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Original Article

Optimal Designing of Quick Switching System with Repetitive Deferred Sampling Plan -2 as Reference plan

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Abstract *- This Paper enlarges the concept of Optimal Designing of Quick Switching System with Repetitive Deferred Sampling Plan-2 as the reference plan. The designing parameters are determined so as to minimize the specified average sample number and producers and the consumer's risks are satisfied. Necessary tables and certain illustration are also presented for the QSSRDS-2.*

Keyword *- Acceptance Sampling Plan, Average sample number, Producer's and consumer's risk, Quick switching system, Repetitive Deferred Sampling Plan, Optimal design.*

1. Introduction

Acceptance sampling plan have been widely used in industry to determine whether the manufactured item satisfy the pre-specified quality levels or not. At this point, an enterprise must have to take a decision for accepting or rejecting the lots in accordance with randomly chosen units. Quick Switching System plays a dual role with normal and tightened level for the sample size and acceptance number. Here pair of sampling plans was chosen and switching between normal and tightened so this system named as Quick Switching System is a procedure used to accept or reject the lots in the acceptance sampling Dodge proposed a new sampling inspection system called "Quick Switching System (QSS-1)". It is operated as follows:

1. Adopt a normal plan (N) and a tightened plan (T), where plan T has a tighter OC Curve than plan N.
2. Use plan N for the first lot. It is also possible to start with plan T when addition protection in the first lot production is desired. The OC curve properties are the same for the both plans.
3. For each is lot inspected; if the lot is accepted, then use plan N for the next lot; and if the lot is rejected, then use plan T for the next lot.

Rombaski studied the QSS-1 with single sampling plan as a reference plan. After comparing the switching rules of many systems, Rombaski made certain modifications on the switching rules of QSS-1. The resulting systems are QSS-2 and QSS-3. These systems are having an operating characteristic curve (OC) which is more discriminating than the corresponding OC curves of normal and tightened plans. Also the sample size required for QSS is much lower than any comparable equivalent sampling plan and system.

2. Literature review quick switching system with repetitive deferred sampling plan

This section deals with the review on Repetitive Deferred Sampling (RDS) plan developed by RambertVaerst (1980).The RDS plan has been developed by Sankar and Mahopatra (1991) and it is an extension of the Multiple Deferred Sampling plan .MDS - (c_1, c_2) due to RambertVaerst. In this plan the acceptance or rejection of a lot in deferred state is dependent on the inspection results of the preceding or succeeding lots under Repetitive Group Sampling (RGS) inspection. So, RGS is the particular case of RDS plan.

Lilly Christina (1995) designed the procedure for selection of RDS plan with given quality levels of sampling plan and also compared RDS plan with RGS plan with respect to operating ratio (OR) and ASN curve. Suresh and Jayalakshmi (2005) have studied repetitive deferred sampling plan for given acceptable and limiting quality Levels. Suresh and Sangeetha (2010) developed designing procedure of quality interval for repetitive deferred sampling plan indexed through quality regions method of sampling plan using poisson distribution. Suresh and Saminathan (2010) constructed the tables for repetitive deferred sampling plan through quality levels, which follows the conditions associated with sampling from an infinite universe based on the perception of a process producing theoretically continuous infinite product flow of inspection sampling plan. Kalaiselvi (2012) studied skip-lot sampling plan of type-2 with RDS plan as reference plan indexed with slope on the OC curve and found minimum angle for fixed set of producer and consumer risks of sampling plan under poisson distribution.

In this paper a new produce for designing Optimal Designing of Quick Switching System Repetitive Deferred Sampling Plan. Aslam M ,Balamurali S ,Ahmad M (2010) Optimal designing of a skip lot sampling of a skip lot sampling plan by two point method. Hsu presented a model involving stochastic and cost components to obtain an optimal skip-lot sampling plan. Hence, the suitable combination of the design parameters can be determined such that it provides minimum ASN than the other combination of sampling plans. According to many authors including Balamurali we can minimize the ASN at the AQL as well as at the LQL. But the selection of the design parameters by minimizing the ASN at the LQL is preferred because sample sizes at first and second stages are larger at LQL than AQL.The optimal parameters are determined such that both the producer and consumer risks are satisfied with minimum sample size.

