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A Comparative Study of Normal, Conditional, Special Type and New Screening Procedure on Double Sampling Plan

D Manjula

Department of Statistics, PSG College of Arts & Science, Coimbatore – 641014
Email: 1987manjula@gmail.com Mobile : 9994145662

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, the rely on the inspection of the incoming items especially raw materials. Sampling plans are playing most 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 Special Type of DSP, Conditional DSP and NSDSP. From the review of all type of DSP, this paper reviews some major principles, Implementation and Operating Characteristic Curve for the good determination of acceptance sampling. Comparative study based on OC and Table values to be determined.

KEY WORDS: Acceptance Sampling, DSP, STDSP, CDSP, NSDSP and OC function.

***Corresponding author**

D Manjula

Research Scholar

Department of Statistics,

PSG College of Arts & Science,

Coimbatore – 641014

Email: 1987manjula@gmail.com Mobile : 9994145662

1. INTRODUCTION

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.

2. REVIEW OF DOUBLE SAMPLING PLAN

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[1] The performance measures of double sampling plan can be seen in Schilling (1982)[2].. Duncan (1986) has provided a compilation of Poisson Unity and operating ratio p_2 /p_1 values for the Double sampling plans[3] taken from the tables of US Army Chemical Corps Engineering Agency (1953)[4].. 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 (p_1,1-α) and (p_2 ,β)[5].

Schilling and Johnson (1980) have developed a table for the construction and evaluation of matched sets of single, double and multiple sampling plans[6]. Muthuraj (1988) constructed tables based on the Poisson distribution for selecting a double sampling plan for a given (p_0 , ho) or (p*, h*)[7]. Similarly, Soundararajan and Vijayaraghavan (1989 a) have given tables for selecting double sampling plan for given AQL and AOQL based on equal rejection numbers[8]. Further. Soundararajan and Arumainayagam (1990) provided tables for easy selection of double sampling plan indexed by AQL, AOQL and LQL[9]. Devaarul (2003) constructed tables for mixed sampling plans having double sampling plan as an attribute plan indexed through AQL and IQL[10]. The recent development by Uma and Manjula (2018) Constructed a New Screening Procedure on Double Sampling Plan indexed by OC[11].

3. 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 (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:

3.1 Under 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.

3.2 Under rectifying sampling plan

If $d_1 \leq c_1$, we 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 $c_1 < d_1 \leq c_2$, we 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 found in it. Suppose 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:

3.3 Under acceptance sampling plan

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

3.4Under rectifying 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.

4. REVIEW OF CONDITIONAL DOUBLE SAMPLING PLAN

Vijayaraghavan (1990) has provided procedures and tables for the selection of conditional double sampling plans with various entry parameters. A search procedure is developed to determine the parameters of the plans when two points on the OC curve are specified. Baker and Brobst (1978) proposed conditional sampling procedures which are similar in structure to double sampling. These conditional double sampling procedures have operating characteristic (OC) curves identical to those of comparable double sampling procedures. Conditional double sampling is operationally different from double sampling in that the results of the second sample, if required, are obtained from a related lot and not from the current lot. According to Baker and Brobst (1978), using sample information from related lots results in more attractive OC curves and smaller sample sizes. This reduction in sample size is the principal advantage of these procedures over traditional sampling procedures.

5. IMPLEMENTATION OF CONDITIONAL DOUBLE SAMPLING PLAN

In Conditional double sampling plan by attributes the lot acceptance procedure is characterizes by the parameters N, n_1 , n_2 , c_1 , c_2 and c_3 The operating procedure for a conditional double sampling plan is given below:

1. Select a random sample size n ($=n_1 = n_2$) 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. 4.If $d_1> c_3$, reject the lot.
5. If $c_1 +1< d_1 < c_3$, take a second sample of size ‘n_2' from the remaining lot and find
6. the number of defectives ‘d_2’
7. If $d_2 < c_2$ or $d_1 + d_2 < c_3$ accept the lot otherwise reject the lot.

6. REVIEW OF STDS PLAN

A special type of double sampling plan wherein no acceptance is allowed in the first stage of sampling is considered and its equivalence to the fractional acceptance number single sampling plan of Hamaker (1950) is established. Whenever sampling plans are designed for product characteristics involving costly or destructive testing by attributes, it is the usual practice to use a single sampling plan with acceptance number Ac=O or Ac=l [see Hahn (1974) and Dodge (1955)]. But the Operating Characteristic (OC) curves of single sampling plans with Ac=O and Ac=l lead to conflicting interest between the producer and the consumer and with Ac=O plan behaves favourably to the consumer while the Ac=l plan favours the producer. In order to overcome the shortcomings given earlier, a Special Type of Double Sampling (STDS) plan is Established by Govindaraju(1991).

7. IMPLEMENTATION OF THE STDS PLAN

1) From a lot, select a random sample of size n_1 units and observe the number of defectives d_1. If $d_1 \geq 1$, reject the lot. If $d_1=0$, select a second random sample of size n_2 and observe the number of defectives d_2.

Table 1 : Operating Ratios for Certain Single Sampling Plans

A_c	Values of p_2/p_1					
	α=0.05 β=0.10	α=0.05 β=0.05	α=0.05 β=0.01	α=0.01 β=0.10	α=0.01 β=0.05	α=0.05 β=0.01
0	44.890	58.404	89.781	229.105	298.073	458.210
1	10.946	13.349	18.681	26.184	31.933	44.686
2	6.509	7.699	10.280	12.206	14.439	19.278
3	4.890	5.675	7.352	8.115	9.418	12.202
4	4.057	4.646	5.890	6.249	7.156	9.072
5	3.549	4.023	5.017	5.195	5.889	7.343

(2) If $d_2 \leq 1$, accept the lot. Otherwise, that is if $d_2 \geq 2$, reject the lot.

