International Journal of Advanced Science and Technology
Vol. 29, No. 7s, (2020), pp. 4450 - 4457

Construction Quick Switching Repetitive Group Sampling Plan Indexed through Quality Decision Region (QSSRGS-1) (n, kn, c_0)

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Abstract

This paper enlarges the concept of Quick Switching System and Repetitive Group Sampling Plan in to a new procedure for Quick Switching System with Repetitive Group Sampling Plan as reference plan indexed through Acceptable Quality Level (AQL), Limiting Quality Level (LQL), Indifference Quality Level (IQL) Necessary tables and certain illustrations are also presented for the plan.

Keywords

Repetitive Group Sapling Plan (RGS), Quality Decision Region (QDR), Probabilistic Quality Region (PQR)

Introduction

Acceptance sampling uses statistical sampling to justify whether to accept or reject a production lot of material. It has been a general quality control technique used in industry and involves both the producer's and the consumer's risk. Acceptance sampling technique consists of different Sampling Plans and it is mainly developed for the protection of both producer and consumer for less the producer's and consumer's risk. Quick switching system for acceptance sampling consists of two sampling procedures plus a set of rules for switching between them. The first sampling procedure is reduced inspection. It requires a relatively low sample size and is used during periods of good quality. The second sampling procedure is tightened inspection. It uses a higher sample size when defects are encountered.

A new two-plan sampling system was introduced by Dodge (1967) involving normal and tightened inspection, followed by Romboski (1969) who proposed Quick Switching System(QSS), that involves instantaneous switching from normal to tightened inspection when the rejection comes under normal inspection.

Repetitive Group Sampling Plan

Soundararajan and Aruminayagam (1988) constructed tables for the selection of QSS of type QSS-1(n, c_N, c_T) and QSS-1 (n, kn, c_0) and formed tables and presented certain procedures Suresh (1993) studied the Quick Switching System of type QSS-1(n, c_N, c_T) and (n, kn, c_0) with Single sampling plan as Reference plan. Deepa (2003) investigated the Quick Switching System of type QSS-1(n, c_N, c_T) and (n, kn, c_0) with Special Type Double Sampling as Reference plan.

Jayalakshmi (2009) Quick Switching System-2, 3 (n, c_N, c_T) and (n, kn, c_0) with Special Type Double Sampling (STDS) plan, Quick Switching System -1, 2 and 3(n, c_N, c_T) and (n, kn, c_0) with Repetitive Deferred Sampling (RDS) plan and Quick switching System -1, 2 and 3 (n, c_N, c_T) and (n, kn, c_0) with Multiple Deferred Sampling (MDS) plan as reference plan.

Suresh and Kaviyarasu (2008) studied QSS-1 with Conditional Repetitive Group sampling plan as reference plans indexed through various quality limits.

Nick for Application

1. The production is steady so that results on current and preceding lots are broadly indicative of a continuing process.
2. Lots are submitted substantially in the order of their production.
3. The inspection involves costly or destructive normally tests such that normally only a small number of tests per lot can be justified.

Operating Protocol

For a lot, take a random sample of size ‘n’ at the normal level. Count th number of defectives 1

1. If $d \leq c_0$ accept the lot and repeat step 1.

2. If $d > c_0$, reject the lot and go to step 2. From the next lot, take a random sample of size ‘kn’

at the tightened level.

Count the number of defectives ‘D’.
1. If $D \leq c_0$, accept the lot and use step l
2. If $D > c_0$, reject the lot and repeat step 2.

