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PERFORMANCE MEASURES FOR BSKSP-2 WITH BMCHSP-1 AS A REFERENCE PLAN

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ABSTRACT

This paper is concerned with the tables for the selection of Bayesian Skip Lot Sampling Plan (BSkSP-2) with Bayesian Modified Chain Sampling Plan (BMChSP-1) as a reference plan. Gamma distribution is considered as the prior distribution for BMChSP-1.

INTRODUCTION

The purpose of acceptance sampling plan is to determine a course of action. To be more specific either to accept or reject a specific lot based on one or more samples from that lot. A methodology that deals with procedures, by which decision the to accept or reject are based on the inspection of samples. The two major classifications of Acceptance Sampling Plans are: by attributes and variables. Skip-lot sampling plans are designed to reduce the inspection cost. Inspection of samples may be drawn from only a fraction of the submitted lots in skip-lot sampling. To decrease the frequency of sampling inspection is the main purpose of ski-lot sampling; thus it reduces the total inspection costs. The designing of skip-lot sampling plan was initially done by Dodge (1955), which is based on the principle of Continuous Sampling Plan (CSP-1) by applying it to a series of lots or batches of material.

Bayesian Acceptance Sampling

The utilization of prior history of the selection of distributions (viz., Beta Binomial, Gamma Poisson) to describe the random fluctuations involved in Acceptance Sampling, which the approach associated with Bayesian Acceptance Sampling. The requirement of Bayesian sampling plans is that they want the user to specify explicitly, the distribution of defectives from lot to lot. The prior distribution is the expected distribution of a lot quality on which the sampling plan is going to operate. The distribution is called prior, because it is formulated prior to the taking of samples. The combination of prior knowledge, represented with the prior distribution, and the empirical knowledge based on the sample leads to the decision on the lot. In this paper, a new procedure is proposed towards minimizing the risks with skip lot sampling plan of type-2 with Modified chain sampling plan as a reference plan through Bayesian methodology. Perry (1970) has developed a system of sampling inspection plan known as SkSP-2. This plan involves the inspection of only a fraction 'f' of the submitted lots when quality of the submitted product is good as demonstrated by the quality of the product. Parker and Kessler (1981) have modified the existing SkSP-2 plan under which at least one unit is always sampled from a lot. The expression for probability of acceptance is derived and compared with standard skip lot plans. Calvin (1984) has distributed procedures and tables for employing Bayesian sampling plans. Hald (1981) has also provided an excellent comparison of classical and Bayesian theory and methodology for attributes acceptance sampling.

K. Bharathan (2012), has given contributions to the study of skip-lot sampling plans using chain sampling plan as a reference plan. Kalaichelvi (2012) has studied the selection of

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skip-lot sampling plans for given p_1, p_2, α and β involving producer and consumer risks with various reference plans. Recently Muhammed Aslam *et.al* (2012) has studied optimal designing of an SkSP-V skip lot sampling plan with Double Sampling Plan as the reference plan. Balamurali and Subramani (2012) developed Optimal designing of Skip-lot sampling plan of type SkSP-2 with Double sampling plan as the reference plan.

Bayesian Skip-Lot Sampling Plans

This paper focuses on selection procedures and tables constructed for BSkSP-2 using Bayesian Modified Chain Sampling Plan (which uses Gamma prior distribution) as a reference plan.

The Reference Plan

The reference plan considered in developing Bayesian skip-lot sampling plans, namely, BSkSP-2, is Bayesian Modified chain sampling plan BMChSP-1. The OC function Pa(p) of the MChSP-1 plan was derived by Govindaraju and Lai (1998) as

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

Operating Procedure of MChSP-1 Plan

1. Draw a random sample of size n from each submitted lots. If one or more nonconforming units are found in the sample, Reject the lot.
2. If no conforming units are found in the sample, provided that the preceding i samples also contained no nonconforming units except in one sample, which may contain at most one nonconforming unit, accept the lot. Otherwise, reject the lot.

