International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2023; 8(5): 90-93

https://www.mathsjournal.com
Received: 10-06-2023
Accepted: 12-07-2023

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Designing of quality interval skip-lot sampling plan with multiple deferred state sampling plan

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DOI: https://dx.doi.org/10.22271/maths.2023.v8.i5b.1222

Abstract
The Importance of this paper is to account for the possibility of dependence among the items of a sample. The development of new method for designing sampling plans based on range of quality instead of point-wise description of quality by invoking a novel approach called Quality Regions. This method seems to be versatile and can be adapted to the elementary production process where the stipulated quality level is advisable to fix at a later stage and provides a new procedure meant for designing of Quality interval skip-lot sampling plan with multiple deferred state sampling plan MDS (0, 2). (MAPD) is also considered for the selection of parameters for Skip-lot sampling plan. New quality descriptors called operating ratios are introduced to design the sampling plan.

Keywords: Skip lot sampling plan, SkSP-R, Multiple deferred state sampling plan (MDS), Quality intervals

1. Introduction

Acceptance sampling is an important field of statistical quality control that was popularized by Dodge and Roming. The important of sampling inspection is reduce the cost of inspection while at the same time assuring the customer to satisfy an adequate level of quality on item being inspected. Dodge [1] has introduced the concept of skip-lot sampling, by applying the principles of a continuous sampling plan of type CSP-1 to a series of lots or batches of material. Perry [2] has developed a system of sampling inspection plan known as SkSP-2. This plan involves inspection of only some fraction 'f' of the submitted lots when quality of the submitted product is good as demonstrated by the quality of the product. Suresh [3] has given for the selection of Skip-lot Sampling Plan of type SkSP-2 with reference plans SSP(c=0), SSP (c≠0) and DSP (0, 1) using consumer and producer quality levels.

Recently Balamurali [4] has studied optimal designing of skip-lot sampling plan V with Double Sampling Plan as the reference plan. The design parameters are determined so as to minimize the average sample number while the specified producers risk and the consumer's risks are satisfied. Perry (1973) [7] formalized the application of skip-lot sampling to the situation in which each lot to be inspected and sampled according to lot inspection plan called the reference plan. This plan is designed as the SkSP-2 plan. Vijayaraghavan (2000) [9] introduced designing and evaluation method of skip-lot sampling plan of type SkSP-3 plan and the operating characteristic function is derived using the Marcov-chain approach. Balamurali and Chi-Hyuck jun (2006) [3] have developed SkSP-V plan based on the principles of CSP-V plan. Aslam et al. (2010) [1] have established the designing methodology to determine the parameters for syaytem of skip-lot sampling plan (2012) developed Optimal designing of skip-lot sampling plan of type SkSP-2 with double sampling plan as the reference plan. Further Kavithamani (2014) [6] has studied SkSP-V with various attribute reference plans towards acceptable and limiting quality levels of inspection lots. Recently, a new tpe of skip-lot sampling plan called SkSP-R was developed by Balamurali, *et al*. (2014) [3] based on the principle of continuous sampling procedure and resampling scheme for the quality inspection of continuous flow of bulk products.

2. Operating procedure for SkSP-R plan

The operating procedures of SkSP-R are as follows

- Begin the procedure with normal inspection by applying specified reference plan (For instance MDS (0, 2). During normal inspection, lots are inspected one by one in order of being submitted.
- When consecutive lots are accepted based on the reference plan under normal inspection, discontinue the normal inspection and switch to skipping inspection. during the skipping inspection, inspect only a fraction f of lots selected at random by applying reference plan. The skipping inspection is continued until a sampled lot is rejected.
- When a lot is rejected, after s consecutively sampled lot have been accepted, then go for re-inspection procedure for the immediate next lot as in step (5) given below.
- During re-inspection procedure, perform the inspection using the reference plan. If the lot is accepted, then continue the skipping inspection. On non-acceptance of the lot, re-inspection is done m times and the lot is rejected if it has been accepted on (m-1) st resubmission.
- If a lot is rejected on the re-inspection scheme, then we immediately revert to normal inspection.
- Replace or correct all non-conforming units found with conforming units in the rejected lots.

The proposed plan involves the reference plan with parameters, namely f, ($0<f<1$), the fraction of lots inspected in skipping inspection mode, i, the clearance number of normal inspection, s, the clearance number for re-inspection procedure and m, the number of time the lots are submitted for reinspection. In general, i, s and m are positive integers. So, the plan is designated as SkSP-R (i, f, s, m).

3. Operating procedure for MDS(r, b) plan

- For each lot select a sample of n units and test each unit for conformance to specified requirements
- Accept the lot if d (the observed number of observation of defectives) is less than or equal to r, reject the lot if d greater than or equal to r+b.
- If $r+1 \le d \le r+b$, accept the lot if the forthcoming m lots in succession are all accepted.