Operating Characteristics function

RGS plan can be studied from its operating characteristics curve according to Sherman (1965) the OC function of an RGS plan -2 (n, kn, c_0) defined by

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

$$P_T = \sum_{X=0}^{c_0} \frac{e^{-knp}(knp)^x}{x!}$$

$$P_N = 1 - \sum_{x=0}^{c_0} \frac{e^{-np}(np)^x}{x!}$$

$$P_a(p) = \frac{1-\sum_{x=0}^{c_0}\frac{e^{-np}(np)^x}{x!}\left(\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x}{x!}\right)+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)}{x!}\left(1-\left(1-\sum_{x=0}^{c_0}\frac{e^{-np}(np}{x!}\right)^x\right)\left(1+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x}{x!}\right)}{\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x 2}{x!}+\left(1-\left(1-\sum_{x=0}^{c_0}\frac{e^{-np}(np)^x}{x!}\right)\right)+\left(1+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)}{x!}\right)}$$

1. Quality Decision Region (QDR)

It is an interval of quality ($p_1 < p < p^*$) in which product is accepted at enginer'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 as $d_1 = (p^* - p_1)$ is derived from probability of acceptance

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

$$P_a(p) = \frac{1-\sum_{x=0}^{c_0}\frac{e^{-np}(np)^x}{x!}\left(\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x}{x!}\right)+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)}{x!}\left(1-\left(1-\sum_{x=0}^{c_0}\frac{e^{-np}(np}{x!}\right)^x\right)\left(1+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x}{x!}\right)}{\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x 2}{x!}+\left(1-\left(1-\sum_{x=0}^{c_0}\frac{e^{-np}(np)^x}{x!}\right)\right)+\left(1+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)}{x!}\right)}$$

2.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 Probabilistic Quality Range denoted as $d_2 = (P_2 - P_1)$ is derived from probability of acceptance

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

$$P_a(p) = \frac{1-\sum_{x=0}^{c_0}\frac{e^{-np}(np)^x}{x!}\left(\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x}{x!}\right)+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)}{x!}\left(1-\left(1-\sum_{x=0}^{c_0}\frac{e^{-np}(np}{x!}\right)^x\right)\left(1+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x}{x!}\right)}{\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)^x 2}{x!}+\left(1-\left(1-\sum_{x=0}^{c_0}\frac{e^{-np}(np)^x}{x!}\right)\right)+\left(1+\sum_{x=0}^{c_0}\frac{e^{-knp}(knp)}{x!}\right)}$$

For specified QDR and PQR

Table - 2 is used for the selection of the plans in which the Quality Decision Region (QDR) and Probabilistic Quality Region (PQR) levels are identified. By fixing the values of (d_1) and PQR d_0 (d_2) , one can find the ratio $T = d_1/d_2$ which is a monotonic increasing function find the value in **Table -2** under the column T which is equal to or just less than the specified ratio. Then the corresponding values of a_1, a_2 and k is noted. From this, one can determine the parameters a_1, a_2 and k for the Repetitive Group Sampling Plan -2 (n, kn, c_0) .

Example

For a biscuit company 6% chocolate biscuits defects are seen in QDR and 9% defects are seen in PQR. Then $d_1 = 0.06$ and $d_2 = 0.09$, $T = d_1/d_2 = \frac{0.06}{0.09} = 0.66$ .Select values of T equal or just less then this ration using **Table -2** .The values of T is 0.66 which is associate with $a_1 = 9$, $a_2 = 4$ and $k = 4.75$ also $nd_1 = 1.5117$, $nd_2 = 2.2746$ corresponding to $a_1 = 9$ and $a_2 = 4$ .Thus n is calculated .The parameters for Repetitive Group Sampling Plan -2 Repetitive Group Sampling Plan -2 (n, kn, c_0) (25,4.75,9,4)

Illustration ($\alpha = 0.05, \beta = 0.10$)

A Car manufacturing company produces Bike Car at 1% defects in AQL and 2% defects in LQL, for the given P_1 = 0.03, P_2 = 0.06, first calculate the operating ratio $R = P_2/P_1$ AQL/LQL =2 from Table-3 one can find the values of R nearest to the Operating ratio, which is $R = 2.1676$. Which is associate with $a_1 = 2$, $a_1 = 1$, $k = 3.75$ also $np_1 = 0.984, np_2 = 2.9843$ Corresponding to $a_1 = 2$, $a_1 = 1$, $k = 3.75$.Thus n is calculated the parameters for Repetitive Group Sampling Plan -2 (n, kn, c_0) (33,3.75,2,1)

CONCLUSION

The main objective of this article is to develop Repetitive Group Sampling Plan -2 (n, kn, c_0) This approach help minimize the sample size and both risks .Quality Interval Sampling (QIS) plan possesses wider potential applicability in industry ensuring higher standard of quality attainment for product or process. Thus Quality Interval Sampling (QIS) plan is a good measure for defining quality and designing any acceptance sampling plan which are readymade use to industrial shop-floor situations.

