International Journal of Statistics and Applied Mathematics 2018; 3(2): 78-82

International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2018; 3(2): 78-82

www.mathsjournal.com
Received: 07-01-2018
Accepted: 10-02-2018

DevaArul. S
Assistant Professor,
Department of Statistics,
Government Arts College,
Coimbatore, Tamil Nadu, India

Vijila M
Assistant Professor,
Department of Mathematics,
Karunya University,
Coimbatore, Tamil Nadu, India

Correspondence
DevaArul. S
Assistant Professor,
Department of Statistics,
Government Arts College,
Coimbatore, Tamil Nadu, India

Modified complete chain sampling plans for inexpensive or non-destructive products - MCChSP (c_1, c_2, i, j)

DevaArul S and Vijila M

Abstract
A new algorithm known to be operating procedure of Modified Complete Chain Sampling plans for inexpensive or non-destructive items during inspection or testing is developed and presented in this article. The complete Chain sampling plan gives double protection to the consumer while giving pressure on the producer to maintain the quality of the lots. Based on the new algorithm the measures of the sampling plans such as operating characteristics function, average sample number etc., are derived and provided. Necessary proofs are given in case of efficiency measures. Tables are constructed and illustration is given for easy implementation in the quality control section of industries.

Keywords: Producer, Consumer, Inexpensive, non-destructive, Complete Chain, Sampling, OC function.

1. Introduction

Acceptance sampling plans play a vital role in testing or inspection of the products and hence will control the lot quality. In industries defective products are not entertained while producing costly or destructive items. Dodge [1] has introduced the ChSP-1 plans for small sampling and costly situations. However due to several factors non-conformities may exist in the lots which comes from the production process. In many industries inexpensive products are manufactured and accordingly lean inspection is practiced in the quality control section. And also during inspection or testing, items or components may be non-destructive. Hence appropriate sampling plans should be developed for specific need of such inspection. At the same time double sided chaining principle is embedded in the system so that pressure is given to the producer to maintain the quality products.

The Chain Sampling Plans developed by many authors are one sided chaining and the operating procedure mainly deals with only the results of past lots to decide about the current lot acceptance or rejection. To overcome the disadvantage in Chain Sampling Plans, Devaarul S and Edna K [2] have designed and developed two sided complete chain sampling plans CChSP (0,1). On an improvement of chain sampling plans, Devaarul S and Vijila M [3] have developed relational chain sampling plans with a new operating procedure which gives more pressure on the producer to maintain the quality of the lot. Devaarul S and Vijila M [4] have designed and developed variable quality characteristics based complete chain sampling plans.

Since products are inexpensive or non-destructive while testing or inspection few defectives may be allowed instead of zero defective maintenance during sampling inspection. In order to compensate the allowance given, the chaining principle is applied on both sides of current lot (i.e) preceding and succeeding lots. In this paper by the recommendation of internal quality auditor, the pressure on the producer is reduced by allowing few defectives during sampling inspection and at the same time double sided chaining principle is embedded in the system. The new sampling plan is known to be modified complete chain sampling plans and is termed as MCChSP(c_1,c_2,i,j).

Clark C.R [5] has developed OC curves for chain sampling plans. Frishman & Fred [6] have developed an extended chain sampling plans. Dodge H.F. and Stephens K.S. [7-8] have contributed towards new chain sampling inspection and evaluation of OC through Markov Chain approach. Soundararajan. V [9-10] has given procedure and tables for construction and selection of Chain sampling plans. Kuralmani .V and Govindaraju .K [11] have contributed towards the selection of Conditional sampling plans for the known AQL and LQL. Raju C [12] has developed OC functions for certain Conditional sampling plans. Suresh K.K. and Devaarul.S [13] have developed Mixed Sampling Plans with Chain Sampling as attribute plan. Vijila M and Devaarul S [14] have designed Complete Chain Sampling Plans based on Average Outgoing Quality Limit.