2.1. The condition for application of Quick Switching System

- The production is steady so that results on current and preceding lots are broadly . Indicative of a continuing process and submitted lots are expected to be essentially of same quality.
- Lots are submitted substantially in his order of production.
- Inspection by attributes is considered with quality defined as fraction non-conforming ‘p’

3. Operating Procedure

- Under the normal inspection, inspect using the RDS as reference plan with Parameter $n, u_1$and u_2. If a lot is accepted, continue with normal inspection. If a lot is rejected. Go to step 2
- Inspect under tightened inspection using the RDS as reference plan with sample Size ‘n’ and acceptance number v_1 and v_2 . If a lot is accepted, use step 1 for the next lot , otherwise continue step 2. The expression for QSRDSS is

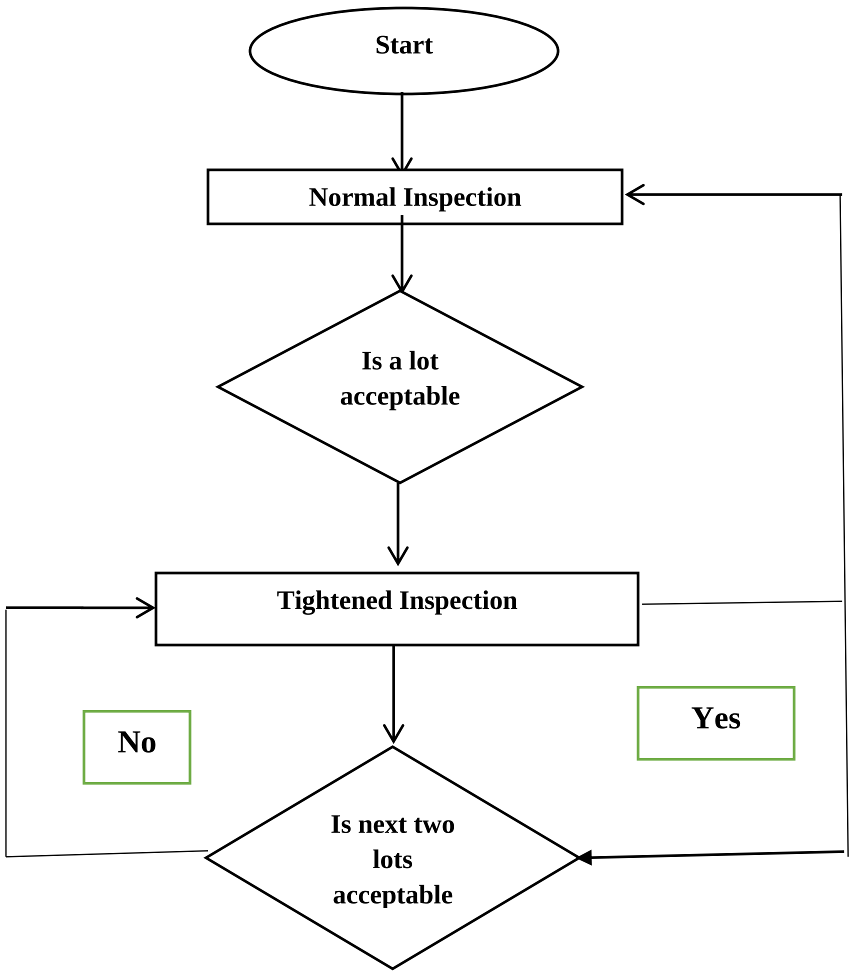

Fig. 1 Operating procedure for QSS-2

4. Designing of quick switching system repetitive deferred sampling plan

AQL is denoting by $p_1$and the LQL is denoted byp_2. Based on the principal of two points on the OC curve, the designing methodology of the QSRDSS -2 plan

Romboski (1965) and Sankar and Mahopatra (1991), the expression for OC function of QSRDSS is given by.

