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QUALITY CONTROL IN FOOD INDUSTRY THROUGH STATISTICAL TECHNIQUES

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ABSTRACT

Restaurants are on the rise and is growing rapidly in Indian market every day. The current situation in the country is all the adult members in a family have to earn to live a happy life, and therefore the time available for them to spend in their homes is getting reduced day by day. This makes them so busy in their work outside and they prefer to dine outside. Because of this, the food industry is growing at a rapid rate and at the same time, they have to maintain the quality and taste of their food items in order to retain their customers. In this connection, the researcher thought of applying statistical tools in maintaining and controlling quality at the restaurants during food production process itself, so that necessary control action can be taken at once, if any deviation is found. The researchers had selected one of busy restaurants in South Bengaluru area and studied the possibility of applying statistical quality control tools like X-bar chart and R chart for quality control and collected data on fixed intervals from the customers on quality of food and taste of food. The study revealed that the control charts were useful in detecting deviations in the perception of customers on quality and taste of food and the findings can be used to modify the food production process from time to time, if required.
Keywords: Restaurant, production process, Quality control, X-bar chart, R-chart,

1. Introduction

Quality has become one of the main customer choice variables in the shaping customer satisfaction. The peculiarity is boundless, whether or not the buyer is an individual, an association, a retail location, or a tactical safeguard program. Thus, understanding and further developing quality is key element prompting achievement in business, growth, and an upgraded cutthroat position. There is a significant profit from speculation from worked on quality and from effective utilization of quality as a fundamental piece of by and large business methodology. The articulation 'quality' typically alludes to the standards of an incredible item or administration that satisfies or surpasses client's assumptions. The nature of item can be assessed in various aspects, viz. Reliability, Serviceability, Durability, Perceived Quality, Conformance to Standards, Esthetics, Features, and so on. The customary definition for quality is

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readiness for use. The cutting-edge definition relates quality to fluctuation, i.e., quality is contrarily corresponding to inconstancy. Unnecessary fluctuation in process execution frequently brings about squander. In this way, a substitute and profoundly helpful description is that quality improvement is the decrease of waste.

In order to meet the growing expenses, many families in India have both husband and wife go for work to earn money to meet their expenses. Further, the rise of women in the last 25 years helped them to occupy the works in all the fields as men can do. This has caused a dramatic change in the cultural habits in the people, as dual career couples go for work in a family and ultimately the food habits had also changed. Many of the working couples prefer to take food outside due to non-availability of time to prepare food at home, as they have to rush to their working place. Since the working couples do not have time to prepare food in their house, they prefer to take food in nearby hotels or rely on online food service companies. As a result of this, the food industry is growing at a faster rate. At the same time, the hotels have to maintain their quality and taste, so that they can attract their customers repeatedly. At this juncture, the researcher felt that a constant check has to be kept on quality and taste of food at hotels, and how it can be achieved systematically by application of statistical tools. This idea has resulted in the current study of application of statistical tools for controlling quality at hotels through statistical quality control.

The main objective of the study is to assess whether the food manufacturing process is in control. This is done with the help of two criteria – quality and taste. The opinion of customers at constant time interval was obtained to achieve this objective.

2. Literature review

Peter Jones & Michael Dent (1994), reviewed the implementation of statistical process control techniques in restaurant at Forte plc. The author deployed the basic control chart techniques through X-bar and R charts to monitor quality of variety of food, temperature of food, and hygiene separately and the results showed that the process was under control. The author utilized this study as an attempt to achieve consistency in service which becomes increasingly important with branded hospitality operations. The study helped the company to have a positive discussion and follow-up action between managers and employees about their performance levels and removes complacency among employees in their job. The study mainly helped the company to establish some benchmark to improve consistency and this was achieved with the help of statistical techniques like process control charts. Nigel Peter Grigg & Lesley Walls (2007) thought of “Developing statistical thinking for performance improvement in the food industry’ which was aimed to describe the use of SQC methods in manufacturing of food and drinks. It deals with problems in successful uptake of such methods, including organizational motivation, probable application, costs and returns, critical success factors and the central importance of prerequisite statistical thinking (ST). The paper concluded that SQC methods are of bearing in the industry, given the process is appropriate and management has a basic consciousness on the basics of ST. The paper concluded with argument of an original model, which illustrates the “filters” that tend to reduce the effectiveness with which methods are used in the industry, with a suggestion to overcome the issues.

