International Journal of Statistics and Systems
ISSN 0973-2675 Volume 17, Number 1 (2022), pp. 19-24

http://www.ripublication.com

Investigations on the Properties of Intra Lot Group Acceptance Sampling Plans with Chain Sampling Protocol (ILGASP-ChSP-1)

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Abstract

In this article the properties of ILGASP-ChSP-1 is investigated in detail and the relevant Group Acceptance Sampling Plans are reviewed. It is found that if the process average increases, then the probability of acceptance decreases for the newly developed ILGASP-ChSP. It is also found that if the process average is minimum or zero then the lot will be accepted with the probability of acceptance $1 - \alpha$. When the production process is stable and if the producer assures zero non-conformity in the lot, the lots are accepted 100%.

ALGORITHM OF ILGASP- ChSP TO SENTENCE A UNIQUE LOT:

Muhammad Aslam and Chi-Hyuck Jun (2009) have developed a Group Acceptance Sampling Plans For Truncated Life Tests Based On The Inverse Rayleigh and Log-Logistic Distributions. Aslam (2009,2011…) et.al. have contributed towards GASP. Devaarul S and Santhi T (2021), have developed a novel Intra Lot Group Acceptance Sampling Plans with Chain Sampling Protocol within the same lot and termed as ILGASP-ChSP. The Algorithm is given below for the reference.

Step 1: Let the size of the batches be large and life experiment is conducted with type I censoring with a specified minimum time t_0.

Step 2: Draw a random sample of size $n_i=g * r$ and put them into life test such that 'g' is the number of groups and r items are allocated to each group. Let it be first group and i=1.

Step 3: Count the number of non-conformities in each group. Let it be $d_1+d_2+\ldots+d_g=\sum_j d_j=D$.

Step 3: If each d_j is zero, (i.e) D=0, accept the batch.

Step 4: If D > 1, reject the lot.

Step 5: If D =1, draw 'i' consecutive samples of size n from the same current lot and put each sample items into life test with g groups and r items in each sample such that $n_i = g*r$.

Step 6: Accept the batch of products provided all 'i' samples have resulted in zero defective during inspection otherwise reject it.

Property 1:

The OC function of Intra Lot Group Acceptance with Chain sampling protocol is

$$P_a(p) = (P_{0.r})^g + P_{1,n}(P_{0,r})^{ig}$$

$P_{0,r}$= Probability of getting exactly 0 defective in a group of r units.

$P_{1,n}$= Probability of getting exactly 1 defective in a sample of n units such that n=g*r

i = Chaining index of number of samples in the same lot.

n = sample size

g= number of groups

r= number of units in each group

The OC function of Intra Group Chain sampling plan with type B probabilities is,

$$P_a(p) = (e^{-rp})^g + (npe^{-np})\ (e^{-rp})^{ig}$$

Proof:

The Lot may be accepted in the following cases:

Case 1:

A sample of n items is drawn and are grouped into g groups with r units in each group.

The batch will be accepted if in each groups, number of non-conformities is zero. The Probability of acceptance is

$$P[D = d_1, d_2, \ldots, d_g = 0] = (P_{0.r})^g$$

Case 2: If the batch of products is not accepted on the basis of first sample result and if D = 1, then the lot will be accepted with following probabilities.

$$P_n[D = 1] \text{ and } \{ (P_r[D = 0])^g \}^i$$

The above two cases are mutually exclusive. Hence the probability of acceptance of the batch is given below.

$$P_a(p) = (P_{0.r})^g + P_{1,n}(P_{0,r})^{ig}$$

Property 2:

When g =1 and r =n, the OC function of ILGASP reduces to Ordinary Chain Sampling Plan due to Dodge(1955).

Proof:

The OC function of ILGASP is

$$P_a(p) = (P_{0.r})^{g} + P_{1,n}(P_{0,r})^{ig}$$

Let there be a single group g=1, the OC function reduces to

$$P_a(p) = (P_{0.r}) + P_{1,n}(P_{0,r})^{i}$$

Suppose if the number of units in the group is n and only one group is available then n=r.

Then the OC function of ILGASP will reduces to

$$P_a(p) = (P_{0.n}) + P_{1,n}(P_{0,n})^{i}$$

Property 3:

The OC function of ILGASP reduces to Single Sampling Plan when the number of group is one and the lot is accepted with the acceptance constant c=0 with sample size and subgroup size are equal.

Proof:

The OC function of ILGASP

$$P_a(p) = (P_{0.r})^{g} + P_{1,n}(P_{0,r})^{ig}$$

When g=1,

$$P_a(p) = (P_{0.r}) + P_{1,n}(P_{0,r})^{i}$$

If the lot is accepted with c=0 in a single sample then, the OC function reduces to

$$P_a(p) = (P_{0.r})$$

Suppose if the sample size n is equal to the group size r, then the OC function becomes

$$P_a(p) = P_{0.n}$$

The is the OC function of Single sampling plans when c=0 for the known sample size n.

