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SELECTION OF QUICK SWITCHING SYSTEM WITH SINGLE SAMPLING PLANS THROUGH MAPD AND MAAOQ

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ABSTRACT

Romboski (1969) has introduced the concept of QSS-1 (n, C_N, C_T) **is a system which considers single sampling plan** (n, C_T) and (n, C_T) **which are the normal tightened plans with** C_N **and** C_T**. Suresh (1993) has studied the** QSS-1 **with single sampling plan using acceptable and limiting quality levels.**

Suresh and Ramkumar (1996) have introduced the concept of Maximum Allowable Average Outgoing Quality (MAAOQ) for single sampling plan and studied the selection procedure. This methodology is considered for selection of QSS-2 & 3 **with Single sampling plan as reference plan. Procedures and necessary tables are indicated with suitable illustration, which are useful for the shop-floor condition.**

KEYWORDS: Acceptable Quality Levels, Limiting Quality Levels, Quick Switching System, Single Sampling Plan, Maximum Allowable Average Outgoing Quality Levels, Maximum Allowable Percent Defective.

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Introduction

Mandelson (1962) has explained the desirability of developing a system of sampling plans indexed through the Maximum Allowable Proportion Defective (MAPD) and shown that $p^* = c/n$ **for an SSP with sampling size 'n' and acceptance number 'c'. Mayer (1967) has suggested that the quality measure, this paper provides tables and procedures for the selection of** QSS-2 and QSS-3 **with Single Sampling Plan using MAPD as a standard and the MAAOQ as an average outgoing quality, the parameters of a Quick Switching System are determined.**

Any system of sampling inspection involving only normal and tightened inspection is usually referred as two-plan system. This system considers tightened inspection plans for the poor quality levels and normal plans involving smaller sample size for the good quality levels. Due to instantaneous switching between normal and tightened plan this system is referred as "Quick Switching System".

Romboski (1969) has introduced the concept of QSS-2(n, C_N, C_T) **is a system which considers single sampling plan** (n, C_N) **and** (n, C_T) **which are the normal tightened plans with** C_N & C_T**.**

The 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 his order of production.**

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

The Operating Procedure for QSS-2 (N, C_N, C_T) System

Step1:- From the lot, take a random sample of size 'n' **at the normal level, count the number of defectives** 'd'

1. **If** $d \leq C_N$ **accept the lot and repeat step1.**
2. **If** $d > C_N$ **reject the lot and go to step2.**

   Step: -2 From the next lot take a random sample of size 'n' **at the tightened level. Count the number of defectives** 'D'**.**

1. **If** $D \leq C_T$ **accept the lot and continue inspection until two lots in succession are accepted. If so go to step-1 otherwise repeat step2.**
2. **If** $D \leq C_T$ **reject the lot and repeat step2.**

Romboski (1969) has derived the OC function for QSS-2 (n,C_N,C_T) **as**

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

Romboski (1969) has presented tables for the selection of QSS-2 (n, C_N,C_T) **sytem for given** p_1, p_2, α, β. **Devaraj Arumainayagam (1991) has studied Quick Switching Systems with various references and its applications.**

Suresh (1993) has studied the QSS-1 (n, C_N, C_T) **with single sampling plan for Acceptable and Limiting quality levels. Subramanian (1990) has studied the** QSS-2 **with Single Sampling Plan indexed by** (p^*, h^*)**.**

Romboski (1969) has introduced another type denoted as QSS-3 (n, C_N, C_T) **is a system which consider single sampling plan** (n, C_N) and (n, C_T) **which are the normal tightened plans with** C_N and C_T**.. The conditions for application of this system are similar to that of** QSS-2 (n, C_N, C_T).