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Amer Ibrahim Al-Omar (2011), used quality control charts for the mean and used robust extreme ranked set sampling (RERSS) method. These charts were compared with the traditional control charts using simple random sampling (SRS) and ranked set sampling methods (RSS). It was found that the RERSS performed better than the other charts in terms of their average run length (ARL).

Sethu and Bhavya (2016) examined the perception of students' behavior and satisfaction of online food shopping. The data were collected from 212 students at Manipal University through a questionnaire. The study revealed that the buying decisions were influenced by the views of family and friends and discussions on online forums.

Neha and Sakina (2017) studied the shift in the behaviour on consumers in the technological world and tried to find what makes satisfied about the service. They studied the relation between facilities and the purchase behaviour. The study revealed the most popular app in the food delivery industry and technology plays an important role in the restaurant industry.

Suryadev and Mahik (2018) studied the recent development of Internet and found that it has increased the e-commerce industries in India. The development of e-commerce has made it seamless for people who want delivery of food at their doorstep through online food ordering services. Although people remain to go out for the meals, they feel convenient to order food online since it releases them from personally visiting the restaurants. The study identified the factors that have played a dominant role to attract consumer in India towards them. It shows how easily people search for a favourite restaurant, choose from available items and place their orders in just a few minutes.

Suhartanto et al. (2018) assessed the effect of quality of food and quality of e-service on customer loyalty toward online food delivery service and its indirect effect through mediation of customer satisfaction and perceived value. 405 customers were taken for the study and found the partial mediation role of customer satisfaction and perceived value on the relationship between both food quality and e-service quality on online loyalty towards OFD services.

3. Methodology

The empirical research design is used for the study. The researchers employed primary data collection method using the on-the-spot data collection approach to collect data concerning the measurement of quality and taste perceived by the customers. Control chart tools were used for data analysis using POM/QM software. The primary intent of this statistical approach is that it allows a researcher to check if the food production process in under control, by analysing the data collected from customers on two criteria – quality and taste. Statistical tools like X-bar chart and R chart were used in the study. These charts were used to check as to whether quality and taste are in control or not from time to time in a day.

Sample Specifications

The population selected for the study is customers of a restaurant in southern part of Bengaluru city. The customers visiting the restaurant for dining purpose from morning 8 a.m. clock to night 10 p.m. in a day form the population for the study. The opinion

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of customers regarding quality and taste is measured in a five-point scale on every hour and the same is recorded. These measurements were collected from a sample size of 20 at each fixed time interval of one hour during the entire day. The number of sample points from 8 a.m. to 10 p.m. will be 15. The sub-size of each sample point is 20, *i.e.*, opinion is gathered randomly from 20 customers in each time interval.

Data Collection

Primary data was collected for this study. Primary data are gathered and assembled specifically for the first time for the research project and gives the first-hand information. Data were collected during the entire day from 8 a.m. to 10 p.m.

SQC Tools

A control chart is a graphical display of quantities or values of a process through time. By examining the chart, a quality control consultant can identify any possible problems in the production process. When a process is in control, the criteria being measured – the average of every 4/5 observations should remain stable through time. The mean should revolve somewhere around the central line and not meander off “too much”. In statistics, the term “too much” means more than several standard deviations of the process. The number of required standard deviations is selected so that there will be a small chance of surpassing them when the process is in control. Addition and subtraction of the required number of standard deviations (normally three) give us the *upper control limit* and the *lower control limit* of the control chart. When these bounds are violated, the process is believed to be out of control and must be modified. A control chart is illustrated in Figure 1.1.

The control chart method for variables is a means of visualizing the variations that occur in the central tendency and dispersion of a set of observations. It is a graphical display of the quality of a particular characteristic, such as a sample average, range, standard deviation, or proportion, with a centerline and *upper and lower control limits*. The limits give the desired range of values for the statistic. When the statistic is outside the control limits, the process may be out-of-control.