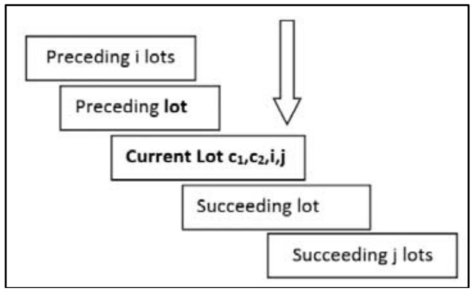

Fig 1: A schematic structure of Two-Sided-Modified Complete Chain Sampling

2. Operating Procedure Of MCChSp (C_1,C_2,, i, j)

The algorithm for sentencing a lot or batch is as follows:
Step 1: Draw a random sample of size n from a lot.
Step 2: Count the number of defectives d.
Step 3: If $d \le C_1$ accept the lot
Step 4: If $d > C_2$ reject the lot
Step 5: If d lies in the interval, $C_1 + 1 \le d \le C_2$, accept the current lot provided 'i' preceding and 'j' succeeding lots are accepted on the basis of the result $d \le C_1$

3. Measures of Sampling Plans

3.1 Operating Characteristic function (OC)

The authors have derived the new measures and are given below. The Probability of acceptance of the lot is as follows:

(i) $P_a(p) = P[d \le C_1] + P[d \le C_1]^i \, P[C_1 + 1 \le d \le C_2] P[d \le C_1]^j$, if $i \ne j$

(ii) $P_a(p) = P[d \le C_1] + P[d \le C_1]^{2i} \, P[C_1 + 1 \le d \le C_2]$ if i=j

In case of type B Poisson process,

$$P_a(p) = \sum_{x=0}^{C_1} \frac{e^{-np}(np)^x}{x!} + \sum_{x=C_1+1}^{C_2} \frac{e^{-np}(np)^x}{x!} \left[\sum_{x=0}^{C_1} \frac{e^{-np}(np)^x}{x!} \right]^{2i}$$

3.2 Average Sample Number (ASN)

Derivation of ASN is straight forward and is given below

ASN= $n + in\, P[d \le C_1]^i \; nP[C_1 + 1 \le d \le C_2] \; jn\, P[d \le C_1]^j$

ASN= $n + n^3 i^2 P[d \le C_1]^{2i} \, P[C_1 + 1 \le d \le C_2]$ if i=j

ASN= n if current lot has lesser than or equal to $c_1$defectives.

3.3 Average Outgoing Quality (AOQ)

AOQ= p P_a(p)

AOQ = p $\left\{ P[d \le C_1] + P[d \le C_1]^{2i} \, P[C_1 + 1 \le d \le C_2] \right\}$

$$AOQ = p \left\{ \sum_{x=0}^{C_1} \frac{e^{-np}(np)^x}{x!} + \sum_{x=C_1+1}^{C_2} \frac{e^{-np}(np)^x}{x!} \left[\sum_{x=0}^{C_1} \frac{e^{-np}(np)^x}{x!} \right]^{2i} \right\}$$

4. Derivation of OC function

The operating Characteristics function of MCChSP(c_1,c_2,i,j) is

(i) $P_a(p) = P[d \le C_1] + P[d \le C_1]^i \, P[C_1 + 1 \le d \le C_2] P[d \le C_1]^j$, if $i \ne j$

(ii) $P_a(p) = P[d \le C_1] + P[d \le C_1]^{2i} P[C_1 + 1 \le d \le C_2]$ if i=j

Proof:
The incoming lots are accepted based on the results of the inspection. The lot is accepted if the following cases are true.
Case 1: The lot is accepted if the number of defective d is lesser than the acceptance constant c_1. The required probability of acceptance is

$$P [d \le c_1].$$

Case 2: The lot is accepted if the number of defective lies in between c_1 and c_2 and also the number of defective should be less than or equal to c1 in the preceding and succeeding lots. The required probability of acceptance is

$$P [d \le c_1]^i P [c_1+1 \le d \le c_2]. P [d \le c_1]^j$$

Case 1 and case 2 are mutually exclusive events. Therefore by addition theorem on probability we get

$$P_a(p) = P[d \le C_1] + P[d \le C_1]^i P[C_1 + 1 \le d \le C_2] P[d \le C_1]^j \text{, if } i \ne j$$

Due to practical reasons one can fix i=j. The probability of acceptance is

$$P_a(p) = P[d \le C_1] + P[d \le C_1]^{2i} P[C_1 + 1 \le d \le C_2] \quad \text{if i=j}$$

Hence the proof.