3.1 Operating Procedure for MDS (0, 2)

A multiple deferred State sampling plan of Wortham and Baker (1976) with r=0 and b=2 is operated as follows:

- From each lot, take a random sample of n units and observe the non-conforming units d.
- If d=0, accept the lot; if d>2, reject the lot. If d=2, accept the lot, provided the forthcoming m lots in succession are all accepted (previous m lots in case of multiple dependent state sampling)

3.2 Operating procedure for SkSP-R with Multiple Deferred Sampling plan MDS (0, 2) as reference plan

Step 1: Begin the procedure with normal inspection following the procedure of Multiple Deferred State Sampling plan MDS (0, 2) as the reference plan. During normal inspection, lots are inspected one by one in order of being submitted satisfying the conditions of MDS (0, 2).

Step 2: From each lot submitted for inspection, take a random sample of size n and measure the number of defectives d. If d=0, accept the lot; if d>2, reject the lot. If d=2, accept the lot, provided the forthcoming m lots in succession are all accepted (previous m lots in case of multiple dependent state sampling).

Step 3: When i consecutive lots are accepted based on the reference plan under normal inspection, discontinue the normal inspection and switch to skipping inspection. During the skipping inspection, inspect only a fraction f of lots selected at random by applying Multiple Deferred Sampling plan MDS (0, 2) as the reference plan. The skipping inspection is continued until a sampled lot is rejected.

Step 4: When a lot is rejected, after s consecutively sampled lot have been accepted, then go for re-inspection procedure for the immediate next lot as in step (5) given below.

Step 5: During re-inspection procedure, perform the inspection using the reference plan. If the lot is accepted, then continue the skipping inspection. On non-acceptance of the lot, reinspection is done m times and the lot is rejected if it has been accepted on (m-1)st resubmission. If a lot is rejected on the reinspection scheme, then we immediately revert to normal inspection. Replace or correct all non-conforming units found with conforming units in the rejected lots.

4. Designing of SkSP-R with MDS (0, 2) for given n, i, f, k, m_1 and m_2

The procedure for designing SkSP-R with MDS (0, 2) as reference plan indexed through Acceptable and Limiting Quality Level is drawn and Tables are simulated for various combinations of parameter values n, i, s, f, m_1, m_2 and k using MS- Excel Software.

4.1 Quality Decision Region (QDR)

This is an interval of quality ($p_1 < p < p_*$) in which product is accepted at Engineer's quality average. The quality is maintained up to p*. (MAPD) and sudden decline in quality is expected. This region is also called Reliable Quality Region (RQR).

Quality decision Range denoted as d1= ($p_* - p_1$) is derived from probability of acceptance with

$$(p_1 < p < p_*) = P_a(P) = \frac{fP+(1-f)P^{i}+fP^{k}(P^{i}-P)(1-Q^{m})}{f(1-P^{i})\left[1-P^{k(1-Q^{m})}\right]+P^{i}(1+fQP^{k})} \text{ for } p_1 < p < p_*$$

4.2 Probabilistic Quality Region (PQR)

This is an interval of quality ($p_1 < p < p_2$) in which a product is accepted with a minimum probability 0.10 and maximum probability 0.95. Probabilistic Quality Range denoted as d_2= (p_2-p_1) is derived using the probability of acceptance expression.

$$P_a(p_1 < p < p_2) = P_a(P) = \frac{fP+(1-f)P^{i}+fP^{k}(P^{i}-P)(1-Q^{m})}{f(1-P^{i})\left[1-P^{k(1-Q^{m})}\right]+P^{i}(1+fQP^{k})} \text{ for } p_1 < p < p_2$$

Where, $e^{-np}+npe^{-np}e\text{-}^{npm}{}_{2p,}$ Where P is the operating characteristic function of quality intervals $d_1 < d_0 < d_3 < d_2$

4.3 Limiting Quality Region (LQR)

It is an interval quality (($p_* < p < p_2$) in which product is accepted with a minimum probability 0.10 and maximum probability 0.95. Limiting Quality Range denoted as d_3 = (p_2-p_*) is derived from the average acceptance

$$(p_1 < p < p_2) = P_a(P) = \frac{fP+(1-f)P^{i}+fP^{k}(P^{i}-P)(1-Q^{m})}{f(1-P^{i})\left[1-P^{k(1-Q^{m})}\right]+P^{i}(1+fQP^{k})} \text{ for } p_* < p < p_2$$

4.4 Indifference Quality Region (IQR

It is an interval quality (($p_1 < p < p_0$) in which product is accepted with a minimum probability 0.50 and maximum probability 0.95. Indifference Quality Range denoted probability of as $d_0 = (p_0 - p_1)$ is derived from the average probability of acceptance