$$P_a(p) = \frac{P_N P_T^2 + P_T(1-P_N)(1+P_T)}{P_T^2 + (1-P_N)(1+P_T)} \quad (1)$$

Where $P_a(p)$ is the probability of acceptance of a lot under QSS sampling system and $p$is the acceptance probability under the RDS plan which is given by

$$P(d \le c_N; n) = \frac{P_a(1-P_c)^i + P_c P_a^i}{(1-P_c)} \quad (2)$$

Where $p_a = p[d \le u_1]$and $P_c = P[u_1 < d < u_2]$

$$P(d \le c_T; n) = \frac{P_a(1-P_c)^i + P_c P_a^i}{(1-P_c)} \quad (3)$$

Where $p_a = P[d \le v_1]$ and $P_c = p[v_1 < d < v_2]$

Where $P_a = (d \le c_1) = \sum_{x=0}^{c_1} \frac{e^{-x} x^r}{r!}$

and$P_c = p(c_1 < d < c_2) = \sum_{r=0}^{c_2} \frac{e^{-x} x^r}{r!} - \sum_{r=0}^{c_1} \frac{e^{-x} x^r}{r!}$

also$x = np$ (4)

Under AQL (p_1) and LQL (p_2) conditions respectively in above equation can be written as

$$p_1 = p(d \le c_N; n) = \frac{P_a(1-P_c)^i + P_c P_a^i}{(1-P_c)} \quad (5)$$

$$p_2 = p(d \le c_T; n) = \frac{P_a(1-P_c)^i + P_c P_a^i}{(1-P_c)} \quad (6)$$

To design parameters of the QSRDSS plan can be determined such that the following inequalities should be satisfied .

$$P_a(p_1) \ge 1 - \alpha$$

$$P_a(p_2) \le \beta \quad (7)$$

Similarly under the conditions of AQL and LQL the parameters of a QSRDSS plan namely $n, u_1, u_2, v_1, v_2, i.$ will be determined. Such that the following inequalities are satisfied.

$$P_a(p) = \frac{P_N P_T^2 + P_T(1-P_N)(1+P_T)}{P_T^2 + (1-P_N)(1+P_T)} \ge 1 - \alpha \quad (8)$$

$$P_a(p) = \frac{P_N P_T^2 + P_T(1-P_N)(1+P_T)}{P_T^2 + (1-P_N)(1+P_T)} \le \beta \quad (9)$$

Where P_N and $P_T$are obtained by using equation respectively. There may exist many combinations of the design parameters of the QSRDSS -1 plan for specified requirements. Therefore we will use the average sample number as the criterion to select the suitable combination of the design parameters.

There may exist many combinations of the design parameters of the QSRDSS plan for specified requirements. Therefore, we will use the average sample number (ASN) as the criterion to select the suitable combination of the design parameters. ASN is defined as "the average number of sample units per lot used for making decision (acceptance or non-acceptance)". Hence, the suitable combination of the design parameters can be determined such that it provides minimum ASN than the other combination of sampling plans.

To design the proposed Quick Switching Repetitive Deferred Sampling System-1$n, u_1, u_2, v_1, v_2, i.$ with the intention of minimizing the Average Sample Number (ASN) at both AQL and LQL. The parameters are determined such that both the producer and consumer risks are satisfied with minimum sample size using the optimization in order to determine to optimal parameters the following