The Operating Procedure for QSS-3 (N, C_N, C_T) System

Step1:- From the lot, take a random sample of size 'n' **at the normal level, count the number of defectives '**d'

1. **If** $d \leq C_N$ **accept the lot and repeat step1.**
2. **If** $d \leq C_N$ **reject the lot and go to step2.**

Step:-2 From the next lot, take a random sample of size 'n' **at the tightened level. Count the number of defectives '**D'**.**

1. **If** $D \leq C_T$ **accept the lot and continue inspection until three lots in succession are accepted. If so go to step-1 otherwise repeat step2.**
2. **If** $D \leq C_T$ **reject the lot and repeat step2.**

Romboski (1969) has derived the OC function for QSS-3 (n, C_N, C_T) **as**

$$Pa(p) = \frac{P_N P_T^3 + P_T(1-P_N)(p_T^2 + P_T + 1)}{P_T^3 + (1-P_N)(p_T^2 + P_T + 1)} ------(2)$$

Romboski (1969) has presented tables for the selection of QSS-3 (n, C_N, C_T) **system for given** p_1, p_2, α, β. **Devaraj Arumainayagam (1991) has studied Quick Switching System with various references and its applications. Subramanian (1990) has studied** QSS-3 (n, C_N, C_T) **with Single sampling plan indexed by (p*, h*).**

Definition of MAAOQ:

The MAAOQ of a single sampling plan is defined as the average outgoing quality (AOQ) at the MAPD. Assuming Poisson conditions for quality characteristics

AOQ = p. P_a (p). (N-n)/n

= p. P_a (p)

Then we have

MAAOQ = MAAOQ a^{-1} p = p*

This can be rewritten as

MAAOQ = p*. Pa (p*)

Suresh and Ramkumar (1996) have introduced the concept of Maximum Allowable Average Outgoing Quality (MAAOQ) for designing plans. They have designed single sampling plans using MAPD as an incoming quality and MAAOQ as the outgoing quality. Further they have established that, for a particular MAPD, MAAOQ is better than the plans index with AOQL with same MAPD in the sense that the cost of inspection for the producer. This method of designing helps the producer towards reduction of inspection cost and the consumers in getting good quality than the other plans.

Selection of QSS-2 (N, C_N, C_T) Sampling Plans

1. For specified MAAOQ and MAPD

Table-1 is used to construct the plans when MAPD and MAAOQ are specified. For any given values of MAPD (p*) and MAAOQ (pMAQ)**, find the value in Table-1 under the column** R_1 **which is equal to or just less then the specified ratio. Then the corresponding values of** C_N and C_T **are noted. From this One can determine the parameters** n_1 (normal) and n_2 **(Tightened) for Quick Switching System**(n, C_N & C_N)

Example

Given MAAOQ (p_{MAQ}) = 0.04 and MAPD (p_*) = 0.06**, compute the ratio** R_1= MAAOQ / MAPD = 0.6666 **and select the value of** R_1**, which is equal to or just less then the specified ratio using Table-1. Thus, the corresponding value** R_1 **is 0.6672, which is associated with** C_N=7 and C_T=3 **From this one can find the sample size** n_1= 116 (for normal case), n_2 = 50 **(for tightened case) and** C_N=7 and C_T=3 **are the parameters selected for the Quick Switching System with single sampling plan as reference plan for which** MAAOQ is 0.04 **and MAPD is 0.06 defectives.**

2. For specified n, AOQL or MAAOQ

Table 1 is used to construct a plan when the sample size n and AOQL or MAAOQ are specified. Find the value n MAAOQ or n AOQL. This is a monotonic increasing function in C_N and C_T**. Find the value in Table-1 under n MAAOQ or n AOQL value which is equal to or just less then the calculated value. Then the corresponding value of** C_N & C_T **is noted. From this one can determine the parameters n and** C_N C_T

for Quick Switching System.