A compact representation of the STDS plan is given below:

Table – 2

Stage	Sample Size	Accept	Reject
1	n_1	*	1
2	n_2	1	2

*Cannot Accept

8. REVIEW OF NEW SCREENING PROCEDURE ON DOUBLE 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 Schneider man(1958) and Schneider man (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 (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 second sample even it is not lie in the region but under the condition of past experience (i.e., last two rejection is nearer to third acceptance number).

9. IMPLEMENTATION OF A NEW SCREENING PROCEDURE IN DOUBLE SAMPLING PLAN

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

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

Step 2: We 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: We 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: We take the decision on the basis of the first sample as follows:

Step 5: If $d_1 > c_2$ but nearer value, we can also draw a second random sample of size n_{22} 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_{22}.

Step 6: We combine the number of defective units (d_1 and d_{22}) found in both samples and consider $d_1 + d_{22}$ for taking the decision about the lot on the basis of the third sample as follows:

Step 7: If $d_1 + d_{22} \leq c_2$, we accept the lot otherwise reject the lot.

10. 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. 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 (d_1) 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 ($d_1 + d_2$) in both samples is greater than c_1 and less than or equal to the acceptance number c_2. Therefore, if $Pa_1(p)$ and $Pa_2(p)$ 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:

$$P_a(p) = P_{a1}(p) + P_{a2}(p) \quad \text{-------------------------------------}(1)$$

Under Poisson model the OC function of the Conditional double sampling plan is

$$P_a(p) = \sum_{r=0}^{c_1} \frac{e^{-n_1 p}(n_1 p)^r}{r!} + \left[\sum_{k=c_{1+1}}^{c_2} \frac{e^{-n_1 p}(n_1 p)^k}{k!}\left\{\sum_{r=0}^{c_2-k} \frac{e^{-n_2 p}(n_2 p)^r}{r!}\right\}\right] \text{----------} (2)$$

The OC function of the STDS plan is

$$P_a(p) = (1-\theta)\, e^{-np} + \theta\, (e^{-np} + n\, p\, e^{-np}) \text{ ------------------------------- } (3)$$

The OC function of the NSDSP is

$$P_a(p) = P_{a1}(p) + (P_{a21}(p) + P_{a22}(p)) \text{ ----------------------------------} (4)$$

A COMPARISON MADE FOR SAME SAMPLE SIZES WITH DSP, STDSP, CDSP AND NSDSP

Table -3(n_1,n_2,n_{21},n_{22};c_1,c_2)

p	DSP	STDSP	CDSP	NSDSP
0	1	1	1	1
0.01	0.9813	0.9744	0.9902	0.9603
0.02	0.8645	0.6575	0.9162	0.8822
0.03	0.6739	0.3779	0.7678	0.7186
0.04	0.4832	0.2048	0.5891	0.5178
0.05	0.3303	0.1102	0.4224	0.3459
0.06	0.2205	0.0604	0.2883	0.2243
0.07	0.1456	0.0340	0.1903	0.1452
0.08	0.0957	0.0196	0.1228	0.0946
0.09	0.0628	0.0115	0.0782	0.0620
0.1	0.0411	0.0068	0.0495	0.0406

OC for Table 3

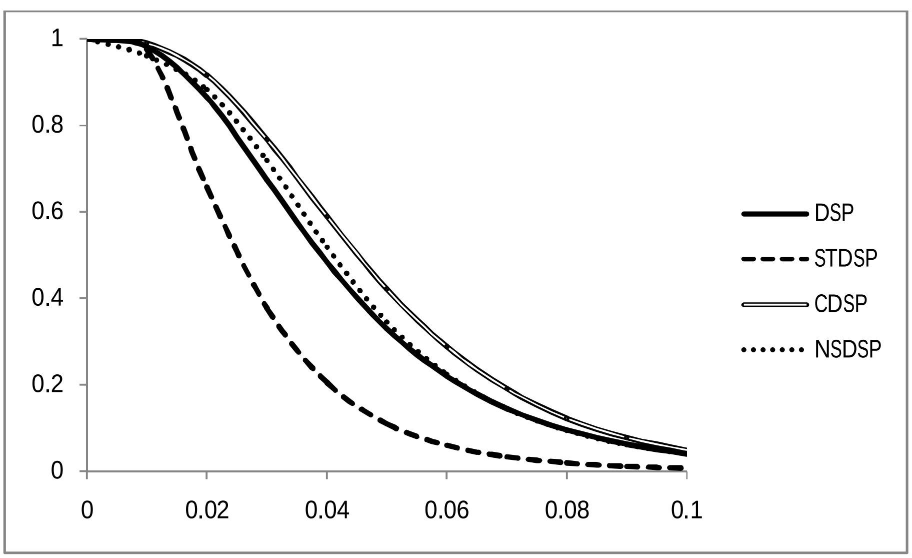

Figure – 1

CONCLUSION

Double sampling plans are generally superior to corresponding single sampling plans from an economic standpoint. That is because the double sampling plans can give an early decision at the first stage whenever lot quality is extremely good or bad. The recent developments also made in DSP. According to that we want some standard stable DSP for minimum sample size with maximum acceptance. From the OC curve it is clear that CDSP is superior to other three plans. When the sample size concerned both the samples are equal in size. In a similar way the NSDSP also have the same sample size in two stages except of taking another sample size. Consider the sample size and good determination between good and bad lots the CDSP and NSDSP is better than that of STDSP and DSP.

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