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Design of Double Inspection Quick Switching System [DIQSS (0,1)]

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***Abstract* - During the production process, due to various reasons defectives may occur. The professionals are inspecting all the observations in each sample with very strict quality control measures, to avoid rejection and satisfy the need of the customer. At this situation arriving at a definite sample size is very important. This paper proposes the study on Double Inspection Quick Switching System [DIQSS (0,1)] with reference to single sampling plan based on the poisson model. The table is constructed for the easy selection of the sample size and a numerical example is illustrated.**

Keywords – Double inspection, OC and AOQ, Quick switching system, Single sampling plan.

INTRODUCTION

Quality is an essential tool to create goodwill of the product and industry. There are several paths to produce a good product and reduce errors in production. One of the essential methods in production is statistical quality control, now various concepts of statistical quality control are in progress in industrial sectors, but quick switching system is the basic and most widely used sampling system in SQC. Dodge (1967) has proposed a new type of sampling plan namely Quick Switching Sampling System and investigated by Romboski (1969), after many authors extended and applied Quick Switching Sampling System in various branches of statistical quality control.

Romboski introduced QSS-1 $(n;c_N,c_T)$ which is a QSS-1 with single sampling plan as a reference plan $[(n,c_N)$, (n,c_T) respectively the normal and tightened single sampling plans with $c_T < c_N]$, Soundarrajan and Devaraj Arumai Nayagam (1990) have developed Construction and Selection of Modified Quick Switching System. Govindaraju and Subramani (1990) have developed Selection of Single-sampling Quick Switching System for given Acceptable and Limiting Quality Levels. Soundarrajan and Devaraj Arumai Nayagam (1992) have developed Quick switching system for costly and destructive testing.

Senthilkumar et al. (2012) have developed Construction of quick switching variable sampling system indexed by cross over point. Senthilkumar et al (2018) developed Construction of modified quick switching variable sampling system indexed by crossover Point. Vennila and Devaraj Arumainayagam (2018) have developed Quick Switching System with different reference plans. Senthilkumar and Sabarish (2020) have developed the Construction and Selection of Double Inspection Single Sampling Plan [DISSP (0,1)]. Senthilkumar and Sabarish (2021) have developed Selection and Development of Double Inspection Single Sampling Plan. Senthilkumar and Sabarish (2021) have developed Economic Design of Double Inspection Single Sampling Plan. The work presented in this paper is Double Inspection Quick Switching System with acceptance number 0 for tightened level and 1 for normal level [DIQSS (0,1)] with reference to single sampling plan based on the poisson model. In double inspection, the first inspection does not depend on second inspection, the inspection process has to be continued until the lot is either accepted or rejected.

Operating Procedure for DIQSS (0, 1)

Select a random sample of size 'n' units from the lot 'N'. The first inspection is to test the first quality characteristic of the product using quick switching methodology.

First Inspection

1. In first inspection, find the number of defectives d_{11} at the normal level, if $d_{11} \leq 1$ move to second inspection otherwise shift to tightened level.
2. Count the number of defectives 'd_{12}' at the tightened level, if $d_{12} \leq 0$ move to second inspection, otherwise reject the lot.

After the conditions in first inspection is satisfied, move to second inspection for the same sample, to test the second quality characteristic of the same product using quick switching methodology.

Second Inspection

1. In Second inspection find the number of defectives d_{21} at the normal level, if $d_{21} \leq 1$ accept the lot otherwise shift to tightened level.
2. Count the number of defectives 'd_{22}' at the tightened level, if $d_{22} \leq 0$ accept the lot otherwise reject the lot.

NOTATION TO BE USED

n - Sample size
c_N – Acceptance number for normal level (1)
c_T –Acceptance number for tightened level (0)
d_{11} – number of defectives from the first inspection in normal level
d_{12} – number of defectives from the first inspection in tightened level
d_{21} – number of defectives from the Second inspection in normal level
d_{22} – number of defectives from the Second inspection in tightened level
Pa_1 (p) - Probability of acceptance for first inspection
Pa_2 (p) - Probability of acceptance for second inspection
Pa (p) - Probability of acceptance for double inspection single sampling plan.

Measures of Performance

Operating Characteristics Function

$$Pa(p) = \left[Pa1(p) = \frac{P_T}{P_T + (1-P_N)}\right] * \left[Pa2(p) = \frac{P_T}{P_T + (1-P_N)}\right]$$

P_N = Proportion of lots expected to be accepted when using Double Inspection Single Sampling Plan at normal level (1).
P_T = Proportion of lots expected to be accepted when using Double Inspection Single Sampling Plan at tightened level (0).

Average Outgoing Quality

$$AOQ = p*Pa(p)$$

Illustration

In the digital world usage of the smart products (smart phone, smart watch, smart ring, smart bag, smart glass,...etc) increases day by day. In DIQSS two inspectors checking two different quality characteristics of smart ring with normal and tightened level, c_{11}= checking the quality of the display and c_{12} = checking the performance of the pulse reader, both the quality characteristics are independent (normal). c_{21}= checking quality of the display and c_{22} = checking the performance of the Pulse reader, both the quality characteristics are independent (tightened).

