CONSTRUCTION OF QUICK SWITCHING DOUBLE SAMPLING SYSTEM [QSDSS - 1 (n; k; a_1, a_2)] INDEXED THROUGH QUALITY REGIONS

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Abstract

The Quick Switching Double Sampling System (QSDSS-1) is indexed through Quality Regions in this study. The quality areas employed in this study play an important role in reducing defects and improving quality in the industrial manufacturing process. To support the selection of system indexed by QDR and PQR, specified values for QSDSS-1 are given. LQL/AQL was compared to QDR/PQR. According to the data, QDR/PQR has an improved performance quality level.

Keywords: *Acceptance Sampling Plan, Quick Switching Sampling, Double Sampling plan, AQL, LQL, QDR and PQR.*

Introduction

The Quick Switching System (QSS) is a highly efficient acceptance sampling process. Due to instantaneous switching between normal and tighter plans, Dodge (1967) proposed a novel sampling method named "Quick Switching System" (QSS) for attributes acceptance sampling plan. When a rejection happens under normal inspection, Romboski (1969) has thoroughly given a technique of immediately switching to tighter inspection. When compared to a two-plan system, Romboski (1969) made certain changes and evaluated the advantages and disadvantages of QSS switching rules (m,d). He made several changes to systems QSS-r (n; c_N, c_T) (r=1, 2, 3) based on this research. QSS-2, QSS-3, and QSS-d are the modified systems' identities.

Devaraj Aruminayagam and Soundararajan (1991 and 1993) investigated the QSS with a double sampling plan as a reference plan and gave fundamental tables and processes for selecting a QSDSS indexed by AQL, LQL, and AOQL. Quick switching method combining standard double sampling plan and tighter double sampling plan as reference plan was given by Devaraj Arumainayagam (1995). Suresh and Sangeetha (2011) developed a QIS and investigated the use of Quality Regions in the construction and selection of Bayesian Chain Sampling Plan (BChSP-1). Suresh and Sangeetha (2011) investigated

Bayesian Skip-lot Sampling Plan Selection Using Quality Regions. Suresh and Kaviyarasu (2013) investigated QSS-1, QSS-2, and QSS-3 Quick Switching Systems.

To increase the quality of any product or service, it is common practise in the manufacturing process to update quality methods while reducing the price of inspection and quality improvement. Due to the fast development of manufacturing technology, suppliers demand high-quality goods with very low fraction defects, which are generally measured in parts per minute. To resolve these issues, the Quality Interval Sampling (QIS) strategy was developed.

This study is a continuation of Devaraj Arumainayagam and Soundararajan's (1995) study of the QSDSS-1 system (n; k; a_1; a_2). The values in QDR and PQR are computed based on the work of QSDSS-1. When OR is compared to Quality Region, it is discovered that QDR/PQR is more efficient than LQL/AQL.

Condition for application of Quick Switching System

a) 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 the same quality.

b) Lots are submitted substantially in their order of production.

c) Inspection by attributes is considered with quality defined as fraction nonconforming p.

Using the tightened plan, switch back to the normal plan and continue as before.

Operating Procedure of QSDSS – 1 (n; k; a_l, a_2)

1) Inspect under normal inspection using the double sampling plan with parameters n, k, a_1 and a_2. If a lot is rejected, switch to tightened inspection (step 2).

2) Under tightened inspection, inspect using the double sampling plan with sample sizes kn (k>1) acceptance numbers a_1 and a_2. When r lots in succession are accepted, go to normal inspection (step 1).

Quick sampling double sampling system (QSDSS – 1)

The OC function of QSDSS-1 and QSDSS-3 are given by Soundararajan and Arumainayagam (1995b) as

$$Pa\ (p) = \frac{P_T}{1 - P_N + P_T} \tag{1}$$

Under the assumption of Poisson model,

$$\left.\begin{aligned} P_N &= G(a_1,l_1)+G(a_1,l_2)-\sum_{X_1=a_1+1}^{a_2} g(X_1,l_1),G(a_2-X_1;l_1) \\ P_T &= G(b_1,l_2)+\sum_{X_1=a_1+1}^{a_2} g(X_1,l_2),G(a_2-X_1;l_2) \\ &\text{Where } l_1 = np \text{ and } l_2 = knp \end{aligned}\right\} \quad (2)$$

Designing of QSDSS Indexed through Quality regions of Acceptable and Limiting Quality Levels

In this paper, tables are constructed to design (QSDSS - 1) (n; k; a_1, a_2). The procedures used to design the systems. The systems are explained below:

Designing of Quality Interval

Quality Decision Region (QDR)

It is an interval of quality $(p_1 < p < p_*)$ in which product is accepted at engineer's quality average. The quality is reliably maintained up to p_* (MAPD) and sudden decline in quality is expected. This region is also called Reliable Quality Region (RQR). Quality decision Range is denoted $d_1 = (p_* - p_1)$ is derived from the average probability of acceptance.