Minimize $\frac{1}{2}[ASN(p_1) + ASN(p_2)]$

Subject to $P_a(p_1) \geq 1 - \alpha$

$$P_a(p_2) \leq \beta \quad (10)$$

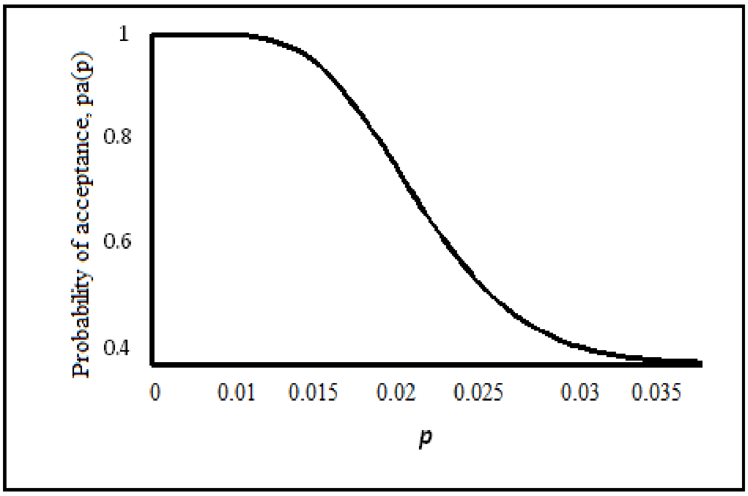

Fig. 2 OC Curve for QSRDSS-2 (71,(0.5),(0.1),1)

Figure 1.Shows the OC curve for optimal sample size with different values of ‘p’. As ‘p’ value increases, the probability of acceptance decreases. For small values of p the plan has more chance of being accepted.

Example

Table 1 can be used to select the optimal parameters of QSRDSS -2 plan for specified AQL $(= p_1)$ and LQL $(= p_2)$ with $\alpha = 5$ % and $\beta = 10$ % .Suppose one wants to determine parameters of QSSDSS -2 plan according to the conditions given thatp_1 =0.001 ,p_2 =0.021 ,α =0.05 ,β =0.10. From table 5.5.1 we obtain the optimal parameters as $u_1 = 0, u_2 = 5, v_1 = 0, v_2 = 1, i = 1, n = 71$corresponding to the above-mentioned AQL, and LQL conditions. Average Sample Number of proposed sampling plan is 10 which is minimum. Based on these parameters. QSRDSS -2 plans is operated as follows

Step1: In Quick Switching System, start with normal inspection using Repetitive Deferred SamplingPlan as reference plan of taking a sample size n, until a rejection occurs specified by acceptance number c_N.

Step 2: If $d \geq c_N$lot is reject, switch to tightened inspection using Repetitive Deferred SamplingPlan specified by the acceptance number $c_T(< c_N)$ and continue until two lots are accepted.

Step 3: If two lots are accepted under the condition $D \leq c_T$ in tightened inspection, go to normal inspection and the process is repeated as uttered.

Construction of Table

Based on the assumption of poisson model the expression for the OC curves of QSRDSS-2 are defined by Romboski (1965) and Sankar and Mahopatra (1991), as

$$P_a(p) = \frac{P_N P_T^2 + P_T(1-P_N)(1+P_T)}{P_T^2 + (1-P_N)(1+P_T)} \qquad P_a(p) = \frac{P(d \leq C_T; n)}{1 - p(d \leq C_N; n) + p(d \leq C_T; n)}$$

$$P_N = \frac{P_a(1-P_c)^i + P_c P_a^i}{(1-P_c)}$$

$$P_T = \frac{P_a(1-P_c)^i + P_c P_a^i}{(1-P_c)}$$

Where

$P_a = P(d \leq u_1)$; $P_a = P(d \leq v_1)$

$P_c = P(u_1 < d < u_2)$; $P_c = P(v_1 < d < v_2)$

For various assumed values of P_1, P_2in equation (10) obtain the several of $u_1, u_2, v_1, v_2$and$P_a(p)$.The equation (1) is solved for np using iteration technique .In order to determine the optimal parameters;the following condition can be used

Minimize $\frac{1}{2}[ASN(p_1) + ASN(p_2)]$

For the various values ofn, u_1, u_2, v_1, v_2, i. Calculate Average Sample Number (ASN) equation (10)satisfying the condition.

5. Conclusion

In this paper deals with the Optimal Designing of Quick Switching System Repetitive Deferred Sampling Plan-2 as reference plan and sampling system have been design minimizing the average ASN at both AQL and LQL. The optimal parameters are determined such that both the producer and consumer risks are satisfied with minimum sample size.

