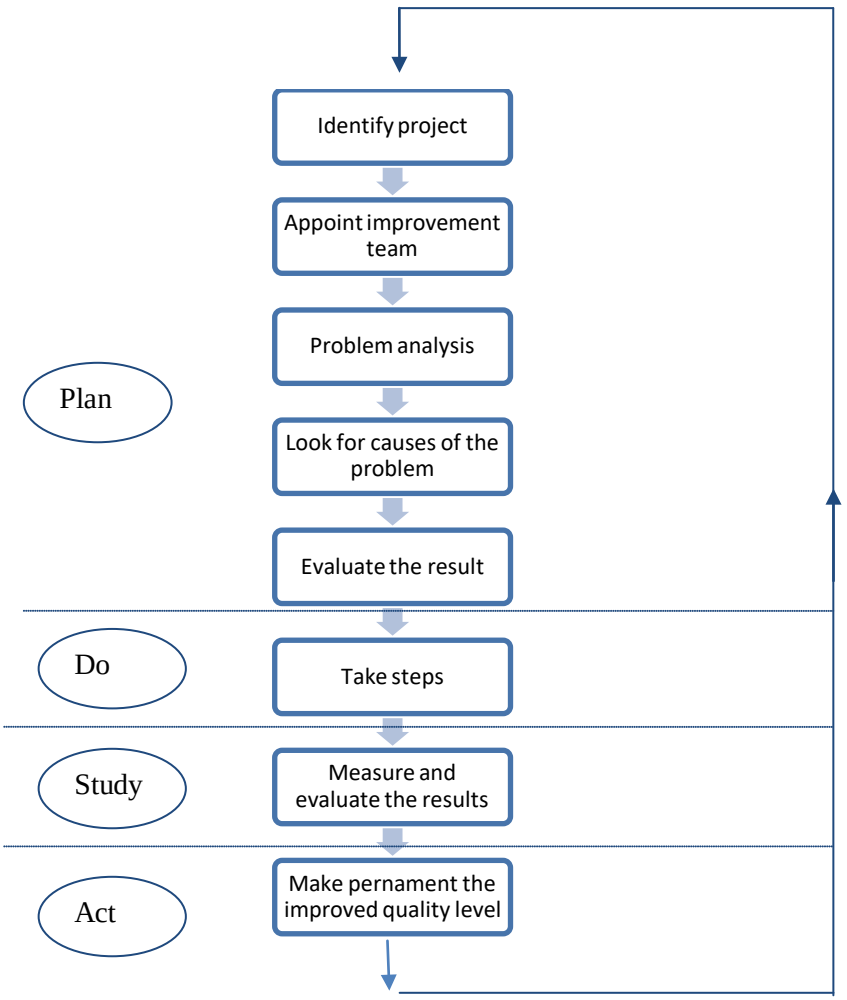

Figure 1: An improvement cycle – Source (Bergman & Klefsjö, 2003)

Plan: After detecting the problem need to establish the principal causes of the problem than need to look systematically for different plausible causes of the problem, and further need to collect data so that problem solver can detect causes of error and variation.

Do: After finding the important cause of problem needs to appoint an improvement team to carry through the appropriate steps. Team members must be fully aware of the problem and the agreed improvement steps.

Study: In this stage need to investigate the result of implementing the improvement program and to see if it was successful.

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Act: If the steps were successful the new better quality should be made permanent if they did not then need to go through the cycle once more.

II. Shwapno Customer Dissatisfaction

The first step in this research is to find out the main causes that may lead to customer´s dissatisfaction, to do that researchers asked target customers through a questionnaire to choose one of the five options researchers expected that they might produce customer dissatisfaction. One hundred ten customers answered the question. After analyzing the data collected from this sample of customers, researchers found out the results showed in table 1.1.

Cause	No. of Complaints	% of Complaints
Waiting time	47	43%
Quality of products	10	9%
Service & staff	11	10%
Price	34	31%
Other	8	7%
Total	110	100%

This information can be illustrated by the Pareto chart as follows:

Pareto diagrams provide an easy method of determining what problems occur most frequently. The Pareto diagram is a special type of bar chart used to determine which problem to work on first to improve a process.