Table 1 values of np for Quick Switching System -2 (n, kn, c_0)) Plan with Repetitive Group Sampling Plan -2

C_0		Probability of Acceptance								
a_1	a_2	k	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
0	1	2.75	0.0047	0.022	0.0474	0.1287	1.7543	0.723	1.6156	1.9820	1.9820
1	2	3.00	1.3300	0.023	1.3479	1.3842	2.7843	1.668	2.6156	1.7055	1.7055
2	1	3.75	1.9835	0.984	1.9851	1.9888	2.133	2.033	2.133	1.9995	1.9995
2	3	4.75	1.9833	0.838	1.9765	1.9836	2.4532	2.056	2.9843	3.0234	3.0234
3	1	3.75	0.0018	1.023	1.0237	4.2537	4.4532	4.255	4.2542	4.0213	4.0213
3	2	4.75	0.9195	0.923	0.9235	0.9314	4.6096	4.509	4.5097	4.5097	4.5097
4	1	2.75	0.0046	0.656	0.0456	0.1235	3.0234	2.148	2.8823	3.3166	3.3166
4	2	3.00	0.0049	0.702	0.0436	0.1118	2.6293	1.960	2.0345	3.0419	3.0419
5	1	2.75	0.0046	0.022	0.0456	0.1231	4.2938	2.563	3.3537	3.2312	3.2312
5	3	4.25	0.0047	0.021	0.0391	0.0940	3.2735	1.592	2.1534	2.9546	2.9546
6	1	3.75	0.0049	0.022	0.0415	0.1072	3.5708	2.183	2.7954	0.03154	0.0315
6	3	4.25	0.0048	0.021	0.0390	3.9412	3.2662	1.856	2.4489	0.0277	0.0277
7	1	2.75	0.0050	0.022	0.0456	0.1234	3.0489	3.374	4.2569	4.5993	4.5993
7	4	3.75	0.0050	0.021	0.0406	0.0985	4.2569	2.378	3.0988	3.1036	3.1036
8	2	4.5	0.0051	0.021	0.0383	0.0922	3.2034	2.286	2.8693	3.2038	3.2038
8	3	5.00	0.0115	0.021	0.0012	1.5300	2.4534	1.745	2.2035	3.0234	3.0234
9	1	2.75	0.0231	0.023	0.9876	1.0234	2.0532	2.034	1.5023	3.4523	3.4523
9	3	4.75	0.0231	0.027	0.9876	1.2342	3.0234	2.303	2.3024	3.0234	3.0234
10	1	2.75	0.0243	0.009	0.9564	1.2034	2.0557	2.304	1.203	3.456	3.456

Table 2.Certain Values of QDR,PQR,, and Operating Characteristics ratio for Specified values of $(n, kn, c_0))$