Table 1: Values of OC for sample size n=20, c_1, c_2 and i

P = AQL	c_1	c_2	Pa(p), i=1	Pa(p), i=2	Pa(p), i=3
0.001	0	1	0.999034	0.998295	0.997586
0.001	0	2	0.999222	0.998476	0.99776
0.001	0	3	0.999224	0.998478	0.997761
0.001	0	4	0.999224	0.998478	0.997761
0.001	0	5	0.999224	0.998478	0.997761
0.001	0	6	0.999224	0.998478	0.997761
0.001	0	7	0.999224	0.998478	0.997761
0.001	0	8	0.999224	0.998478	0.997761
0.001	0	9	0.999224	0.998478	0.997761

Note: Table (1) values are given for same process average and can be extended for various process average and sample sizes.
Illustration:

A production process turns out 2% defective and the agreement between producer and consumer is that 95% lot should be accepted. Determine Modified Complete Chain Sampling Plans when the allowable defectives are c_1=0 and c_2=2 with chaining index i=1.
Solution: It is given that the AQL = 2% and 1-α = 95%.
From table (2), the sample size is found to be n=85 units when c_1= 0 and c_2=2.

Operating procedure
The algorithm for sentencing a lot or batch is as follows:
Step 1: Draw a random sample of size 85 from a lot.
Step 2: Place them into testing and count the number of defectives d.
Step 3: If d = 1, accept the lot
Step 4: If d ≥ 3, reject the lot
Step 5: If d lies in-between, $1 \le d \le 2$, accept the current lot provided 'i' preceding and 'j' succeeding lots are accepted on the basis of the result d =0 otherwise reject it.

5. Determination of parameters by Designing MCChSP(c_1,c_2,i=j) indexed through AQL
Find the process average AQL and corresponding probability of acceptance 1-α such that

$$P_a(p) = P[d \le C_1] + P[d \le C_1]^{2i} P[C_1 + 1 \le d \le C_2] \ge 1\text{-}\alpha$$

The above equation cannot be solved easily. An iterative program is written in Matlab to determine the parameters of the sampling plans and the estimates are given in table (2) and can be extended further.

Table 2: Values of sample size n @ 95% Probability of Acceptance for MCChSP(c_1,c_2,i=j)

AQL	c_1=0 c_2	1	2	3	4	i=5	6	7	8	9	10
0.001	1	150	120	105	90	85	80	75	70	65	60
0.002	2	85	65	53	48	43	40	38	35	33	30
0.003	3	60	42	35	32	28	27	25	23	22	20
0.004	4	45	31	26	24	21	20	19	18	16	15
0.005	5	36	26	21	19	17	16	15	14	13	12