With gamma prior distribution, $w(\mathrm{p}) = e^{-np} p^{s-1} \dfrac{t^s}{\Gamma(s)}$ s, t, p > 0 with parameters s, t.

The average probability of acceptance of BMChSP-1 is given by Latha M. and Rajeswari M. (2013).

The average probability of acceptance is given as

$$\bar{p} = \int_0^\infty P_a(p)w(p)dp = \frac{s^s}{(s+n\mu(1+i))^s} + \frac{s^{s+1}n\mu i}{(s+n\mu(1+i))^{s+1}} \qquad \text{--- (1)}$$

where $\mu = s/t$ the mean value of the product quality p.

Bayesian Skip-Lot Sampling Plan Bsksp-2

Selection procedure is presented for selection of Bayesian Skip-Lot Sampling BSkSP-2 (the SkSP-2 plan with Bayesian Modified Chain Sampling Plan BMChSP-1 plan as a reference plan) for given s, μ_1, μ_2, α and β. Based on this procedure, tables are constructed using which one can select BSkSP-2 under various combinations of incoming and outgoing quality levels.

Operating Procedure for Sksp-2

The operating procedure of Skip-lot sampling plan SkSP-2 is given as follows:

1. Using the reference plan, start with normal inspection (inspecting every lot).
2. Switch to skipping inspection (inspect a fraction, f, of the lots), When i consecutive lots are accepted on normal inspection.
3. Switch to normal inspection, when a lot is rejected on skipping inspection.

The acceptance probability for the skip-lot sampling plan is calculated via the following formula:

$$P_a(f,i) = \frac{fP + (1-f)P^i}{f + (1-f)P^i} \qquad \ldots\ldots\ldots\ldots(2)$$

where P is the OC function of the reference sampling plan.

The skipping parameters of SkSP-2 plan are i and f. In general, 0 < f < 1, and i is a positive integer. The plan reduces to the original reference sampling plan on putting f = 1 in equation (1).

Selection of Plans

Selection procedures of BSkSP-2 Plan with BMChSP-1 as reference plan will now be indicated, under the conditions for application of Poisson model for OC curve, with Gamma prior distribution. Table 2 has been constructed for various parametric values indexed by s, i and μ which can be used for the selection of such plans.

The Average Probability of Acceptance of Bsksp-2 With Bmchsp-1 As A Reference Plan

The Probability of acceptance of Bayesian Skip lot Plan – 2 is given by substituting the $\overline{P}$ of equation 1.1 in place of P of equation 2 will get the new $\overline{P}$ of BSkSP-2 as follows:

$$P_a(f,i) = \frac{f\left(\frac{s^s}{(s+n\mu(1+i))^s} + \frac{s^{s+1}n\mu i}{(s+n\mu(1+i))^{s+1}}\right) + (1-f)\left(\left(\frac{s^s}{(s+n\mu(1+i))^s} + \frac{s^{s+1}n\mu i}{(s+n\mu(1+i))^{s+1}}\right)\right)^i}{f + (1-f)\left(\left(\frac{s^s}{(s+n\mu(1+i))^s} + \frac{s^{s+1}n\mu i}{(s+n\mu(1+i))^{s+1}}\right)\right)^i} \qquad (3)$$

where $\mu = s/t$ the mean value of the product quality p.

Construction of Tables

The Indifference Quality Level (IQL) or point of control μ_0 can be calculated by equating the above equation (3) to 0.50 for values of s = 1, 2, f = 2/3, 1/3, 1/2 & 1/5, also for i = 4, 6, 8, 10, 12 using Newton's method of approximation and those values are presented in Table 1. Similarly, we can find AQL (μ_1) and LQL (μ_2) after equating the same equation (3) to 0.95 and 0.10. Its values are also given in Table 1 and its parametric values are given in Table 2.