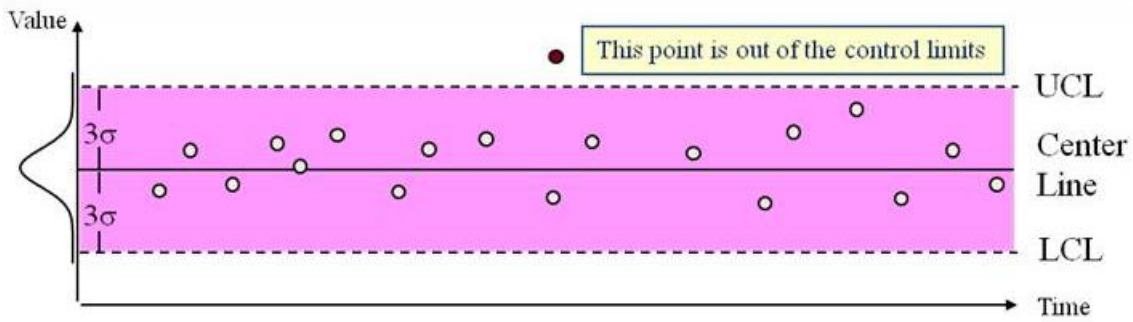

Figure 6.1 A typical Control Chart

When the assignable causes are eliminated from the process to the extent that the points plotted on the control chart remain within the control limits, the process is in a state of control.

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Control Chart for $\overline{X}$ (Mean)

The control chart for $\overline{X}$ uses subgroups each of size n for k consecutive periods of time. To compute control limits for the mean, we have to compute the mean of the subgroup means (called $\overline{\overline{X}}$) and the standard deviation of the mean (which is called the standard error of the mean $\sigma_{\overline{X}}$). The estimate of the standard deviation of the mean is a function of the d_2 factor, which represents the relationship between the standard deviation and the range for varying sample sizes. Equations (1.1) and (1.2) define the control limits for the $\overline{X}$ chart.

Control Limits for the $\overline{X}$ Chart (when σ is unknown)

$$\text{Central Line} = \overline{\overline{X}}$$

$$\text{Upper Control Limit} = \overline{\overline{X}} + 3\frac{\overline{R}}{d_2\sqrt{n}}$$

$$\text{Lower Control Limit} = \overline{\overline{X}} - 3\frac{\overline{R}}{d_2\sqrt{n}}$$

Where $\overline{\overline{X}} = \frac{\sum_{i=1}^{k}\overline{X_i}}{k}$; $\overline{R} = \frac{\sum_{i=1}^{k}R_i}{k}$; $\frac{\overline{R}}{d_2}$ is estimate of σ.

$\overline{X_i}$ = sample mean of n observations at time *i*
R_i = range of n observations at time *i*
k = number of subgroups

We can simplify the calculations in equation (1.1) by utilizing the **A_2 factor**, equal to $\frac{3}{d_2\sqrt{n}}$. The simplified control limits are :

$$\text{Central Line} = \overline{\overline{X}}$$

$$\text{Upper Control Limit} = \overline{\overline{X}} + A_2\overline{R}$$

$$\text{Lower Control Limit} = \overline{\overline{X}} - A_2\overline{R}$$

The values of A_2 can be obtained from Statistical Tables for different values of *n*.

4.Results and Discussion

The data gathered on quality and taste is given in Table-1 of Appendix. The control chart for quality of food is drawn using X-bar chart and the same is displayed in Figure-1. It can be observed that the central line is drawn at 4.0438, Upper control limit (UCL) is 4.3362 and Lower control limit (LCL) is 3.7612. Further, it was found that three sample points fall outside the upper control limit and four sample points fall below the lower control limit. The points above upper control limit may not imply a problem in quality, but at the same time, it may be taken as quality is too good, might be because of additional amount of ingredients added at the time of preparation of food. Therefore,

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necessary care should be taken to check the ingredients, as it may result in additional cost for the hotel. Also, three points falling outside the lower control limit imply that the customers feel that quality is not good, and it is indication of proper care should be taken to check the quality of food prepared. As few points fall outside the control limits, it is concluded that the quality is not in control and the food production process is to be monitored carefully.