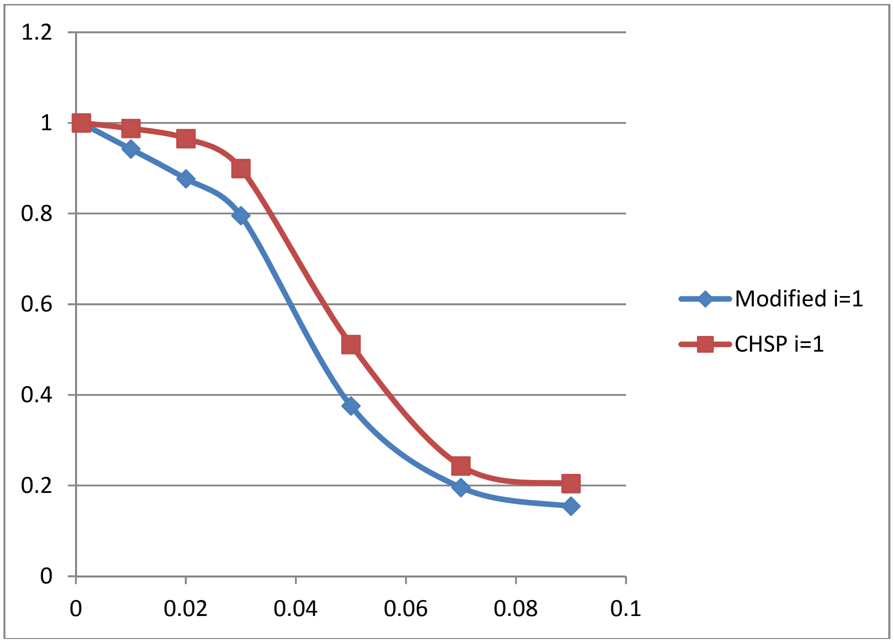

Fig 1: Plot of OC values of MCChSP and CChSP.

6. Conclusion

A new chain sampling operating procedure for inexpensive or non-destructive items during testing is given and the related measures are derived for the first time by the authors. The new two sided complete Chain sampling plan gives more protection to the consumer while giving mild pressure on the producer to maintain the quality of the lots. It is found that the MCChSP(i,j,c_1,c_2) gives pressure on the producer even though allowance is given in terms of acceptance constant when the quality deteriorates. Since few defectives are allowed during sampling inspection, the risk of producer is lesser. It is evident that the probability of acceptance decreases as the chaining index i increase. This will coerce the producer to maintain the quality of the lots. Identifying the chaining index is made easy by setting i and j are equal while designing the sampling plans Thus, this sampling plan is recommended for inexpensive or non-destructive items during testing or inspection.

7. References

1. Dodge HF. Chain sampling Inspection Plans", Industrial Quality control, 1955; 2:10-13.
2. DevaArul S, Rebecca Jebaseeli Edna K. Two Sided - Complete Chain Sampling Plans For Attribute Quality Characteristics (CChsp- 0, 1), Karunya Journal of Research, 2011, 3(1).
3. DevaArul S, Vijila M. Design and Development of Relational Chain Sampling Plans [RChSP]", To appear in COGENT MATHEMATICS, Taylor and Francis, U.S.A., 2017.
4. Devaarul S, Vijila M. Design and Development Of Two Sided Complete Chain Sampling Plans For Variable Quality Characteristics – VCChSP, International Journal of Probability and Statistics, Scientific and Academic Publishing, USA., 2017.
5. Clark CR. OC Curves for Chsp -1, Chain sampling plans", Industrial Quality Control, 1955; 17(4):10-12.
6. Frishman, Fred. An Extended Chain Sampling Plan", Industrial Quality Control, 1960; 17(1):10-12.
7. Dodge HF, Stephens KS. Some new chain sampling Inspection, Industrial Quality Control, 1966; 23(2): 61-67.
8. Dodge HF, Stephens KS. An Application of Markov Chains for evaluation of the Operating Characteristics of Chain Sampling Inspection Plans, IAQR Journal, 1974; 1(3):131–138.
9. Soundararajan V. Contributions to the study of single sampling plans and Chain sampling plans, Ph.D., Thesis, Annamalai University, India. 1971.
10. Soundararajan V. Procedures and Tables for Construction and Selection of Chain Sampling Plans (Chsp -1), part I & Part II, Journal of Quality Technology, 1978; 10(2):56–60, 1978; 10(3):99– 03.
11. Kuralmani V, Govindaraju K. Selection of Conditional Sampling plans for given AQL & LQL", Journal of Applied Statistics, 1993; 20(4):467–479.
12. Raju C. On equivalence of OC functions for Certain Conditional sampling plans," Communication in Statistics, Simulation & Computation, 1992; 24(4):961–969.

13. Suresh KK, Devaarul S. Designing and Selection of Mixed Sampling Plans with Chain Sampling as attribute plan, Quality Engineering, Journal of American Society for Quality, U.S.A., 2002; 15(1):155-160.
14. Vijila M, Devaarul S. Construction and Selection of Two Sided Complete Chain Sampling Plans - CChSP (0, 1) Indexed Through AOQL", International Journal of Scientific Research and Management (IJSRM), 2017; 5(10):7303-7307., ISSN (e): 2321-3418. India