Example: 1

For s =1, f = 2/3, i = 4 and of $\overline{P}$ = 0.95, the value of $n\mu_1$ = 0.0481. For s = 1 and different values of f and i (f = 1/2,1/3, 1/4 & 1/5 and i = 6,8,10,12) using Newton's Method of approximation, the $n\mu_1$, $n\mu_2$ & $n\mu_0$ values are tabulated in table 1.

Table 1 nμ values for Bayesian Skip Lot Sampling Plan 2 (BSkSP-2) for given average probability of acceptance

s = 1	f	i	$n\mu_1$	$n\mu_2$	$n\mu_0$
	2/3	4	0.0481	3.3104	0.4374
		6	0.0374	2.4426	0.3147
		8	0.0303	1.9339	0.2483
		10	0.0253	1.6002	0.2057
		12	0.0217	1.3645	0.1757
	1/2	4	0.0578	3.312	0.4557
		6	0.0436	2.4426	0.3185
		8	0.0346	1.934	0.2491
		10	0.0285	1.6002	0.2059
		12	0.0241	1.3645	0.1758
	1/3	4	0.0739	3.3216	0.5342
		6	0.0534	2.4426	0.3374
		8	0.0412	1.934	0.2535
		10	0.0332	1.6002	0.2069
		12	0.0276	1.3645	0.176
	1/5	4	0.0984	3.3216	0.5342
		6	0.0676	2.4426	0.3374
		8	0.0504	1.934	0.2535
		10	0.0396	1.6002	0.2069
		12	0.0324	1.3645	0.176
s = 2	**f**	**i**	$n\mu_1$	$n\mu_2$	$n\mu_0$
	2/3	4	0.0171	0.994	0.2019
		6	0.0122	0.727	0.1434
		8	0.0094	0.5729	0.1122
		10	0.0075	0.4726	0.0925
		12	0.0063	0.4021	0.0788
	1/2	4	0.0213	0.9943	0.2098
		6	0.0148	0.727	0.1451
		8	0.0112	0.5729	0.1126
		10	0.0088	0.4726	0.0926
		12	0.0073	0.4021	0.0788
	1/3	4	0.0288	0.9949	0.223
		6	0.0192	0.727	0.1481
		8	0.0141	0.5729	0.1133
		10	0.0109	0.4726	0.0928
		12	0.0088	0.4021	0.0789
	1/5	4	0.0406	0.9962	0.2429
		6	0.0259	0.727	0.1532
		8	0.0183	0.5729	0.1145
		10	0.0138	0.4726	0.0931
		12	0.0109	0.4021	0.0789
s = 3	**f**	**i**	$n\mu_1$	$n\mu_2$	$n\mu_0$
	2/3	4	0.0503	1.1752	0.3398
		6	0.0398	0.8597	0.2464
		8	0.0326	0.6773	0.1946
		10	0.0275	0.5586	0.1612
		12	0.0236	0.4753	0.1377
	1/2	4	0.0602	1.1755	0.3501
		6	0.0461	0.8597	0.2486
		8	0.03698	0.6773	0.1951
		10	0.0307	0.5586	0.1613
		12	0.0261	0.4753	0.1317
	1/3	4	0.076	1.1761	0.3669
		6	0.0559	0.8597	0.2525
		8	0.0436	0.6773	0.196
		10	0.0354	0.5586	0.1615
		12	0.0296	0.4753	0.1377
	1/5	4	0.0992	1.1773	0.3921
		6	0.0695	0.8597	0.2591
		8	0.0525	0.6773	0.1976
		10	0.0417	0.5586	0.1619
		12	0.0343	0.4753	0.1378
s = 4	**f**	**i**	$n\mu_1$	$n\mu_2$	$n\mu_0$
	2/3	4	0.0507	1.0422	0.3299
		6	0.0403	0.7613	0.2395
		8	0.033	0.5993	0.1892
		10	0.0278	0.494	0.1567
		12	0.024	0.4202	0.1338