$P_a(p_1 < p < p_0) = P_a(P) = \frac{fP+(1-f)P^{i+fP^k}(P^i-P)(1-Q^m)}{f(1-P^i)\left[1-P^{k(1-Q^m)}\right]+P^i(1+fQP^k)}$ for $p_1 < p < p_0$

4.5 Construction of tables

The operating characteristic function Pa (p) to SkSP-R sampling plan with Multiple Deferred Sampling plan as reference plan [MDS (0, 2)] as reference plan is given as:

$$P_a s(P) = \frac{fP+(1-f)P^{i+fP^k}(P^i-P)(1-Q^m)}{f(1-P^i)\left[1-P^{k(1-Q^m)}\right]+P^i(1+fQP^k)}$$

Here, $P = e^{-np} + npe^{-np}e^{-npm2} + \frac{np2}{2}e^{-np}(1+m_2)$

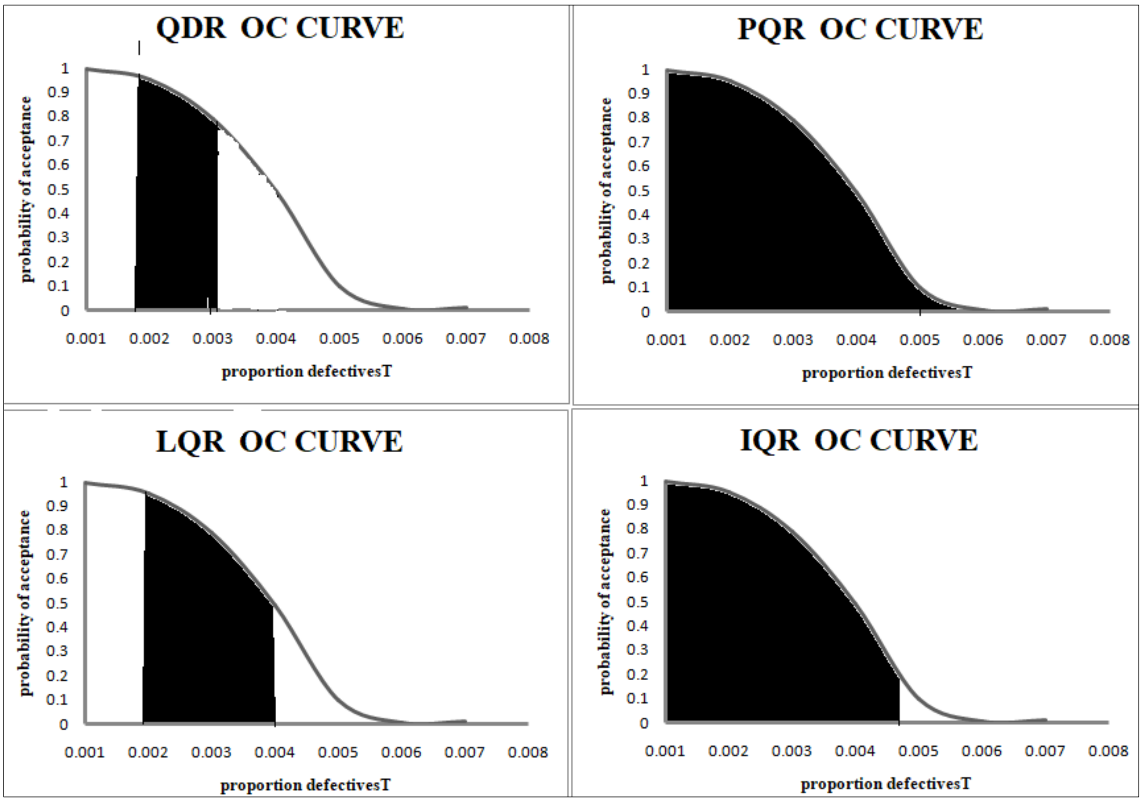

Table 1: Certain values of QDR, PQR, LQD and IQR &operating characteristic ratio

f	I	K	m_1	m_2	d_1	d_2	d_3	d_4	T_1	T_2
1/3	1	1	1	1	0.4286	2.6037	3.0323	1.1413	0.141345	0.375537
1/5	1	1	1	1	0.5675	2.876	3.4435	1.2954	0.164803	0.438089
1/7	1	1	1	1	0.6648	3.0603	3.7251	1.4069	0.178465	0.472528
2/5	1	1	1	1	0.3789	2.5117	2.8906	1.0928	0.13108	0.346724
2/7	1	1	1	1	0.4645	2.6893	3.1538	1.1893	0.147283	0.390566
3/5	1	2	1	1	0.3131	2.2278	2.5409	0.9077	0.123224	0.344938
3/5	2	2	1	1	0.3094	1.8964	2.2058	0.7634	0.140267	0.405292
3/5	3	2	1	1	0.3075	1.8351	2.1426	0.6907	0.143517	0.445201
3/5	4	2	1	1	0.3018	1.8269	2.1287	0.6489	0.141777	0.465095
3/5	5	2	1	1	0.3014	1.8243	2.1257	0.6167	0.141789	0.48873
1/4	3	1	1	1	0.4698	1.7543	2.2241	0.7369	0.211232	0.637536
1/4	3	2	1	1	0.4539	1.7283	2.1822	0.7015	0.208001	0.647042
1/4	3	3	1	1	0.4434	1.7314	2.1748	0.69	0.203881	0.642609
1/4	3	4	1	1	0.4361	1.7371	2.1732	0.6867	0.200672	0.635066
1/4	3	5	1	1	0.4305	1.743	2.1735	0.6872	0.198068	0.626455
1/2	3	2	1	1	0.3356	1.8142	2.1498	0.6937	0.156108	0.483783
1/2	3	2	2	1	0.3553	1.8472	2.2025	0.7625	0.161317	0.465967
1/2	3	2	3	1	0.3588	1.9347	2.2935	0.815	0.156442	0.440245
1/2	3	2	4	1	0.3591	1.9707	2.3298	0.8508	0.154133	0.422073
1/2	3	2	5	1	0.3593	1.9706	2.3299	0.8732	0.154213	0.411475
2/7	4	2	1	1	0.4179	1.7137	2.1316	0.6272	0.19605	0.666295
2/7	4	2	1	2	0.0215	1.7809	1.8024	0.781	0.011929	0.027529
2/7	4	2	1	3	0.2531	1.4801	1.7332	0.4537	0.14603	0.557858
2/7	4	2	1	4	0.2241	1.494	1.7181	0.4344	0.130435	0.515884
2/7	4	2	1	5	0.2047	1.5102	1.7149	0.429	0.119366	0.477156

P_a (P)	0.99	0.95	0.90	0.50	0.10	0.05	0.01
P	0.9825	0.8700	0.6697	0.3892	0.0992	0.0051	0.0096