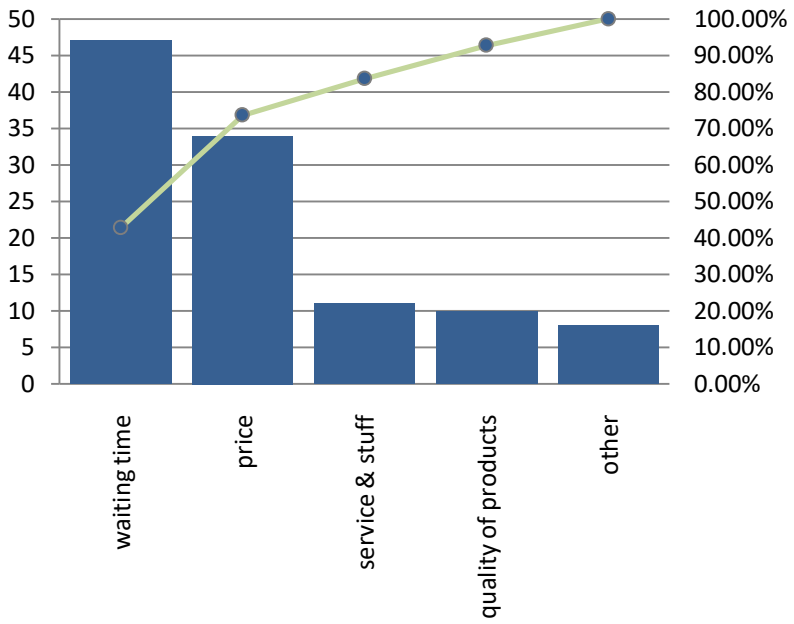

Figure 2: Pareto chart illustrated customers' complaints

This chart gives researchers a very clear picture of the main reasons for customer dissatisfaction. As they see it is clear that the most important reason for customer dissatisfaction is the waiting time on the cash queue which has the highest percent 43%.

According to this information, researchers decided to focus on the process that related to the waiting time of customers, analyze this process, and try to improve it as much as possible.

III. Checkout Waiting Time- Main problem Analyses

a) Histogram

"A picture is worth a thousand words or numbers" it's a true saying heard many times. One way to make this saying reality is through a histogram because it is a good way to make a large group of scores easy to understand, as stated by Aron (2002).

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The making of the histogram was based upon the creation of a frequency table, as to count with organized information and the wait times were collected and measured with a stop cellular timer, waiting times began upon entering the line and ended when the buyer (s) placed the groceries over the counter. The total data collected counted with 450 records of waiting times in minutes and seconds for three different days of the week (See Appendix Table No. 1). Table No.1 shows the data re-arranged in an ascending sort. From the rearrangement of the data, researchers pick the minimum number, 0,02 and maximum number, 11.13. The next step was to make the frequency table for time waiting in line- Shwapno retail store (See Appendix Table No. 2).

This second table represented the base to help in analysis, as follows:

- Seventy-nine buyers were waiting time was registered from 0-1 minutes or 17.56%.
- Eighty-eight buyers were waiting time from 1-2 minutes or 19.56%.
- Sixty-five buyers were waiting time from 2-3 minutes or14.44%.
- Eighty-six buyers were waiting time from 3-4 minutes or 19.11%.
- Fifty-two buyers were waiting time from 4-5 minutes or 11.56%.
- Forty-three buyers were waiting time from 5-6 minutes or 9.56%.
- Twenty-two buyers were waiting time from 6-7 minutes or 4.89%.
- Eight buyers were waiting time from 7-8 minutes or 1.78%.
- Six buyers were waiting time from 7-8 minutes or 1.33%.
- One buyer was waiting time from 11.23 minutes or 0.22%.