Table 1- Continues

	1/3	4	0.0765	1.0429	0.355
		6	0.0765	0.7613	0.2451
		8	0.044	0.5993	0.1904
		10	0.0358	0.494	0.157
		12	0.0299	0.4202	0.1339
	1/5	4	0.0996	1.0438	0.3781
		6	0.0699	0.7613	0.2512
		8	0.0529	0.5993	0.1919
		10	0.0421	0.494	0.1573
		12	0.0347	0.4202	0.1339

Table 2 Parametric Values of Bayesian Skip Lot Sampling Plan 2 (BSkSP- 2)

s =1	f	i	$n\mu_1$	$n\mu_2$	$n\mu_0$	μ_2/μ_1	μ_0/μ_1
	2/3	4	0.0481	3.3104	0.4374	68.8233	9.0936
		6	0.0374	2.4426	0.3147	65.3102	8.4144
		8	0.0303	1.9339	0.2483	63.8251	8.1947
		10	0.0253	1.6002	0.2057	63.2490	8.1304
		12	0.0217	1.3645	0.1757	62.8802	8.0968
	1/2	4	0.0578	3.312	0.4557	57.3010	7.8841
		6	0.0436	2.4426	0.3185	56.0229	7.3050
		8	0.0346	1.934	0.2491	55.8960	7.1994
		10	0.0285	1.6002	0.2059	56.1474	7.2246
		12	0.0241	1.3645	0.1758	56.6183	7.2946
	1/3	4	0.0739	3.3216	0.5342	44.9472	7.2287
		6	0.0534	2.4426	0.3374	45.7416	6.3184
		8	0.0412	1.934	0.2535	46.9417	6.1529
		10	0.0332	1.6002	0.2069	48.1988	6.2319
		12	0.0276	1.3645	0.176	49.4384	6.3768
	1/5	4	0.0984	3.3216	0.5342	33.7561	5.4289
		6	0.0676	2.4426	0.3374	36.1331	4.9911
		8	0.0504	1.934	0.2535	38.3730	5.0298
		10	0.0396	1.6002	0.2069	40.4091	5.2247
		12	0.0324	1.3645	0.176	42.1142	5.4321
s = 2	**f**	**i**	$n\mu_1$	$n\mu_2$	$n\mu_0$	μ_2/μ_1	μ_0/μ_1
	2/3	4	0.0171	0.994	0.2019	58.1287	11.8070
		6	0.0122	0.727	0.1434	59.5902	11.7541
		8	0.0094	0.5729	0.1122	60.9468	11.9362
		10	0.0075	0.4726	0.0925	63.0133	12.3333
		12	0.0063	0.4021	0.0788	63.8254	12.5079
	1/2	4	0.0213	0.9943	0.2098	46.6808	9.8498
		6	0.0148	0.727	0.1451	49.1216	9.8041
		8	0.0112	0.5729	0.1126	51.1518	10.0536
		10	0.0088	0.4726	0.0926	53.7045	10.5227
		12	0.0073	0.4021	0.0788	55.0822	10.7945
	1/3	4	0.0288	0.9949	0.223	34.5451	7.7431
		6	0.0192	0.727	0.1481	37.8646	7.7135
		8	0.0141	0.5729	0.1133	40.6312	8.0355
		10	0.0109	0.4726	0.0928	43.3578	8.5138
		12	0.0088	0.4021	0.0789	45.6932	8.9659
	1/5	4	0.0406	0.9962	0.2429	24.5369	5.9828
		6	0.0259	0.727	0.1532	28.0695	5.9151
		8	0.0183	0.5729	0.1145	31.3060	6.2568
		10	0.0138	0.4726	0.0931	34.2464	6.7464
		12	0.0109	0.4021	0.0789	36.8899	7.2385
s = 3	**f**	**i**	$n\mu_1$	$n\mu_2$	$n\mu_0$	μ_2/μ_1	μ_0/μ_1
	2/3	4	0.0503	1.1752	0.3398	23.3638	6.7555
		6	0.0398	0.8597	0.2464	21.6005	6.1910
		8	0.0326	0.6773	0.1946	20.7761	5.9693
		10	0.0275	0.5586	0.1612	20.3127	5.8618
		12	0.0236	0.4753	0.1377	20.1398	5.8347
	1/2	4	0.0602	1.1755	0.3501	19.5266	5.8156
		6	0.0461	0.8597	0.2486	18.6486	5.3926
		8	0.03698	0.6773	0.1951	18.3153	5.2758
		10	0.0307	0.5586	0.1613	18.1954	5.2541
		12	0.0261	0.4753	0.1317	18.2107	5.0460
	1/3	4	0.076	1.1761	0.3669	15.4750	4.8276
		6	0.0559	0.8597	0.2525	15.3792	4.5170
		8	0.0436	0.6773	0.196	15.5344	4.4954
		10	0.0354	0.5586	0.1615	15.7797	4.5621
		12	0.0296	0.4753	0.1377	16.0574	4.6520