Table 1: Values of Probability of Acceptance of ILGASP-ChSP-1 when group size=1.

p	r	g	Pa(p) When i=1	Pa(p) When i=2	Pa(p) When i=3	Pa(p) When i=4	Pa(p) When i=5
0.001	100	1	0.986710493	0.97891924	0.971869	0.96549	0.959719
0.002	100	1	0.952794762	0.92849308	0.908597	0.892307	0.87897
0.003	100	1	0.905461712	0.862789119	0.831176	0.807757	0.790408
0.004	100	1	0.850051632	0.790797731	0.751079	0.724454	0.706607
0.005	100	1	0.79047038	0.71809574	0.674198	0.647573	0.631424
0.006	100	1	0.729528163	0.647990969	0.603242	0.578684	0.565206
0.007	100	1	0.669203179	0.582304804	0.539152	0.517723	0.507082
0.008	100	1	0.610846179	0.521903327	0.481939	0.463981	0.455913
0.009	100	1	0.555338659	0.467054621	0.431161	0.416568	0.410635
0.01	100	1	0.503214724	0.41766651	0.386195	0.374617	0.370358
0.011	100	1	0.454754558	0.373442568	0.346376	0.337367	0.334367
0.012	100	1	0.410055756	0.333982679	0.31107	0.304169	0.30209
0.013	100	1	0.369087445	0.298846278	0.279703	0.274486	0.273064
0.014	100	1	0.331731052	0.267590771	0.251774	0.247874	0.246912
0.015	100	1	0.297810763	0.239793655	0.226848	0.22396	0.223315

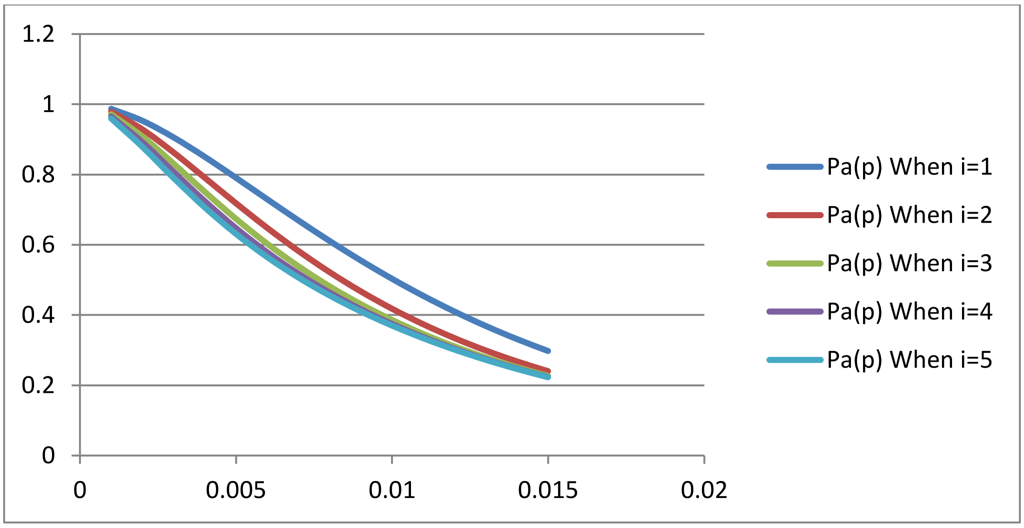

Figure 1: OC curve of ILGASP-ChSP-1 when the group size=1 for various chaining index.

Property 4:

When the production process is stable and if the producer assures zero defective in the lot (i.e) process average is equal to zero, then the lot is accepted almost surely.

Proof:

The OC function of ILGASP-ChSP with type B Probabilities is

$$P_a\,(p) = (e^{-rp})^{g} + (npe^{-np})\ \ (e^{-rp})^{ig}$$

Proof:

If the production process is stable and the producer assures process average is zero then p=0.

Hence $P_a(p)$ becomes

$$P_a\,(p) = (e^{-r*0})^{g} + (n*0)\ \ (e^{-r*0})^{ig}$$

$\Longrightarrow$ $P_a\,(p) = 1$

Hence the Proof.

Property 5:

When the production process is unstable and if the producer cannot assures process average then the lot cannot be accepted almost surely.

Proof:

The OC function of ILGASP-ChSP with type B Probabilities is

$$P_a\,(p) = (e^{-rp})^{g} + (npe^{-np})\ \ (e^{-rp})^{ig}$$

Proof:

If the production process is not stable and the process average is very large then $p \to \infty$.

Hence $P_a(p)$ becomes

$$P_a\,(p) = (e^{-\infty})^{g} + (n*\infty)\ \ (e^{-\infty})^{ig}$$

$\Longrightarrow$ $P_a\,(p) = 0$

Hence the Proof.

SUMMARY

In this article the properties of ILGASP-ChSP-1 are studied in detail. It is found that if the process average increases then the probability of acceptance decreases. It is also found that if the process average is minimum or zero then the lot will be accepted with the probability of acceptance $1 - \alpha$. When the production process is stable and if the producer assures zero defective in the lot, the lots are accepted 100%. Under certain condition the OC function of ILGASP reduces to Ordinary Chain Sampling Plan. The OC function of ILGASP reduces to Single Sampling Plan when the number of group is one and the lot is accepted with the acceptance constant c=0 whenever sample size and subgroup size are equal.

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