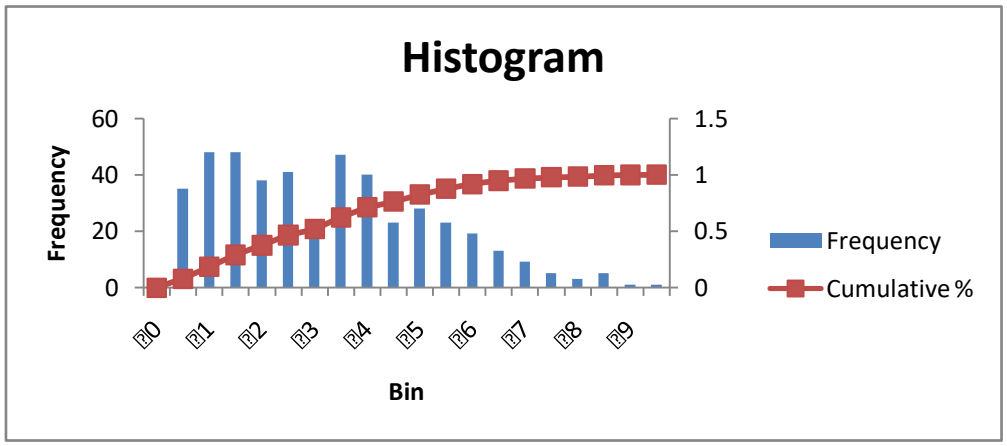

Figure 3: Histogram illustrated customer checkout time for Shwapno Retail Store

The histogram illustrates the outcome from measurements of the waiting time in line in *Shwapno* Retail Store. Using the histogram, it is possible to show the way the process varies. For this case, it is evident that 63% of the observations are above 3 minutes.

Furthermore, the histogram can show us clearly, which range is the highest frequency area, the question that emerges here is, what are the reasons or causes for the process "line waiting time" to present varies? To identify these causes, all relevant activities and events were observed: Age approximately of the buyers, packaging methods, and the number of items purchased, cashier's skills, payment method, technical aspects, interaction customer-employee, etc. These data provide a detailed picture of what happens at the checkout desk, whereas to conclude that variation is caused by common causes or called random variation, as explained by Klesjö and Bergman (2005). However, the waiting time is a different kind of variation occurring form assignable causes or assignable variation, the reason why researchers focused on time and the main source of inconvenience for customer satisfaction.

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b) Control Chart

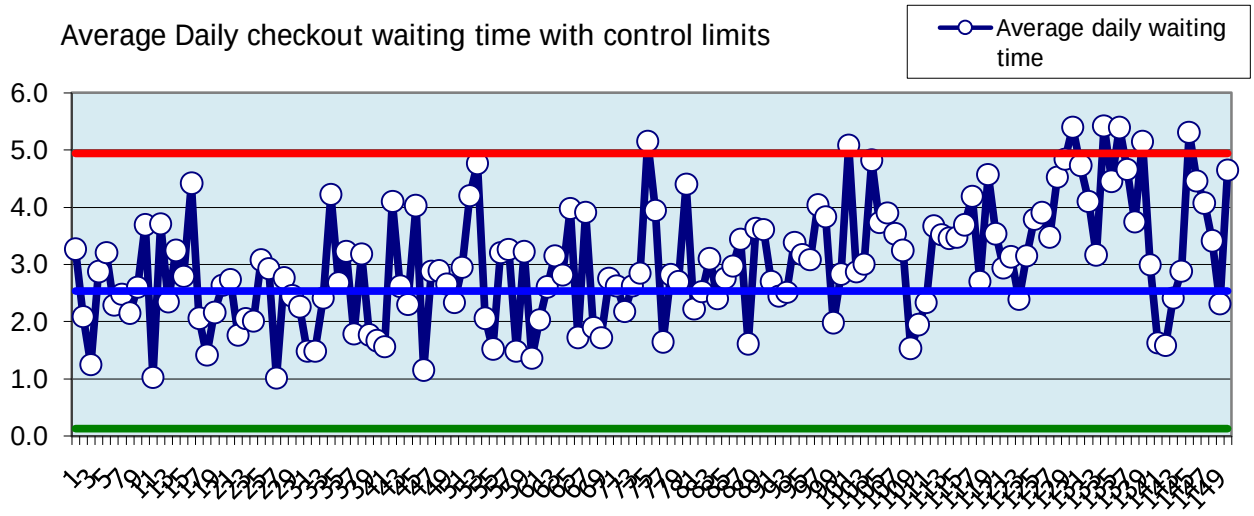

Figure 4: Control chart illustrated daily checkout waiting time

The control chart was made by using the average daily checkout time of the data from three days which are a normal day, Friday to Sunday. By so doing, Researchers have the most appropriate data that describe the customer's waiting time during the week.

The value of the upper control limit (UCL) is 4.94 and, lower control limit (LCL) is 0.13. Most of the data fluctuate within the limit; even so, there is still data fall outside the control limit which shows that the process still out of control. To control the process and achieve better quality, researchers should find out the assignable causes that lead to the variation and eliminating them.

c) Cause and Effect

Cause and effect diagram, which is also called fishbone diagram or an Ishikawa diagram, is an efficient tool to help researchers to identify the root causes that lead to the customer waiting time in *Shwapno* Retail Store. Researchers found out that there are so many plausible factors that lead to this problem and the Cause and effect diagrams help us to simplify these factors.