	1/5	4	0.0992	1.1773	0.3921	11.8679	3.9526
		6	0.0695	0.8597	0.2591	12.3698	3.7281
		8	0.0525	0.6773	0.1976	12.9010	3.7638
		10	0.0417	0.5586	0.1619	13.3957	3.8825
		12	0.0343	0.4753	0.1378	13.8571	4.0175
s = 4	**f**	**i**	**$n\mu_1$**	**$n\mu_2$**	**$n\mu_0$**	**μ_2/μ_1**	**μ_0/μ_1**
	2/3	4	0.0507	1.0422	0.3299	20.5562	6.5069
		6	0.0403	0.7613	0.2395	18.8908	5.9429
		8	0.033	0.5993	0.1892	18.1606	5.7333
		10	0.0278	0.494	0.1567	17.7698	5.6367
		12	0.024	0.4202	0.1338	17.5083	5.5750
	1/2	4	0.0606	1.044	0.3394	17.2277	5.6007
		6	0.0466	0.7613	0.2415	16.3369	5.1824
		8	0.0374	0.5993	0.1896	16.0241	5.0695
		10	0.0311	0.494	0.1568	15.8842	5.0418
		12	0.0264	0.4202	0.1338	15.9167	5.0682
	1/3	4	0.0765	1.0429	0.355	13.6327	4.6405
		6	0.0765	0.7613	0.2451	9.9516	3.2039
		8	0.044	0.5993	0.1904	13.6205	4.3273
		10	0.0358	0.494	0.157	13.7989	4.3855
		12	0.0299	0.4202	0.1339	14.0535	4.4783
	1/5	4	0.0996	1.0438	0.3781	10.4799	3.7962
		6	0.0699	0.7613	0.2512	10.8913	3.5937
		8	0.0529	0.5993	0.1919	11.3289	3.6276
		10	0.0421	0.494	0.1573	11.7340	3.7363
		12	0.0347	0.4202	0.1339	12.1095	3.8588

Example: 2

For s = 2, f = 2/3, i = 4 and of $\overline{P}$ = 0.10, the value of $n\mu_2$ = 0.994 . For s = 2 and different values of f and i (f = 1/2, 1/3, 1/4 & 1/5 and i = 6,8,10,12) using Newton's Method of approximation, the $n\mu_1$, $n\mu_2$ & $n\mu_0$ values are tabulated in table 2.

CONCLUSION

The Bayesian sampling Plan is the one of the best techniques to evaluate quality. This paper is related to Bayesian Skip lot Sampling Plan (BSkSP-2) and its various parameters with Gamma distribution as the prior distribution. This plan will be more useful to the quality control practitioner to meet out the consumer requirements.

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