Where, P is the probability of acceptance for reference plan and Q=1-P. The reference plan is with conditional repetitive group sampling plan and its parameters fixed. The Operating ratio for the selection of sampling plan are given the parameters. For example when n=100, f=1/2, i= 1, k=1, m_1=1, m_2 =1 each of the entries by n and leads to the values given below

5. Conclusion
Acceptance sampling plan have been widely used in industry to determine whether the manufactured item satisfy the prespecified quality levels or not. This paper provide a new procedure has been evolved involving two methodologies namely Skip-lot Sampling Plan of type SkSP-R and Multiple Deferred Sampling plan MDS (0,2) as reference plan. This plan evolves the Quality decision region (QDR), Probabilistic Quality Region (PQR), Limiting Quality Region (LQR) and Indifference Quality Region (IQR) has been studied. Under Skip-lot sampling inspection, samples may be drawn from only a fraction of the submitted lots. The main purpose for Skip-lot sampling is to decrease the frequency of sampling inspection and reduce the total inspection costs.

6. References

1. Aslam M, Balamurali S, Jun CH, Ahmad M. Optimal designing of a Skip lot Sampling Plan by two point method, Pakistan Journal of Statistics. 2010;26(4):585-592.
2. Balamurali S, Subramani J. Optimal designing of Skip-lot Sampling plan of type SkSP-2 with double sampling plan as the reference plan, Journal of Statistical Theory and Practice. 2012;6:354-36.
3. Balamurali S, Aslam M, Jun CH. A new system of product inspection based on skip-lot sampling plans including resampling, The Scientific World Journal; c2014. p. 1-6. ID 192412.
4. Balamurali S, Jun CH. Repetitive group sampling procedure for variables inspection, Journal of Applied Statistical Science. 2006;33(3):327-338.
5. Dodge HF. Skip-lot Sampling Plan, Industrial Quality control. 1955;11(5):3-5.
6. Kavithamani M. Designing on System of Skip Lot Sampling Plan with Different Attribute Reference Plans, Ph.D. Thesis, Bharathiar University, Coimbatore, India; c2014.
7. Perry RL. Skip-lot Sampling Plans, Journal of Quality Technology. 1973;5(3):123-130.
8. Rambert Vaerst R. A procedure of construct multiple deferred state sampling plans. Methods of Operations Research. 1982;37:477-485.
9. Vijayaraghavan R Design and evaluation of skip-lot sampling plans of type SkSP-3, Journal of Applied Statistics. 2000;27(7):901-908.
10. Wortham AW, Baker RC. Multiple Deferred State Sampling Inspection, the International Journal of Production Research. 1976;14(6):719-731.