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A Technical Study on Varieties of Sampling Plan and Implementation of New Screening Tri-Sampling Plan

G Uma[1], D Manjula[2]
Assistant Professor[1], Ph.D[2] Research Scholar
Department of Statistics
PSG College of Arts & Science
Coimbatore – 641014
1987manjula@gmail.com

Abstract - Every industry gives much attention for the improvement of quality of products. Acceptance sampling is an inspection procedure used to determine whether to accept or reject the specific quantity of material. In recent scenario most of the industries are adopting the TQM concepts and Six sigma in order to have zero percent defective and to ensure the quality of the product for the customer satisfaction. In many companies, they rely on the inspection of the incoming items especially raw materials. Sampling plans plays an important role for the inspection of products from the raw material to finished products in the industry. The sampling plans pressurize and protect both the producer and consumer. This paper presents the review of the procedure for the construction and selection of Double Sampling plan, Standard Double Sampling Plan and New Screening Tri sampling Plan. From the review of DSP, New Screening Tri Sampling Plan for costly and destructive items concerned with maximum acceptance chance with average quality has been done. The NSTSP gives an additional chance for taking third sample based on their past experience. Also, this paper reviews some major principles of acceptance sampling, Double Sampling Plan with emphasis on the cost and destructive items aspect and also the recent developments.

Index Terms- Acceptance Sampling Plan, SSP, DSP, NSTSP and OC function.

1. INTRODUCTION

One of the basic and simple is the single sampling plan,the decision of accepting or rejecting a lot is based on single sample. Sometimes, situations arise when it is not possible to decide whether to accept or reject the lot on the basis of a single sample. In such situations, a sampling plan known as the double sampling plan is applied. In this plan, the decision of acceptance or rejection of a lot is taken on the basis of two samples. A lot may be accepted immediately if the first sample is good or may be rejected if it is bad. If the first sample is neither good nor bad, the decision is based on the evidence of the first and second sample combined. But in the case of costly or destructive items one cannot decide the rejection based on single. In case if we go for Double sampling the second sample should be taken only when it is lies between acceptance numbers otherwise we reject the lot. In this complicated situation if we feel the quality of the product good based on the past experience and the defective near to the acceptance number we introduce a new sampling plan " The NSTSP gives an additional chance by considering third sample based on the precious / past experience..

In this Paper, concept of the Single sampling plan, Double sampling plan and a new concept of New Screening Tri Sampling and their procedure for implementing is designed.

2. SINGLE SAMPLING PLAN

2.1 Operating Procedure

In single sampling plan by attributes, the lot acceptance procedure is characterized by two parameters n and c. The operating procedure for a single sampling plan is given as follows:

1. Select a random sample size n from a lot of size 'n'.
2. Inspect all the articles included in the sample. Let 'd_1' be the number of defectives in the sample.
3. If $d_1 < c_1$, accept the lot.
4. If $d_1 > c_1$, reject the lot.

2.2 Review on Single Sampling Plan

Peach and Littauer (1946) have given tables for determining the single sampling plan for fixed $\alpha = \beta = 0.05$. Burguess (1948) has given a graphical method to obtain single sampling plans for the given (p_1. 1- α) and (p2. β). Grubbs (1949) has given a table, which can be used for selecting a single sampling at AQL and LQL. Cameron (1952) has also given a table which is an extension of Peach and Littauer (1946) Guenther (1969) has developed a systematic search procedure for finding a single sampling plan for the given p_1, p_2, α and β based on Binomial. Hyper geometric and Poisson models. Golub (1953) has given a method and tables for finding the acceptance number c of a single sampling plan involving minimum sum of producer and consumer risks when the sample size n is fixed.

Dodge and Roming (1959) have considered double sampling plans as an extension of single sampling plan. A detailed comparison of various attributes sampling plans and the merits of the double sampling plan can be seen in Duncan (1986) and Schilling (1982).Soundararajan and Govindaraju (1983) have made contributions in designing single sampling plans.

Latha (1988) has constructed tables for mixed sampling plans having single sampling as an attribute plan indexed through AQL and LQL. Devabharathi (1990) has designed mixed sampling plans having single sampling plan as an attribute plan indexed through AQL and IQL.

Radhakrishnan (2002) contributed to the study on the selection of certain Acceptance sampling plans indexed through MAAOQ. Sampathkumar (2008) constructed mixed Variables-Attributes sampling plans. Sekkizhar (2008) designed sampling plans using intervened random effect Poisson distribution. Radhakrishnan and Ravishankar (2008) constructed SSP for three attribute classes indexed through AQL. Radhakrishnan and Mohanapriya (2008) studied single sampling plan using Conditional weighted Poisson Distribution. Radhakrishnan and Sivakumaran (2008) constructed and selected six sigma sampling plan indexed through six sigma quality level.