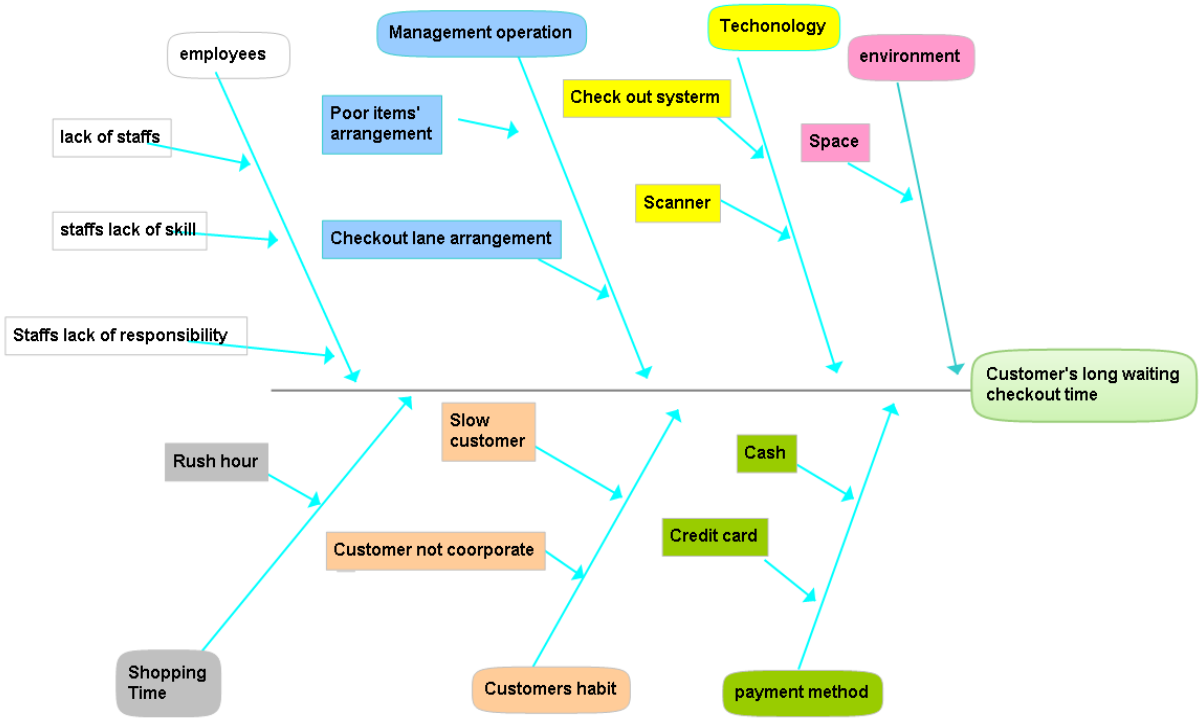

Figure 5: Cause and effect diagram illustrating a problem with the customer waiting time

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The causes of waiting time were divided upon the store's control. There are the causes that under the store's control such as management operation, employees, technology, and environment. Management operation factors such as the item arrangement beside the checkout lane, the checkout lane arrangement and, staffs arrangement could influence customer perception of waiting time. If the checkout lane item is interesting that can attract customer, they might feel the waiting time shorter. For instant, IKEA the Swedish giant Superstore put the cheapest and the highest discount items on the checkout lane, *Shwapno* Retail Store also have stuffed life candy, chewing gum, etc. The checkout lane whether it is long enough for the line, whether they open more counter in time when the line is long? How long the queue that it should have more counter? Technology and employment are the factors that in the store control, however, these factors are not easy to change. In the technology aspect, if the checkout system works smoothly? If they have enough scanners for self-scan customer? And the environment factor, if space is comfortable enough for customer?

On the other hand, non-control factors also contribute a large part in waiting time such as customer's shopping time; customer's shopping habit and the payment method. Those are the factors that the store can adapt to instead of control it. Customers shop more at after working time, from 6 pm to 9 pm, and during the weekend, which calls the rush hours, and these times contributing to the long waiting line at the counter. The store can only adapt to by open more counter in rush hours, promotion more during the week day to pull customers to the store. Customer's shopping habit, if they are slow or fast if they are comfortable with a little waiting or not. Also, the payment method, if they pay by cash or by credit cards/debit cards also affect the waiting time. Some stores cost a bit less to encourage customer paying by credit card.

