OPTIMIZING AND CONTROLLING PROCESSES THROUGH STATISTICAL PROCESS CONTROL

Definition and Rationale for Statistical Process Control (SPC)

Statistical Process Control (SPC) is an industry-standard methodology for measuring and controlling quality during the manufacturing process to enable continual improvement. The degree of process conformity or non-conformity is determined by the following factors:

- **Quality of conformance.** It refers to a manufacturing state where the product fully conforms with its intended design and characteristics.
- **Chance variation/Random variation.** It refers to a manufacturing state where the product differs in design and characteristics due to the combined natural influences in the production process. For instance, the use of older machines may generally exhibit a higher degree of variability to the output, in comparison to the use of newer machines that may have incorporated design improvements that lessen the variability of the output.
- **Assignable variation/Nonrandom variation.** It refers to a manufacturing state where the product differs in design and characteristics due to an identifiable cause which can be easily eliminated. The typical sources of assignable variation include an equipment that needs adjustment, defective materials, or human sources such as carelessness, fatigue, and incapacity to perform assigned task.

The rationale of Statistical Process Control are the following:

- **Continual Improvement.** The statistical process control aims to improve processes which yields improved products and services on a continual basis.
- **Predictability of Process.** The statistical process control aims to establish production standards resulting to a repeatable and predictable process that meet customer requirements.
- **Lower Cost of Goods.** The statistical process control aims to maximize resources and minimize wastes in the production resulting to lower cost of production which yields lower cost of goods produced.
- **Sampling and Auditing.** The statistical process control aims to eliminate output variations and impose production control resulting to lesser cost in inspection and audit of the quality assurance team of a company.

Control Charts

A control chart is a time-ordered plot of sample statistics that aims to monitor the causes of output variation. It is used to distinguish random variation and nonrandom variation within a production process. The control chart has two (2) limits called upper control limits (UCL) and lower control limits (LCL) as illustrated in *Figure 1.* A process can be characterized under quality of conformance if the data points fallbetween the upper and lower control limits. On the other hand, if the data falls outside the control limits,the process may have a random or nonrandom variation that causes the inconsistency in the produced output.

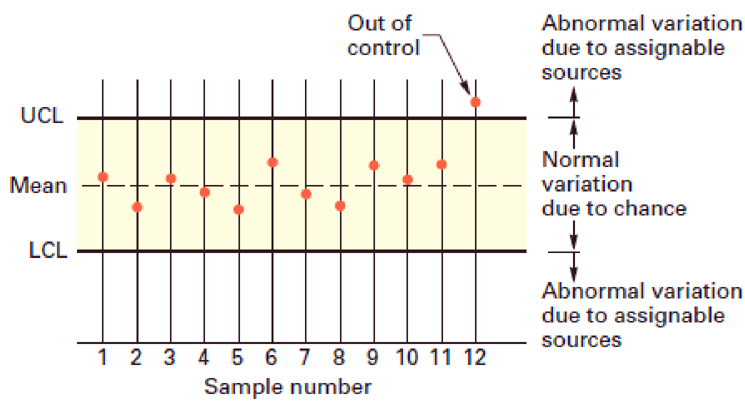

Figure 1. Example of a control chart

Source: Operations Management (12th ed.), 2015, p. 420.

The following are the different uses of control charts in organizational setting and several areas of anorganization:

- **In industrial settings.** The control charts are designed for speed which makes it useful in the industrial aspect of a business. Using a control chart, engineers may easily identify a broken machine that needs to be replaced in order to retain high quality of outputs produced. For instance, a system glitch in a factory may result to thousand parts or materials produced incorrectly before anyone notices that the machine is broken resulting to wasted time and materials as well as angry customers since this may cause a delay in the shipment or delivery of the products.