Example:-

For n = 100, MAAOQ (PMAQ) =2.5**, and AOQL. Compute the values of nMAAOQ and AOQL. Select the respective value form Table-1. The nearest values are nMAAOQ = 2.5878 and nAOQL = 2.5577 with respective** C_N=6, C_T = 4 and C_N=5, C_T = 2**. Thus, the sampling plan has** (n=100, C_N=6, C_T = 4) **has** MAAOQ = 2.5 **and the sampling plan** (n=100, C_N=5, C_T = 2) **has** AOQL = 2.5.

3. **For specified n, MAPD and AOQL**

Table- 1 is used to construct the plans when MAPD and AOQL are specified. For any given values of AOQL and MAPD, find the value in Table.1 under the column R2 which is equal to or just less then the specified ratio. Then the corresponding values of C_N & C_T **are noted. . From this one can determine the parameters n for** QSS-2 (n,C_N,C_T).

Example:-

Given AOQL = 0.05 and MAPD = 0.065, compute the ratio R_2 **is 0.7692. Select the value of** R_2 **which is equal to or just greater then the specified ratio using Table-1. The corresponding value** R_2 **is. 0.7649 Which is associated with** C_N=9 & C_T=1. **From this one can find the sample size** n_1(normal) = 138, n_2(tightened) =15 **are the parameters for the QSS-2 with single sampling plan as reference plan for which the AOQL is 0.05 and MAPD is 0.065 defective.**

Selection of QSS-3 (N, C_N, C_T) Sampling Plans

1. **For specified MAAOQ and MAPD**

   Table-2 is used to construct the plans when MAPD and MAAOQ are specified. For any given values of MAPD (p*) and MAAOQ (pMAQ)**, find the value in Table-2 under the column** R_1 **which is equal to or just less then the specified ratio. Then the corresponding values of** C_N and C_T **are noted. From this One can determine the parameters** n_1 **(normal) and** n_2 **(Tightened) for Quick Switching System** (n, C_N & C_N)**.**

Example

Given MAAOQ (pMAQ) = 0.05 and MAPD (p*) = 0.07**, compute the ratio** R_1= MAAOQ / MAPD = 0.7143 **and select the value of** R_1**, which is equal to or just less then the specified ratio using Table-2. Thus, the corresponding value** R_1**is 0.7351, which is associated with** C_N=4 and C_T=3. **From this one can find the sample size** n_1**= 57 (for normal case),** n_2**= 43 (for tightened case) and** C_N=4, C_T=3 **are the parameters selected for the Quick Switching System with single sampling plan as reference plan for which MAAOQ is 0.05 and MAPD is 0.07 defectives.**

2. **For specified n, AOQL or MAAOQ**

   Table 2 is used to construct a plan when the sample size n and AOQL or MAAOQ are specified. Find the value n MAAOQ or n AOQL. This is a monotonic increasing function in C_N and C_T**. Find the value in Table-2 under n MAAOQ or n AOQL value which is equal to or just less then the calculated value. Then the corresponding value of** C_N & C_T **is noted.**

From this one can determine the parameters n **and** C_N , C_T **for Quick Switching System.**

Example:-

For n **=** 180, MAAOQ (PMAQ) =2.0, and AOQL. **Compute the values of nMAAOQ and AOQL. Select the respective value form Table-2. The nearest values are** nMAAOQ = 2.10046 and nAOQL = 2.0623 **with respective** C_N=4, C_T = 2 and C_N=5, C_T = 2. **Thus, the sampling plan has** (n=180, C_N=4 , C_T = 2) **has MAAOQ = 2.0 and the sampling plan** (n=180, C_N=5 , C_T = 2) has AOQL = 2.0.