3. DOUBLE SAMPLING PLAN

A sampling plan in which a decision about the acceptance or rejection of a lot is based on two samples that have been inspected is known as a double sampling plan.

The double sampling plan is used when a clear decision about acceptance or rejection of a lot cannot be taken on the basis of a single sample. In double sampling plan, generally, the decision of acceptance or rejection of a lot is taken on the basis of two samples. If the first sample is bad, the lot may be rejected on the first sample and a second sample need not be drawn. If the first sample is good, the lot may be accepted on the first sample and a second sample is not needed. But if the first sample is neither good nor bad and there is a doubt about its results, we take a second sample and the decision of acceptance or rejection of a lot is taken on the basis of the evidence obtained from both the first and the second samples.

A double sampling plan requires the specification of four quantities which are known as its parameters. These parameters are

n_1 – size of the first sample,
c_1 – acceptance number for the first sample,
n_2 – size of the second sample, and
c_2 – acceptance numbers for both samples combined.

3.1 Implementation of Double Sampling Plan

Suppose, lots of the same size, say N, are received from the supplier or the final assembly line and submitted for inspection one at a time. The procedure for implementing the double sampling plan to arrive at a decision about the lot is described in the following steps:

Step 1: Draw a random sample (first sample) of size n_1 from the lot received from the supplier or the final assembly.

Step 2: Inspect each and every unit of the sample and classify it as defective or non-defective. At the end of the inspection, Count the number of defective units found in the sample. Suppose the number of defective units found in the first sample is d_1.

Step 3: Compare the number of defective units (d1) found in the first sample with the stated acceptance numbers c_1 and c_2.

Step 4: Take the decision on the basis of the first sample as follows:

3.1.1Under acceptance sampling plan

If the number of defective units (d_1) in the first sample is less than or equal to the stated acceptance number (c_1) for the first sample, i.e., if $d_1 \leq c_1$, we accept the lot and if $d_1 > c_2$, we reject the lot. But if $c_1 < d_1 \leq c_2$, the first (single) sample is failed.

3.1.2 Under rectifying sampling plan

If $d_1 \leq c_1$, accept the lot and replace all defective units found in the sample by non-defective units. If $d_1 > c_2$, we accept the lot after inspecting the entire lot and replacing all defective units in the lot by non-defective units. But if $c_1 < d_1 \leq c_2$, the first (single) sample is failed.

Step 5: If $c_1 < d_1 \leq c_2$, draw a second random sample of size n_2 from the lot.

Step 6: Inspect each and every unit of the second sample and count the number of defective units. If the number of defective units found in the second sample is d_2.

Step 7: Combine the number of defective units (d_1 and d_2) found in both samples and consider $d_1 + d_2$ for taking the decision about the lot on the basis of the second sample as follows:

3.1.3 Under acceptance sampling plan

If $d_1 + d_2 \leq c_2$, Accept the lot and if $d_1 + d_2 > c_2$, we reject the lot.

3.1.4Rectifying sampling plan

If $d_1 + d_2 \leq c_2$, we accept the lot and replace all defective units found in the second sample by non-defective units. If $d_1 + d_2 > c_2$, we accept the lot after inspecting the entire lot and replacing all defective units in the lot by non-defective units.

3.2. Review on Double Sampling Plan

The performance measures of double sampling plan can be seen in Schilling (1982).There are number of tables available to design a double sampling plan including Dodge and Roming (1959) which provide Double sampling plans with minimum Average Total Inspection. Duncan (1986) has provided a compilation of Poisson Unity and operating ratio p2 /pi values for the Double sampling plans taken from the tables of US Army Chemical Corps Engineering Agency (1953). Hald (1981) has constructed tables for single and double sampling plans with the fixed 5% procedures and 10% consumer's risks. Guenther (1970) developed a trial and error procedure for finding double sampling plans for given (pi,l-α) and (p2 ,P). Schilling and Johnson (1980) have developed a table for the construction and evaluation of matched sets of single, double and multiple sampling plans. Muthuraj (1988) constructed tables based on the Poisson distribution for selecting a double sampling plan for a given (p0 , ho) or (p*, h*). Similarly, Soundararajan and Vijayaraghavan (1989 a) have given tables for selecting double sampling plan for given AQL and AOQL based on equal rejection numbers. Further.Soundararajan and Arumainayagam(1990) provided tables for easy selection of double sampling plan indexed by AQL, AOQL and LQL. Devaarul (2003) constructed tables for mixed sampling plans having double sampling plan as an attribute plan indexed through AQL and IQL.

Vijayaraghavan (1990) mentioned the situations for which DSP-(0,l)plan can be used and presented tables for selection of DSP-(0,1) plan under Poisson and Binomial conditions. Search procedure was also used to select the plan parameters. Although DSP-(0,1) plan is valid under general conditions for applications of attributes sampling inspection, the plan will specially be useful to product characteristics involving costly or destructive testing.