- **In non-profit organizations.** The control charts are designed for promoting work efficiency which makes it useful in the campaigns of charities and various organizations. Using a control chart, it can be easily determined when an online donation system shuts down. For instance, a simple lag in the official website of a certain charitable institution may halt critical donations that will result to a failed campaign and unhappy beneficiaries of the charity.
- **Budget.** The control charts can be used to examine the percentage of monthly expenditures of a given company. For instance, if a company places a ceiling of 20% expenditure in their budget and they already spend over 15% of their budget in a particular period, it is extremely helpful to know right away so they can cut back on expenses over the rest of the year. In addition, if a company spends less than 8% of their budget for a couple of months, then they may perhaps allot the excess budget in maintenance of equipment that promotes continual improvement.
- **Retention rate.** The control charts can be used to monitor the retention rate of the human resource department of a given company. For instance, if an organization is retaining talents at a rate above the normal control limit or in the upper control limit then, the organization may have to assess if their staffs are being evaluated selectively. On the other hand, if the retention rate falls at the lower control limit, then, the organization will easily know that they have to dedicate more resources in recruitment for a certain period of time until the retention rate reach the normal control limit.
- **Customer surveys.** The control charts can be used in monitoring customer surveys. Through the use of a control chart a company will be vigilant to negative feedbacks of the customers that will help them determine their possible areas for improvement. For instance, if the customer survey of a company is within the normal control limit then, the company will know that they are doing something good and they just have to continue to do it well and better the next time. On the other hand, if the customer survey of a company falls in the lower control limit, then the company will immediately know that they must improve somewhere to retain their customer survey in the normal control limit.

Implementation and Deployment of SPC

The implementation of Statistical Process Control (SPC) involves the following steps:

- **STEP 1: Commit to SPC.** The top management must show full support in the implementation of SPC since it requires spending money, utilizing human resources, changing the organization's culture, and hiring employees with new skills.
- **STEP 2: Form an SPC committee.** The top management must form a cross-functional team that will oversee the implementation and execution of SPC in the organization. The team must be composed of representatives from different departments like manufacturing, quality assurance, engineering, finance, and statistics.
- **STEP 3: Train the SPC committee.** The top management must provide basic training in statistical data for the SPC committee. In this way, the members of the committee will be knowledgeable enough to set objectives and to determine which processes should be targeted first.
- **STEP 4: Set SPC objectives.** The SPC committee through the help of a consultant must set objectives for the program. The objectives must be based on a target measure of success in terms of customer feedback, elimination of waste, and lower cost of production.
- **STEP 5: Identify target processes.** The SPC committee must select a few pilot processes for the initial implementation of SPC. These processes must be relatively easy to bring under control and must have a significant impact to the overall success of the organization once improved.
- **STEP 6: Train appropriate operators and teams.** The SPC committee together with the management must provide extensive training for the operators and teams who will be directly involved with the collection, plotting, and interpretation of SPC data. The training must cover the use of quality tools and flowcharts.
- **STEP 7: Ensure repeatability of methods.** The in-house experts must ensure that all the measuring equipment that will be used, from basic calipers to complex micrometers, are properly calibrated and certified for accurate collection of data**.**
- **STEP 8: Delegate responsibility to the operators.** The management must delegate responsibility in maintaining SPC control charts, collecting, and plotting data to the operators since they are directly involved in the process.
- **STEP 9: Flowchart the process.** The SPC committee together with the operators must create graphical representation of the entire production process. The graphical

representation must include inputs, outputs, and all the steps in between each process.

- **STEP 10: Eliminate the special causes of variation.** The SPC committee must formulate a cause- and-effect diagram listing all the factors that might impact the result of the output during the production process. After the causes of output variations has been identified, the entire organization from the top management down to the operators must cooperate in eliminating all these factors.
- **STEP 11: Develop control charts.** The in-house experts must develop the appropriate control chart that will be used to monitor the different steps in the production process. This is to ensure that causes of output variation were fully eliminated, and correct procedures are being undertaken on a daily basis.
- **STEP 12: Collect and plot SPC data**. The process operator must take the sample data and plot them on the control chart at regular intervals.
- **STEP 13: Determine process capability**. The SPC committee must determine whether the established process and standards are effective in achieving continual improvement. For instance, if the process output are metals with specified length of between 5.999 and 6.001 inches, but the process turns out that greater number of produced metals has a length outside the given dimensions, then the process is not effective and there is something in between the process that must be changed.