The employee is the main factor that stores controllable and more flexible in changing and organizing them. There are three common reasons from employees that cause to customer's waiting time that are store lack of staff, staff lack of skill and staff lack of responsibility. The reason cause staff lack of responsibility might be they do not have any motivation for doing their work, or might because of their attitude toward their work. Lack of training is the reason cause to staff lack of skill; they might need more training to do better work. Lack of staff is the clearest reason lead to waiting time.

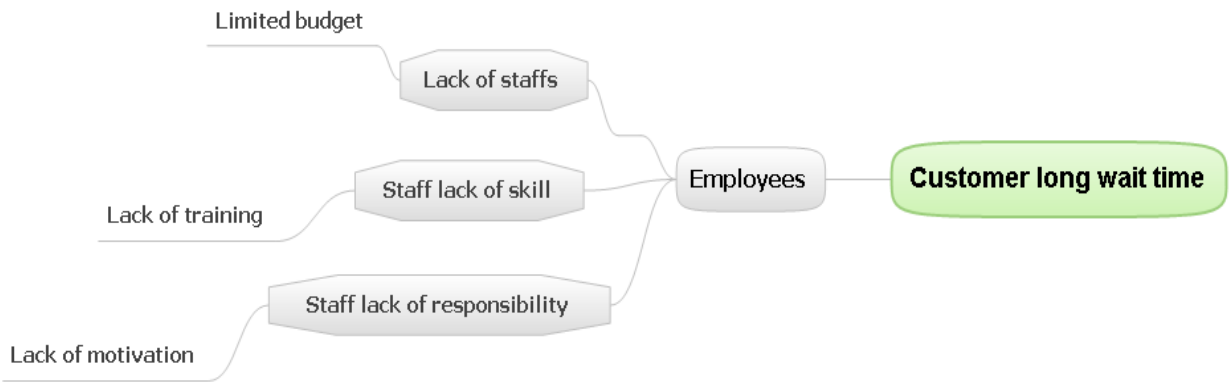

Figure 6: Cause – and – effect diagram illustrating a problem with employees

If they have more cashiers and more counter, the waiting line will reduce. Therefore the waiting time will shorter. To demonstrate this hypothesis, researchers going to measure if they use one more staff and open one more counter, the researchers could measure how it effects to the waiting time variation.

IV. Evaluating the Result

Researchers' hypothesis is adding one more cashier in *Shwapno* Retail Store; after that, researchers collecting data and measure the result. To be able to do so, researchers simulated the process, generated random data and analyzed based on simulated data. The data also were generated in three days, normal day, Friday to Sunday and the control chart was created with the average data of three days.

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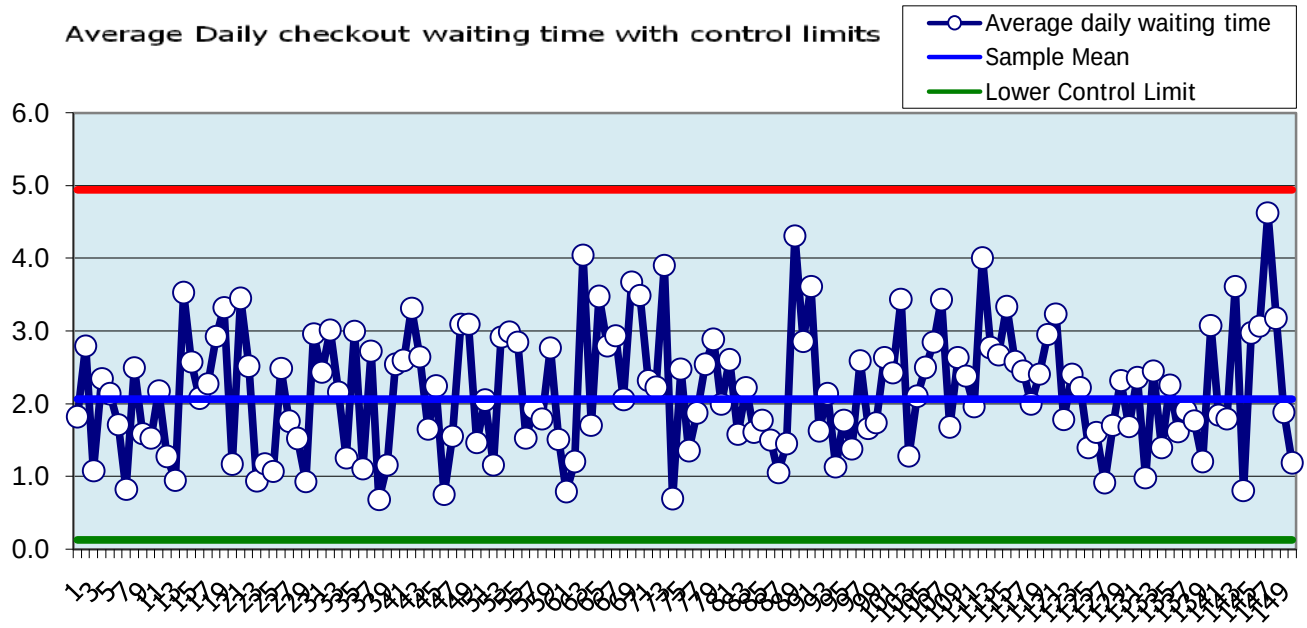