4. NEW SCREENING TRI -SAMPLING PLAN

The purpose of this paper is to describe a method and to present a set of tables for constructing two and three stage drug screening procedures of the type discussed by Armitage and Schneiderman(1958) and Schneiderman(1961). These procedures allow rejection at any stage but acceptance at only final stage. Similar procedures have been advocated by Davies (1957) and Dunnett(1961), based on this Operating Characteristic curve and accept-reject rules for two and three stage screening procedures had been derived by Roseberry and Gehan (1964). Mixed sampling product control for costly or destructive items by Deva Arul and Rebecca (2011) for switching variable to attribute plan for accepting the lot.

Based on this screening procedure and switching rule of variable to attribute gives an idea for creating a new concept in double sampling plan. Generally we are going to second sample when the defective lies in between two acceptance number, but in this procedure we are allow to take third sample even it is not lie in the region but under the condition of past experience and the defectives nearer to second acceptance number (i.e.,c_2+1).

4.1 Implementation of New Screening Tri Sampling Plan

The procedure for implementing to arrive at a decision about the lot is described in the following steps:

Step 1: Draw a random sample (first sample) of size n_1 from the lot received from the supplier or the final assembly.

Step 2:Inspect each and every unit of the sample and classify it as defective or non-defective. At the end of the inspection, we count the number of defective units found in the sample. Suppose the number of defective units found in the first sample is d_1.

Step 3: Compare the number of defective units (d_1) found in the first sample with the stated acceptance numbers c_1 and c_2.

Step 4: Take the decision on the basis of the first sample as follows.

Step 5: If $d_1 > c_1$,accept the lot otherwise reject or if $c_1 < d_1 \leq c_2$ we go for second sample or if $d_1 > c_2$ but nearer value (i.e., c_2+1) draw a third random sample of size n_3 from the lot. We inspect each and every unit of the third sample and count the number of defective units found in it. Suppose the number of defective units found in the third sample is d_3.

Step 6: Combine the number of defective units (d_1 ,d_2 and d_3) found in both three samples and consider $d_1 + d_2 + d_3$ for taking the decision about the lot on the basis of the third sample as follows:

Step 7: If $d_1 + d_2 + d_3 \leq c_3$, we accept the lot otherwise reject the lot.

5. OPERATING CHARACTERISTIC (OC) CURVE

The Operating Characteristic (OC) curve displays the discriminatory power of the sampling plan. That is, it shows the probability that a lot submitted with a certain fraction defective will either be accepted or rejected.

The operating characteristic of single sampling plan using Poisson distribution is given by

$$P_a(p) = P_{a1}(p) = \sum_{r=0}^{c_1} \frac{e^{-\lambda_1}{\lambda_1}^r}{r!} \quad (1)$$

where $\lambda_1 = n_1 p$

In a double sampling plan, the decision of acceptance or rejection of the lot is taken on the basis of two samples. The lot is accepted on the first sample if the number of defective units (d1) in the first sample is less than the acceptance number c1. The lot is accepted on the second sample if the number of defective units (d1 + d2) in both samples is greater than c1 and less than or equal to the acceptance number c2. Therefore, if Pa1(p) and Pa2(p) denote the probabilities of accepting a lot on the first sample and the second sample, respectively, the probability of accepting a lot of quality level p is given by:

$$P_a(p) = P_{a1}(p) + P_{a2}(p) \quad (2)$$

$$P_{a2}(p) = \left(\sum_{k=c_1+1}^{c_2} \frac{e^{-\lambda_1}{\lambda_1}^k}{k!}\right) * \left(\sum_{r=0}^{c_2-k} \frac{e^{-\lambda_2}{\lambda_2}^r}{r!}\right)$$

where $\lambda_1 = n_1 p$ & $\lambda_2 = n_2 p$

The implementation of the Tri – Sampling plan holds the following conditions:

