

DESIGNING OF CONTINUOUS SAMPLING PLAN (CSP-T) THROUGH QUALITY DECISION REGIONS

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Abstract: This paper introduces a result oriented designing and selection procedure for Continuous Sampling Plan (CSP-T) indexed through Quality Decision Region (QDR). Expressions for performance measures such as Operating Characteristic function is derived in this work. Computing Probabilistic Quality Region (PQR), Limiting Quality Region (LQR), Indifference Quality Region (IQR) and QDR are derived in this work based on fuzzy logic approach on "degrees of acceptance" in the lot, which is a preferred quality index for engineers and quality controllers. Tables and figures are constructed for the selection of parameters of the plan, which are tailor made for shop-floor industrial situation.

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Key Words: continuous sampling plan, quality decision region, probabilistic quality region, limiting quality region, indifference quality region

1. Introduction

The concept of continuous sampling plan is originated by Dodge, (1943). Known as CSP-1, continuous sampling is used where products flow are continuous and

not easily grouped in lots. Two parameters exist for continuous sampling, namely frequency (f) and second clearing number (i). Balamurali and Chi-Hyuckjun (2004) have proposed the tightened continuous sampling plan (CSP-T plan) and point out that the advantage of the CSP-T plan is that it provides consumer protection against poor process quality and improved administration of the plan. This paper provides new structure quality regions for CSP-T plan.

2. Operating Procedure

CSP-T plan with its parameters are i, f, and k. Where $k = i$ this sampling plan. The average fraction of total production, $P_a(p)$, accepted or passed on a sampling basis is given as: The Average fraction of total production accepted on a sampling basis is

$$P_a(p) = \frac{q^i f_2(1 - q^k) + f_1 q^k}{f_1 f_2(1 - q^i) + f_2 q^i(1 - q^k) + f_1 q^i} \quad (1)$$

3. 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 as $d_1 = (P_* - P_1)$ is derived from the average probability of acceptance,

$$P_a(P_1 < P < P_*) = \frac{q^i f_2(1 - q^k) + f_1 q^k}{f_1 f_2(1 - q^i) + f_2 q^i(1 - q^k) + f_1 q^i} \text{ for } (P_1 < P < P_*) \quad (2)$$

Where $p_a(p)$ is the mean value for the product quality p.

4. 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 the average probability of acceptance,

$$P_a(P_1 < P < P_2) = \frac{q^i f_2(1 - q^k) + f_1 q^k}{f_1 f_2(1 - q^i) + f_2 q^i(1 - q^k) + f_1 q^i} \text{for}(P_1 < P < P_2) \quad (3)$$

Where p_a (p) is the mean value for the product quality p.

5. Limiting Quality region (LQR)

It is an interval of 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 probability of acceptance,

$$P_a(P_* < P < P_2) = \frac{q^i f_2(1 - q^k) + f_1 q^k}{f_1 f_2(1 - q^i) + f_2 q^i(1 - q^k) + f_1 q^i} \text{for}(P_* < P < P_2) \quad (4)$$

Where p_a (p) is the mean value for the product quality p.

6. Indifference Quality Region (IQR)

It is an interval of 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 as $d_0=(P_1 - P_0)$ is derived from the average probability of acceptance,

$$P_a(P_1 < P < P_0) = \frac{q^i f_2(1 - q^k) + f_1 q^k}{f_1 f_2(1 - q^i) + f_2 q^i(1 - q^k) + f_1 q^i} \text{for}(P_1 < P < P_0) \quad (5)$$

Where p_a (p) is the mean value for the product quality p.

7. Numerical Example

A Ceramics manufacturing company producing ceramic components fix the QDR as 1% (0.01) defects are seen QDR given $p_1 = 0.01$, 'i' = 2, and $f = 1/5$. Given $p_1 = 0.01$, $i=2$, and $f= 1/5$ compute the values of QDR, PQR, IQR and LQR. Then compute T, T1 and T2. Select the respective values from Table 1. The nearest values are QDR=0.41669, PQR=0.434869, IQR=0.310537, LQR=0.018179, T=0.958196, T1=22.92 and T2=1.341 with respect to 'i', and 'f'. Corresponding 'i' and 'f' one can obtain the values of p_1 from Table 2.

8. Conclusion

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. Quality Decision Region (QDR) depends on the quality measure MAPD, which is a key measure assessing to what degree of inflection point empowers the OC curve to discriminate between good and bad lots. The present development would be valuable addition to the literature and a useful device for quality control engineers.