Table 1 reveals the probability of acceptance of first inspection with normal and tightened level for the sample of size n=32 and acceptance number c_N = 1, c_T=0, the probability of acceptance of second inspection with normal and tightened level for the sample of size n=32, and acceptance number c_N = 1, c_T=0, and the acceptance number and the probability of acceptance of Double Inspection Quick Switching System size n=32, c_N=1 and c_T=0. Also the table 1 provides the average outgoing quality of DIQSS(0,1).

TABLE 1

n= 32, c_T=0, and c_N=1		
p	**DIQSS**	**AOQ**
0.001	0.999	0.001
0.003	0.9905	0.003
0.005	0.9735	0.0049
0.007	0.948	0.0066
0.009	0.9144	0.0082
0.01	0.8948	0.0089
0.02	0.6334	0.0127
0.03	0.3666	0.011
0.04	0.1863	0.0075
0.05	0.0889	0.0044
0.06	0.0416	0.0025
0.07	0.0195	0.0014

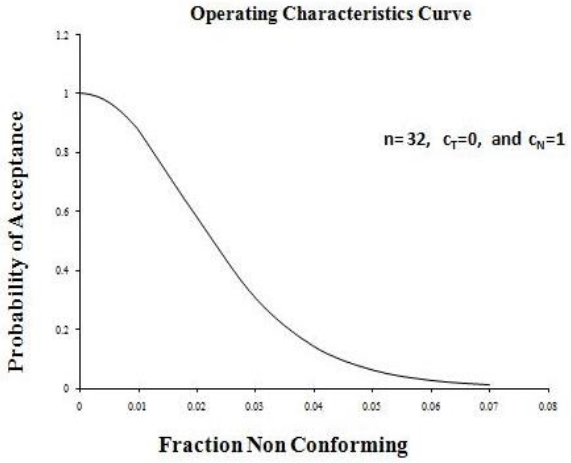

FIGURE 1

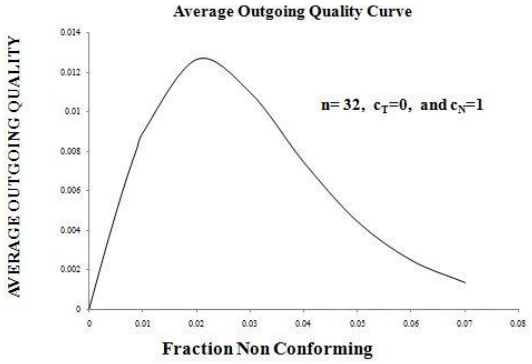

FIGURE 2

Figure 1 reflects the operating characteristics curve of Double Inspection Quick Switching System and Figure 2 reflects the Average Outgoing Quality curve of Double Inspection Quick Switching System. These curves formed by the plan parameters n=32, c_N=1 and c_T=0 and points of the curves are shown in the Table1.

DESIGNING SYSTEM OF DIQSS (0,1)

Table 2 locates the values of sample size 'n', this sample size 'n' is indexed by the parameters 'p' and Pa(p).

The following steps shows, how to access the table 2 for selecting sample size,

1. Fix the parameters, probability of acceptance Pa (p) and proportion defective 'p'.
2. Find the sample size 'n' for the corresponding of the parameters Pa (p) and 'p'.

For example, if one fixes Pa(p)=0.95 and p=0.007, then the resulting DIQSS (0,1) as follows.

1. In the column headed by Pa(p)=0.95, and p=0.007.
2. Corresponding to the parameters the sample size in n=32.

TABLE 2
VALUES OF 'N' INDEXED BY THE PARAMETERS OF C_T=0 AND C_N=1 WITH VARIOUS LEVELS OF P_A(P).

p	Probability of Acceptance Pa(p)							
	0.99	**0.95**	**0.90**	**0.75**	**0.50**	**0.25**	**0.10**	**0.05**
0.001	98	219	311	509	790	1146	1550	1842
0.002	49	109	155	254	395	573	775	921
0.003	32	73	103	170	263	382	516	614
0.004	24	55	78	127	197	287	387	460
0.005	19	44	62	102	158	229	310	368
0.006	16	37	52	85	132	191	258	307
0.007	14	32	45	72	112	164	221	263
0.008	12	28	39	63	98	143	193	230
0.009	10	25	35	56	87	127	172	204
0.01	10	22	31	51	79	114	155	184
0.02	4	11	16	25	39	57	77	92

CONCLUSION

This plan helps the consumer to get good quality products because of inspecting two different and major characteristics of the same product. Also, this article presents a method for the easy selection of sample size to the producer in table 2. The sample size is formed on Double Inspection Quick Switching System [DIQSS (0,1)] with reference to a single sampling plan based on the poisson model. This plan is widely applicable for mass and expensive industries like gold ornament, food manufacturing, smart gadgets manufacturing, and so on.

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