Probabilistic Quality Region (PQR)

It is an interval of quality $(p_1 < p < p_2)$ in which product is accepted with a minimum probability 0.10 and maximum probability 0.95. The probability quality region is denoted by $d_2 = (p_2 - p_1)$ is derived from the probability of acceptance.

Specified QDR and PQR

Table 1 is used to make the systems when the QDR and PQR are specified. For any given values of the QDR (d_1) and PQR (d_2), one can find the ratio T = d_1 / d_2 which are a monotonic increasing function. Find the value in Table 1 under the column T which is equal to or just less than the specified ratio. Then the corresponding values of a_1, a_2 b_1, and b_2 are noted. From this, one can determine the parameters a_1, a_2 b_1, and b_2 for the QSDSS-1.

Specified AQL and LQL

Table 1 is used to make the systems when the AQL = p_1 and LQL = p_2 are specified. For any given values of the AQL (p_1) and LQL (p_2), one can find the ratio $T_1= p_2/p_1$ which is a monotonic increasing function. Find the value in Table 1 under the column T_1 which is equal to or just less than the specified ratio. Then the corresponding values of a_1, a_2 b_1, and b_2 are noted. From this, one can determine the parameters a_1, a_2 b_1, and b_2 for the QSDSS-1.

Designing the systems given QDR and PQR

Table 1 is used to design QSDSS–1 (n; k; a_1, a_2) when d_1 and d_2 values are specified. Find the ratio $T=nd_1/nd_2$. In the respective table, under the column headed T, find the value which is equal to or just less than the specified ratio. Locate the corresponding acceptance numbers and nd_1. The sample size is obtained from nd_1/d_1.

Example

In a pencil manufacturing company, 1.5% defects are seen in d_1 and 2% defects are seen in d_2. Hence, T = nd_1 / nd_2 = 0. 75. In Table 2.2.3 the ratio which is equal to or just less than 0.75 is 0.7590, which is associated with k=2.00, a_1=0, a_2=2 nd_1=0.9379. The sample size is determined as $n=nd_1/d_1$= 0.9379 / 0.015 = 62. The designed system is QSDSS-1 (62; 2.00; 0, 2).

Construction of Table 1

In table 1 shows the different np values and operating raio values are taken from QSDSS-1. Based on the previous study, the work is extended and QDR and PQR values are calculated. Finally comparison also made and values are also presented in Table 1.

np_* values for both systems are found solving (using equation 1)

$$\frac{d^2 Pa(p)}{dp^2} = 0 \qquad (3)$$

np_1 and np_2 values for QSDSS-1(n; k; a_1, a_2) are taken from Soundararajan and Arumainayagam (1995b), and np_* values are found using 3 and these values are utilized to determine

nd_1 (QDR) = $np_* - np_1$

nd_2 (PQR) = $np_2 - np_1$ and (4)

$$T = \frac{nd_1}{nd_2} = \frac{np_* - np_1}{np_2 - np_1}$$

nd_1, nd_2 and T values are tabulated in Table 1.

Comparison

In the Table 1 represent the values of QDR/PQR and AQL/LQL of QSDSS – 1 (n; k; a_1, a_2) This table is useful for making comparisons between the values of T and T_1 of QSDSS – 1. From this table, it is observed that the compared (QSDSS - 1) operating ratio values of T = QDR/LQR and T_1=AQL/LQL, T values are provide higher probability of acceptance compared with T_1.

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Table 1: Certain Values of QDR/PQR and LQL/AQL for specified values for QSDSS - 1 (n, k; a_1, a_2)