References

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i	f	QDR	PQR	IQR	LQR
2	1/5	0.41669	0.434869	0.310537	0.018179
2	2/5	0.425098	0.4368	0.303777	0.011702
2	1/2	0.4175	0.419051	0.263541	0.001551
3	1/5	0.286842	0.315468	0.224402	0.028626
3	1/5	0.305406	0.335247	0.244654	0.029841
3	2/5	0.300877	0.324953	0.225842	0.024076
3	2/5	0.321775	0.346636	0.247865	0.024861
3	1/2	0.32841	0.338988	0.21509	0.010578
3	1/2	0.352094	0.363167	0.239355	0.011073
4	1/5	0.193249	0.220377	0.138385	0.027128
4	1/5	0.205889	0.234337	0.152911	0.028448
4	1/5	0.213992	0.243311	0.162123	0.029319
4	2/5	0.208772	0.232938	0.144565	0.024166
4	2/5	0.222743	0.247895	0.159936	0.025152
4	2/5	0.232811	0.257964	0.170187	0.025153
4	1/2	0.172967	0.258769	0.152111	0.085802
4	1/2	0.260771	0.275492	0.168985	0.014721
4	1/2	0.273684	0.288284	0.181837	0.0146
5	1/5	0.125095	0.147477	0.064402	0.022382
5	1/5	0.133971	0.157552	0.075026	0.023581
5	1/5	0.140323	0.164751	0.082505	0.024428
5	1/5	0.145916	0.169857	0.087786	0.023941
5	2/5	0.140407	0.160838	0.072838	0.020431
5	2/5	0.150134	0.171558	0.083975	0.021424
5	2/5	0.157507	0.179444	0.092067	0.021937
5	2/5	0.163639	0.185271	0.098016	0.021632
5	1/2	0.179649	0.19294	0.090365	0.013291
5	1/2	0.190533	0.204065	0.101665	0.013532
5	1/2	0.199757	0.213411	0.111084	0.013654
5	1/2	0.207511	0.22126	0.118961	0.013749

Table 1: Values of QDR, PQR, IQR and LQR for specified values of 'i' and 'f' for Tightened Continuous Sampling Plan (CSP-T)

i	f	P*	P0	P1	P2	(R1)	(R2)
2	1/5	0.469731	0.363578	0.053041	0.48791	0.958196	9.198733
2	2/5	0.492869	0.371548	0.067771	0.504571	0.973209	7.445235
2	1/2	0.544556	0.390597	0.127056	0.546107	0.996298	4.29816
3	1/5	0.326029	0.263589	0.039187	0.354655	0.909258	9.050323
3	1/5	0.324299	0.263547	0.018893	0.35414	0.910987	18.74451
3	2/5	0.351065	0.27603	0.050188	0.375141	0.925908	7.474715
3	2/5	0.349911	0.276001	0.028136	0.374772	0.928278	13.32002
3	1/2	0.420095	0.306775	0.091685	0.430673	0.968794	4.697311
3	1/2	0.419472	0.306733	0.067378	0.430545	0.969509	6.389994
4	1/5	0.222347	0.167483	0.029098	0.249475	0.8769	8.573613
4	1/5	0.220381	0.167403	0.014492	0.248829	0.878601	17.17009
4	1/5	0.21924	0.167371	0.005248	0.248559	0.879499	47.36261
4	2/5	0.246411	0.182204	0.037639	0.270577	0.896254	7.18874
4	2/5	0.244953	0.182146	0.02221	0.270105	0.898536	12.16141
4	2/5	0.244781	0.182157	0.01197	0.269934	0.902493	22.55088
4	1/2	0.243844	0.222988	0.070877	0.329646	0.668421	4.650959
4	1/2	0.314746	0.22296	0.053975	0.329467	0.946564	6.104067
4	1/2	0.314812	0.222965	0.041128	0.329412	0.949354	8.009434
5	1/5	0.146616	0.085923	0.021521	0.168998	0.848232	7.852702
5	1/5	0.144763	0.085818	0.010792	0.168344	0.850327	15.59896
5	1/5	0.143589	0.085771	0.003266	0.168017	0.851726	51.44427
5	1/5	0.143969	0.085839	0.00195	0.16791	0.85905	86.2404
5	2/5	0.168951	0.101382	0.028544	0.189382	0.87297	6.634739
5	2/5	0.167458	0.101299	0.017324	0.188882	0.875119	10.90291
5	2/5	0.166714	0.101274	0.009207	0.188651	0.877748	20.48995
5	2/5	0.166937	0.101314	0.003298	0.188569	0.88324	57.17677
5	1/2	0.23449	0.145206	0.054841	0.247781	0.931112	4.518171
5	1/2	0.234052	0.145184	0.043519	0.247584	0.933686	5.689101
5	1/2	0.233851	0.145178	0.034094	0.247505	0.936019	7.259488
5	1/2	0.233725	0.145175	0.026214	0.247474	0.937859	9.440528

Table 2: Certain Characteristic values and its ratios for Tightened Continuous Sampling Plan (CSP-T)