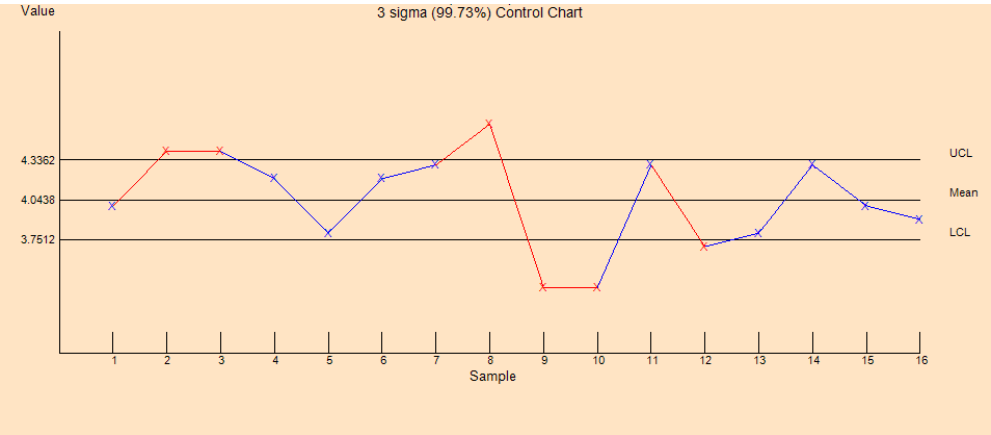

Figure 1 X-bar chart for Quality

The control chart for quality of food is drawn using R chart and the same is displayed in Figure-2. It can be observed that the central line is drawn at 1.625, Upper control limit (UCL) is 2.5594 and Lower control limit (LCL) is 0.6728. Further, it was found that none of the sample point's fall outside the control limits and it may be concluded that the variation in the perception of customers regarding quality at different times in a day is not statistically significant.

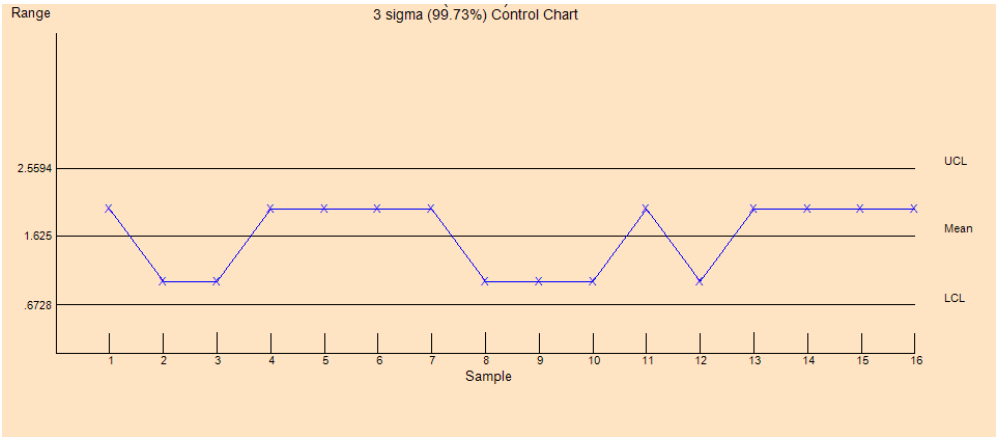

Figure 2 R chart for Quality

The control chart for taste of food is drawn using X-bar chart and the same is displayed in Figure-3. It can be observed that the central line is drawn at 3.45, Upper control limit (UCL) is 4.0913 and Lower control limit (LCL) is 2.8088. Further, it was found that none of the sample point's fall outside the control limits and it may be concluded

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that the variation in the perception of customers regarding taste at different times in a day is not statistically significant.