(i) $n_1 = n_2$
(ii) $n_3 = n_1 + n_2$
(iii) $c_1 < c_2 < c_3$

OC function of the Tri –Sampling plan is,

$$P_a(p) = P_{a1}(p) + (P_{a2}(p) * P_{a3}(p)) \quad (3)$$

$$P_{a3}(p) = \sum_{r=c_1}^{c_2+1} \frac{e^{-\lambda_3}{\lambda_3}^r}{r!}$$

Where $\lambda_3 = n_3 p$

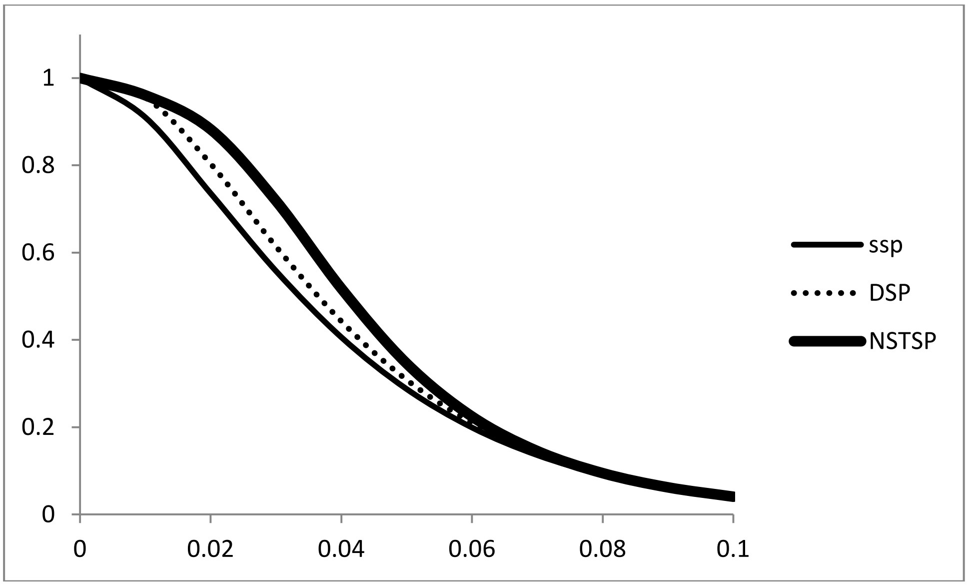
6. CONCLUSION

Directly paper analyses if there under defined conditions exist statistically significant difference between probabilities of lot fraction defectives between the Single Sampling Plan, Double Sampling Plan and New Screenig Tri-Sampling Plan at the same levels of probability of acceptance. If there is statistically significant difference in the probabilities of lot fraction, it can be concluded that these is statistically significant difference in the probabilities of acceptance also. This comes to the expression especially when the sample size in a single sampling plan is much greater than the sample sizes in a double sampling plan. Because of that to prevent possible frauds, the quality manager should keep on mind not to selected too small initial sample size in a double sampling plan and Tri-Sampling Plan. Next conclusion is that when the maximum allowed numbers of defective units in a single and in a double sampling plan are kept in the same proportion to the sample sizes, in most cases there was showed no statistically significant difference in lot fraction defectives between these two sampling plans. The main limitation of this study is for costly or destructive items we cannot reject the lot based on two samples at the same time the past experience of the product was good and the rejection defective is nearer value means we go for New Screening Tri-Sampling. In this new implemented plan gives a chance for good quality products for testing without rejecting. This plan also gives more acceptance probability rather than Single and Double sampling plans with increase in number of sample size.So this method is suggested for industries with costly or destructive items for increase in sample size and not to reject the lot with lower risk and maximum acceptance with good quality.

Table1: Probability of Acceptance values for single sampling plan, Double Sampling plan and New Screening Tri-Sampling plan for various sample sizes

P	SSP n=50	SSP n=60	SSP n=70	DSP n=50	DSP n=60	DSP n=70	NSTSP n=50	NSTSP n=60	NSTSP n=70
	$C_1 = 1$			$C_1 = 1$ & $C_2 = 2$			$C_1 = 1$, $C_2 = 3$ & $C_3 = 4$		
0	1	1	1	1	1	1	1	1	1
0.01	0.90979	0.87809	0.84419	0.9556	0.9323	0.9046	0.960371	0.950033	0.937825
0.02	0.73575	0.66262	0.59183	0.8034	0.7279	0.6514	0.882284	0.826267	0.756894
0.03	0.55782	0.46283	0.37961	0.6138	0.5071	0.4127	0.718605	0.597508	0.479782
0.04	0.40600	0.30844	0.23107	0.4426	0.3321	0.2456	0.517827	0.376331	0.267122
0.05	0.28729	0.19914	0.13588	0.3084	0.2103	0.1415	0.345902	0.224364	0.145259
0.06	0.19914	0.12568	0.07797	0.2103	0.1305	0.08	0.224364	0.133267	0.079925
0.07	0.13588	0.07797	0.04393	0.1415	0.08	0.0446	0.145259	0.079925	0.044278
0.08	0.09157	0.04773	0.02440	0.0943	0.0485	0.0246	0.094687	0.048176	0.024459
0.09	0.06109	0.02890	0.01340	0.0623	0.0292	0.0135	0.062042	0.028998	0.013413
0.1	0.0404	0.0173	0.0072	0.041	0.0175	0.0073	0.040693	0.017369	0.007296

Figure1: The comparitive OC Curve for the Single Sampling Plan, Double Sampling Plan And New Screening Tri – Sampling Plan



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