Table 1. certain parametric value of Quick Switching Repetitive Deferred Sampling System- 2

p_1	P_2	u_1	u_2	v_1	v_2	i	n	ASN	$(1-\alpha)\%$	$\beta\%$
0.01	0.100	0	1	0	0	1	1134	1136	0.9801	0.090609
0.01	0.012	0	0	0	0	1	73	76	0.9800	0.089855
0.01	0.013	0	2	0	1	1	1585	1588	0.9909	0.091738
0.01	0.200	0	3	0	2	1	923	926	0.9905	0.028498
0.01	0.210	0	4	0	3	1	80	85	0.9808	0.092537
0.001	0.021	0	5	0	1	1	71	72	0.9708	0.093521
0.001	0.0231	0	6	0	2	1	141	143	0.9701	0.094795
0.001	0.0421	1	4	0	3	1	155	156	0.9805	0.092438
0.001	0.0321	1	5	0	4	1	175	176	0.9900	0.089213
0.001	0.010	1	6	0	5	1	134	136	0.9700	0.091269
0.001	0.0210	2	2	1	1	1	1225	1226	0.9900	0.091145
0.001	0.100	2	3	1	2	1	733	735	0.9800	0.07689
0.001	0.023	2	4	1	3	1	188	189	0.9607	0.09045
0.001	0.013	1	5	1	4	1	2554	2559	0.9803	0.092318
0.001	0.0214	1	6	1	5	1	1394	1398	0.9705	0.078645
0.002	0.0120	3	3	1	2	1	365	377	0.9806	0.090334
0.002	0.200	3	4	2	3	1	419	450	0.9702	0.089811
0.002	0.1230	0	3	2	4	1	192	230	0.9802	0.09216
0.002	0.0230	0	4	2	5	1	339	360	0.9800	0.093606
0.002	0.0210	2	7	2	6	1	50	90	0.9732	0.093126
0.002	0.0201	2	3	3	3	1	161	180	0.98056	0.087114
0.03	0.0231	2	5	3	4	1	1478	1490	0.9802	0.094792
0.03	0.0210	3	6	3	5	1	1496	1500	0.9905	0.078696

p_1	p_2	u_1	u_2	v_1	v_2	i	n	ASN	$(1-\alpha)\%$	$\beta\%$
0.03	0.100	2	7	3	3	1	30	50	0.9611	0.08983
0.03	0.0210	0	1	0	0	2	105	117	0.9800	0.090274
0.03	0.0210	0	0	0	0	2	67	80	0.9901	0.094172
0.003	0.300	0	2	0	1	2	1132	1136	0.9901	0.094639
0.003	0.210	0	1	0	2	2	100	140	0.9905	0.097192
0.003	0.0123	0	3	0	3	2	50	90	0.9659	0.092094
0.003	0.4321	0	2	0	1	2	40	60	0.9800	0.094619
0.003	0.4210	1	2	0	2	2	999	1120	0.9900	0.095274
0.04	0.500	1	4	0	3	2	137	140	0.9799	0.07888
0.04	0.200	1	5	0	4	2	158	164	0.9700	0.090429
0.04	0.300	1	6	0	5	2	178	183	0.9599	0.078046
0.04	0.3210	2	2	0	1	2	1178	1186	0.9706	0.090125
0.04	0.250	2	3	0	2	2	639	800	0.9803	0.089062
0.004	0.500	2	4	1	3	2	169	230	0.9800	0.090614
0.004	0.3210	2	5	1	4	2	372	423	0.9902	0.088954
0.004	0.200	2	6	1	5	2	173	185	0.9900	0.098229
0.004	0.2101	3	3	2	2	2	377	420	0.9801	0.090205
0.004	0.1101	3	4	2	3	2	430	450	0.9900	0.090489
0.01	0.2101	3	6	2	5	2	559	564	0.9805	0.078423
0.01	0.2103	3	7	2	6	2	30	35	0.9817	0.085456
0.01	0.1103	4	4	3	3	2	212	250	0.9801	0.094067
0.01	0.1250	4	5	3	4	2	50	60	0.9711	0.093351
0.01	0.400	4	6	3	5	2	30	66	0.9606	0.094308
0.001	0.2101	4	7	3	6	2	40	86	0.9997	0.091789
0.001	0.1123	4	8	3	7	2	50	75	0.9843	0.078628

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