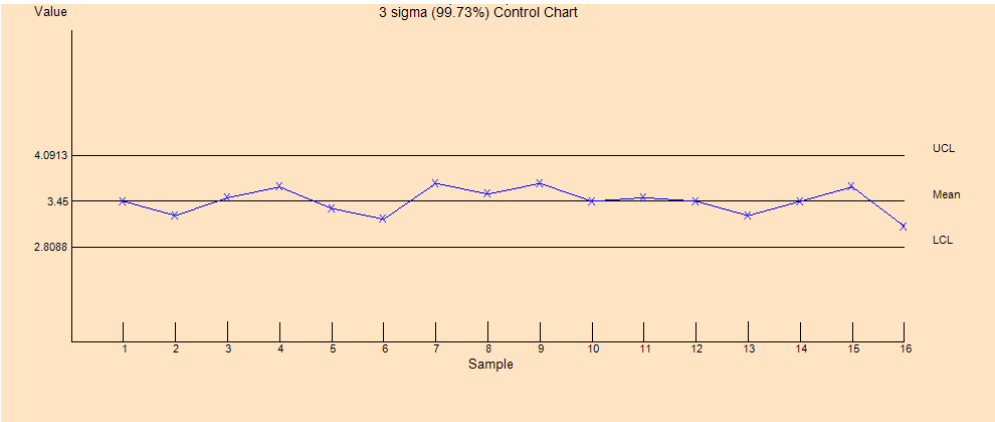

Figure 3 X-bar Chart for Taste

The control chart for taste of food is drawn using R chart and the same is displayed in Figure-4. It can be observed that the central line is drawn at 3.5625, Upper control limit (UCL) is 5.6109 and Lower control limit (LCL) is 1.4749. Further, it was found that none of the sample points fall outside the control limits and it may be concluded that the variation in the perception of customers regarding quality at different times in a day is not statistically significant.

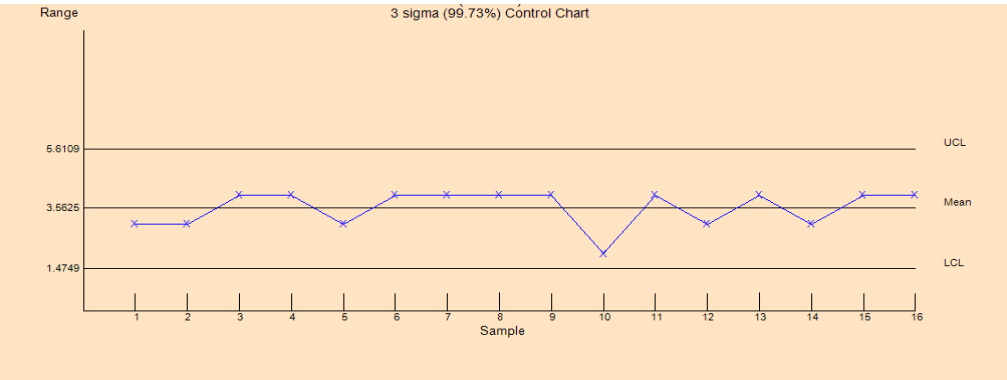

Figure 4 R Chart for Taste

5.Managerial implications and Suggestion

The examination of X-bar and R-charts for quality and taste of food indicate that there is little variation in quality of food and through when it exceeds the UCL, may not cause severe problem on the part of image of restaurant, but the points below LCL during the time between 3 p.m. and 4 p.m. Therefore, it is suggested that the restaurant management / production department has to take sufficient care or remedial care and examine as to why quality has gone marginally down and accordingly necessary steps are to be taken immediately to rectify the problem. One of the potential reasons could be due to change of operational persons during change of shift hours. By maintaining

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quality throughout the day, the restaurant can preserve their image and retain the goodwill of customers.

6. Conclusion

The main purpose of control chart is not only to give alarm as to when the process needs modification, but also it tells us as to when to leave the process alone without any adjustments. Hence it is extremely important in the food industry, to use the process monitoring control charts to ascertain the performance of the process, apart from the routine use of conventional X-bar charts.

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