Figure 7: Control chart illustrated daily checkout waiting time after added one cashier

The new data (after adding one more cashier) now fluctuates between the control limits, which call process now under control. There still the variation and these variations cause by the common causes. From the result, researchers could conclude that by adding one more cashier, *Shwapno* Retail Store achieves a better quality process which is under the store control.

V. Conclusion

Statistical process control (SPC) is a sharp tool to control the quality of the process. In this research, researchers use SPC tool to define the quality problem, which is the checkout waiting time in *Shwapno* Retail Store. Since using the histogram and control chart, researchers find out the variation of customer's waiting time in *Shwapno* Retail Store. After that, SPC also helps us to identify common causes and assignable causes that lead to the variation by applying cause and effect diagram. Then researchers take steps to eliminate the assignable cause which is most appropriately influence the quality problem – the number of the cashiers. Since adding one more counter, the variation decreases significantly. However, to be able to add more cashier and counter, *Shwapno* Retail Store have to make it possible with their budget. Therefore, researchers also suggested other solution that they can combine to minimize the variation such as the focus on management operation, improve technology or training cashier better. As a part of continues improvement, researchers suggested to eliminate or compensate as many assignable causes as possible to improve their quality.

VI. Reflection upon Effort

First of all, researchers' main interest was to do their work according to the improvement cycle model illustrated by Bergman and Klefsjö (2003), by following this model it was easier to determine the direction in every stage of the study.

As researchers mentioned before, from the beginning they found it difficult to decide which process they can analyze, so they suggested many options, but each one was not easily doable by using the seven improvement tools, they met many times in brain storming sessions, and discussed these options and the affordable ways of collecting data , and implementing the seven tools in their research for these processes, these brain storming sessions were very helpful for each of them, because it helped each researcher to think in 2 ways and get the best possible solution.

Finally researchers decided the problem they are going to study which is *Shwapno* Retail Store ´s customer´s satisfaction, then they faced their second challenge which was collecting the needed data, it was not easy to communicate with customers, because most of them were not able to waste their time filling our questionnaire, so they relied mainly on their relations and their friends relations, whom are already customers to *Shwapno* Retail Store.

After analyzing the data by using the Pareto chart they were able to define the main cause of the customer dissatisfaction which was the waiting time on the checkout queue. Then they went to the store for three days and as monitored the store´s cash counters to collect the needed data.

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Monitoring the counters made them able not only to have the needed observation but also to learn about the factors affecting this process; researchers knew that they must consider these factors in analyzing this process in the cause and effect diagram.

Researchers used more than one tool to analyze the collected data, then they had the result which they had explained before, then according to these results they suggested solution or step improve the quality of the process, but they had one problem in implementing the improvement cycle model, that they needed to measure and evaluate the result of taking the suggested step, and of course they were not able to take any practical step on the real process, so they were forced to assume the data that they needed to collect after taking the suggested step, and this objective was difficult to achieve. Researchers tried to stimulate this assumed data to be consistent with the result they needed to have. Researchers felt that they can do that because the main interest from this paper is only to train how to solve SPC problem by using the seven improvement tools.

Finally, and despite the difficulties researchers faced, it was very interesting to do this research, the benefits researchers acquired is worthy.

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