a_1	a_2	k	np_*	np_1	np_2	nd_1	nd_2	$T=nd_1/nd_2$
5	11	1.50	5.9256	3.5187	3.8313	2.4069	0.3126	7.6991
4	9	1.25	5.6399	2.8546	3.8006	2.7853	0.9460	2.9444
4	8	1.25	5.2150	2.5728	3.6722	2.6422	1.0994	2.4032
5	11	2.50	4.6540	3.0479	4.8048	1.6061	1.7569	0.9142
3	7	2.25	3.1682	1.8832	3.3330	1.2850	1.4498	0.8863
2	6	1.75	2.9886	1.3124	3.3903	1.6763	2.0780	0.8067
5	12	2.50	4.6191	3.2820	4.9548	1.3371	1.6729	0.7993
5	12	2.25	4.8988	3.4098	5.3031	1.4890	1.8934	0.7864
4	8	2.00	3.8819	2.3323	4.3319	1.5496	1.9996	0.7750
5	12	2.00	5.2246	3.5450	5.7320	1.6796	2.1870	0.7680
0	2	2.25	1.2307	0.3926	1.4942	0.8381	1.1016	0.7608
0	2	2.00	1.3386	0.4008	1.6364	0.9379	1.2356	0.7590
2	6	2.50	2.4709	1.4395	2.8307	1.0314	1.3912	0.7414
4	9	2.25	3.9151	2.5162	4.4113	1.3989	1.8951	0.7382
3	7	2.50	2.9724	1.8233	3.4105	1.1491	1.5872	0.7240
3	7	1.75	3.6968	2.0060	4.3853	1.6909	2.3794	0.7106
5	12	1.50	6.0657	3.8178	7.0137	2.2479	3.1959	0.7034
2	6	2.00	2.7899	1.5371	3.3471	1.2528	1.8100	0.6921
4	8	2.50	3.4039	2.2135	3.9942	1.1904	1.7807	0.6685
4	8	1.75	4.2054	2.4384	5.1338	1.7671	2.6955	0.6556
1	4	2.25	1.8243	0.9267	2.3057	0.8976	1.3790	0.6509
1	2	1.50	1.9751	0.5109	2.7684	1.4643	2.2575	0.6486
1	4	2.00	1.9395	0.9519	2.5145	0.9876	1.5626	0.6320
3	6	2.50	2.5344	1.3038	3.2953	1.2306	1.9915	0.6179
3	6	2.25	2.6758	1.3552	3.5498	1.3205	2.1946	0.6017
2	5	2.50	2.0971	1.2329	2.6956	0.8642	1.4627	0.5908
0	1	2.50	0.5356	0.0841	0.8681	0.4515	0.7840	0.5758
1	4	1.50	2.2205	0.9998	3.1375	1.2207	2.1377	0.5710
2	5	2.00	2.3554	1.3056	3.1629	1.0498	1.8573	0.5652
2	5	1.75	2.5147	1.3418	3.4933	1.1729	2.1516	0.5451
3	6	2.00	2.8386	1.7049	3.8341	1.1337	2.1293	0.5324
1	3	2.50	1.3369	0.6728	1.9564	0.6641	1.2836	0.5174
3	6	1.75	3.0270	1.7514	4.2332	1.2756	2.4818	0.5140
0	2	1.50	1.2405	0.4164	2.0589	0.8241	1.6425	0.5017
2	4	2.50	1.7960	1.0198	2.5837	0.7763	1.5639	0.4964
1	3	2.00	1.4912	0.7055	2.3107	0.7857	1.6052	0.4895

3	6	1.50	3.2439	1.8007	4.8043	1.4432	3.0036	0.4805
2	5	1.25	2.8916	1.4053	4.5648	1.4863	3.1595	0.4704
1	3	1.75	1.5829	0.7216	2.5611	0.8613	1.8395	0.4682
2	4	1.75	2.1239	1.1001	3.3745	1.0238	2.2744	0.4501
1	3	1.50	1.6822	0.7368	2.8953	0.9455	2.1585	0.4380
2	4	1.50	2.2604	1.1252	3.8118	1.1352	2.6867	0.4225
1	2	2.50	1.0348	0.4729	1.8471	0.5619	1.3742	0.4089
1	3	1.25	1.7765	0.7503	3.3679	1.0262	2.6176	0.3920
2	4	1.25	2.3971	1.1473	4.4312	1.2498	3.2839	0.3806
1	2	2.00	1.1346	0.4922	2.1954	0.6424	1.7032	0.3772
1	2	1.75	1.1888	0.5017	2.4414	0.6871	1.9396	0.3542
0	1	2.25	0.5567	0.1917	1.2608	0.3650	1.0691	0.3414
0	1	2.00	0.5778	0.1948	1.3844	0.3830	1.1896	0.3220
0	1	1.75	0.5970	0.1979	1.5422	0.3990	1.3443	0.2968
0	1	1.50	0.6092	0.2010	1.7516	0.4083	1.5506	0.2633
0	1	1.25	0.6037	0.2039	2.0454	0.3998	1.8415	0.2171