a_1	a_2	k	nd_1	nd_2	nd_3	nd_0	QDR (d_1)	PQR (d_2)	$T = {}^{d_1}/_{d_2}$
0	1	2.75	0.87715	1.5936	0.71645	1.7323	0.87715	1.5936	0.5504
1	2	3.00	1.39215	2.5922	1.20005	2.7609	1.39215	2.5922	0.5370
2	3	3.75	1.0665	1.149	0.0825	1.149	1.0665	1.149	0.9281
2	1	4.00	1.2266	2.1463	0.9197	1.6152	1.2266	2.1463	0.5714
3	1	3.75	2.2266	3.231	1.0044	3.43	2.2266	3.231	0.6891
3	2	4.75	2.3048	3.5866	1.2818	3.6865	2.3048	3.5866	0.6426
4	1	2.75	1.5117	2.2263	0.7146	2.3674	1.5117	2.2263	0.6790
4	2	3.00	1.31465	1.3319	0.01725	1.9267	1.31465	1.3319	0.9870
5	1	2.75	2.1469	3.3317	1.1848	4.2718	2.1469	3.3317	0.6443
5	3	4.25	1.63675	2.1324	0.49565	3.2525	1.63675	2.1324	0.7675
6	1	3.75	1.7854	2.7734	0.988	3.5488	1.7854	2.7734	0.6437
6	3	4.25	1.6331	2.4279	0.7948	3.2452	1.6331	2.4279	0.6726
7	1	2.75	1.52445	4.2349	2.71045	3.0269	1.52445	4.2349	0.3599
7	4	3.75	2.12845	3.0778	0.94935	4.2359	2.12845	3.0778	0.6915
8	2	4.50	1.6017	2.8483	1.2466	3.1824	1.6017	2.8483	0.5623
8	3	5.00	1.2267	2.1825	0.9558	2.4324	1.2267	2.1825	0.5620
9	1	2.75	1.0266	1.4793	0.4527	2.0302	1.0266	1.4793	0.6939
9	3	4.75	1.5117	2.2746	0.7629	2.9956	1.5117	2.2746	0.6646
10	1	2.75	1.02785	1.1932	0.16535	2.0459	1.02785	1.1932	0.8614

			p_2/p_1				p_2/p_1			
a_1	a_2	k	$\alpha = 0.05$ $\beta = 0.10$ R	$\alpha = 0.05$ $\beta = 0.05$ R_1	$\alpha = 0.05$ $\beta = 0.01$ R_2	np_1 *for* $\alpha = 0.05$	$\alpha = 0.01$ $\beta = 0.10$ R	$\alpha = 0.01$ $\beta = 0.05$ R_1	$\alpha = 0.01$ $\beta = 0.01$ R_2	np_1 *for* $\alpha = 0.01$
0	1	2.75	73.43636	90.09091	79.74091	0.022	343.7447	421.7021	421.702	0.0047
1	2	3.00	113.7217	74.15217	121.0565	0.023	1.966617	1.28233	1.28233	1.3300
2	1	3.75	2.167683	2.032012	2.167683	0.984	1.075372	1.0080	1.00781	1.9835
2	3	4.75	3.561217	3.607876	2.927446	0.838	1.504714	1.524429	1.52442	1.9833
3	1	3.75	4.158553	3.93089	4.353079	1.023	2363.444	2234.056	2234.05	0.0018
3	2	4.75	4.885915	4.885915	4.99415	0.923	4.904513	4.904513	4.90451	0.9195
4	1	2.75	4.39375	5.055793	4.608841	0.656	626.587	721	721	0.0046
4	2	3.00	2.898148	4.333191	3.745442	0.702	415.2041	620.7959	620.795	0.0049
5	1	2.75	152.4409	146.8727	195.1727	0.022	729.0652	702.4348	702.434	0.0046
5	3	4.25	102.5429	140.6952	155.881	0.021	458.1702	628.6383	628.638	0.0047
6	1	3.75	127.0636	1.431818	162.3091	0.022	570.4898	6.428571	6.42857	0.0049
6	3	4.25	116.6143	1.319048	155.5333	0.021	510.1875	5.770833	5.77083	0.0048
7	1	2.75	193.4955	209.0591	138.5864	0.022	851.38	919.86	919.86	0.0050
8	2	4.5	147.5619	147.7905	202.7095	0.021	619.76	620.72	620.72	0.0051
8	3	5.00	136.6381	152.5619	143.9714	0.021	562.6275	628.1961	628.196	0.0115
9	1	2.75	104.9286	143.9714	116.8286	0.023	191.6087	262.9043	262.904	0.0231
9	3	4.75	65.31739	150.1	89.26957	0.027	65.03463	149.4502	149.450	0.0231
10	1	2.75	85.27407	111.963	111.9778	0.009	99.671	130.8658	130.883	0.0243

Table 3 Values of $\frac{P_2}{P_1}$ tabulated against a_1, a_2, k forgiven α and β for (QSSRGS-2) (n, kn, c_0)

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