3. For specified n, MAPD and AOQL

Table- 2 is used to construct the plans when MAPD and AOQL are specified. For any given values of AOQL and MAPD, find the value in Table.2 under the column R_2 **which is equal to or just less then the specified ratio. Then the corresponding values of** C_N & C_T **are noted. From this one can determine the parameters** n **for** QSS-3 (n,C_N,C_T)**.**

Example: -

Given AOQL = 0.05 and MAPD = 0.07**, compute the ratio** R_2 **is 0.7143. Select the value of** R_2 **which is equal to or just greater then the specified ratio using Table-2. The corresponding value** R_2 **is. 0.70249 Which is associated with** C_N=4 & C_T=1. **From this one can find the sample size** n_1(normal) = 57, n_2(tightened) =14 **are the parameters for the QSS-3 with single sampling plan as reference plan for which the AOQL is 0.05 and MAPD is 0.07 defective.**

Construction of Tables

The probability of acceptance for QSS-2 (n, CN, CT) **plan with single sampling plan as reference plan is given as**

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

Where

$P_N = \Sigma\ e^{-np}\ np^x\ /x!$

$P_T = \Sigma\ e^{-np}\ np^x\ /x!$

$$\frac{d^2}{dp^2} Pa(p) = \frac{d^2}{dp^2} \frac{P_N P_T^2 + P_T(1-P_N)(1+P_T)}{P_T^2 + (1-P_N)(1+P_T)} = 0.....when...p = p_*$$

The probability of acceptance for QSS-3 (n, CN, CT) **plan with single sampling plan as reference plan is given as**

$$Pa(p) = \frac{P_N P_T^3 + P_T(1-P_N)(p_T^2 + P_T + 1)}{P_T^3 + (1-P_N)(p_T^2 + P_T + 1)} ------(2)$$

Where

$P_N = \Sigma\ e^{-np}\ np^x\ /x!$

$P_T = \Sigma\ e^{-np}\ np^x\ /x!$

$$\frac{d^2}{dp^2} Pa(p) = \frac{d^2}{dp^2} \frac{P_N P_T^3 + P_T(1-P_N)(p_T^2 + P_T + 1)}{P_T^3 + (1-P_N)(p_T^2 + P_T + 1)} = 0.....when...p = p_*$$

AOQ = np* Pa(np*) then

MAAOQ = AOQ at p = p*

R_1 = n MAAOQ / np* = MAAOQ / MAPD
R_2= n AOQL / n MAPD = AOQL / MAPD

Then for any specified values of C_N and C_T**, the unique values of** R_1 **and** R_2 **are listed in Table-1 & 2. Table 1 is also used to select the sampling plan for given AOQL and MAPD values for specified Quick Switching system -2** (n, C_N, C_T)**. Table 2 is specified for Quick Switching system -3** (n, C_N, C_T). **for the values of** $R_1$and R_2 **are listed.**

Conclusion

Acceptance Sampling is the technique which deals with the procedures in which decision to accept or reject the lots on process are based on the examination of samples. The work presented in this paper mainly relates to the new procedures for construction and selection of tables for sampling inspection through MAAOQ. The emphasis in the present work is that the relation of sampling plans with procedure is more advantage to the producer and consumer than the procedures adopted through AOQL. This procedure reduces the cost of inspection for the Producer and the Consumer gets good items.

In acceptance sampling the producer and consumer plays a dominant role and hence one allows a certain level of risk for producer and consumer.

It is understandable to design any sampling plan with the associated quality levels, concern to producer and consumer in practice. Hence selection procedures are considered in this paper with inflection point on the OC curve. Tables provided in this paper are tailor-made which are handy and ready-made, which are also well considered for comparison purposes.

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Table-1:- Certain Parametric Values for QSS-2 (n, C_N, C_T) **with Single Sampling Plan**

C_N	C_T	np_*	nAOQL	nMAAOQ	R_1	R_2
1	0	0.6613	0.4809	0.3180	0.4809	0.7273
2	1	1.5402	1.0297	1.5859	1.0297	0.6686
2	0	1.0279	0.6778	0.6967	0.6778	0.6594
3	2	2.4681	1.6176	3.9923	1.6176	0.6554
3	1	1.9438	1.2861	2.4999	1.2861	0.6616
3	0	1.3570	0.9061	1.2296	0.9061	0.6677
4	2	2.8759	1.9162	5.5108	1.9162	0.6663
4	1	2.3116	1.5669	3.6221	1.5669	0.6778
4	4	4.3803	2.8719	12.5795	2.8719	0.6556
5	3	3.8203	2.5666	9.8051	2.5666	0.6718
5	2	3.2587	2.2338	7.2791	2.2338	0.6855
5	6	6.7017	4.6044	30.8573	4.6044	0.6871
5	2	3.6258	1.8571	6.7335	1.8571	0.6978
5	1	2.9994	2.5577	7.6714	2.5577	0.7054
6	3	4.5889	3.2633	14.9751	3.2633	0.7111
6	5	6.5087	1.3989	9.1048	1.3989	0.7078
6	4	5.9210	2.1512	12.7371	2.1512	0.7172
7	0	1.9762	4.6970	9.2824	4.6970	0.7217
7	3	4.9933	7.1953	35.9286	7.1953	0.7198
7	2	4.3299	2.8830	12.4832	2.8830	0.7240
7	0	2.5729	3.6136	9.2975	3.6136	0.7237
8	1	2.6612	1.6544	4.4026	1.6544	0.7268
8	0	2.2764	4.3476	9.8968	4.3476	0.7343
8	3	5.3130	2.4468	12.9997	2.4468	0.7349
8	0	2.8669	3.2077	9.1960	3.2077	0.7408
9	9	9.9959	3.9616	39.5999	3.9616	0.7457
9	1	3.3295	7.3341	24.4186	7.3341	0.7489
9	8	9.7936	1.9135	18.7397	1.9135	0.7437
9	1	3.9731	4.7154	18.7346	4.7154	0.7498
9	0	3.1588	2.1752	6.8710	2.1752	0.7587
10	4	6.2888	5.0793	31.9426	5.0793	0.7637
10	0	3.4492	3.0388	10.4814	3.0388	0.7649
11	4	6.6507	2.4390	16.2208	2.4390	0.7721
11	0	6.2000	2.7043	16.7667	2.7043	0.7840
12	2	3.9820	2.9709	11.8304	2.9709	0.4792
12	0	4.0264	3.2386	13.0401	3.2386	0.8043
14	1	5.5252	4.5111	24.9248	4.5111	0.8165

Table-2: - Certain Parametric Values for QSS-3 (n, CN, CT) with Single Sampling Plan

C_N	C_T	np_*	nAOQL	nMAAOQ	R_1	R_2
1	0	0.5494	0.4244	0.4645	0.8455	0.7726
2	1	1.3728	0.9614	1.0843	0.7899	0.7003
2	2	2.2657	1.5439	1.7163	0.7575	0.6814
3	0	0.8414	0.5763	0.7484	0.8895	0.6849
3	3	3.1912	2.1574	2.3459	0.7351	0.6760
3	1	1.6966	1.1677	1.4287	0.8421	0.6882
4	2	2.5850	1.7891	2.1005	0.8126	0.6921
4	0	1.1087	0.7654	1.0266	0.9259	0.6903
4	7	7.0273	4.8040	4.8080	0.6842	0.6836
5	1	2.0022	1.4066	1.7713	0.8847	0.7025
5	2	2.9029	2.0623	2.4871	0.8568	0.7104
6	3	3.8153	2.7341	3.1893	0.8359	0.7166
6	4	4.7380	3.4199	3.8823	0.8194	0.7218
7	1	2.2964	1.6564	2.1072	0.9176	0.7213
7	6	6.6073	4.8264	5.2481	0.7943	0.7305
7	3	4.1349	3.0416	3.6076	0.8725	0.7356
7	4	5.0609	3.7286	4.3336	0.8563	0.7368
8	1	2.5825	1.9100	2.4331	0.9422	0.7396
8	6	6.9291	5.1896	5.7586	0.8311	0.7490
8	2	3.5188	2.6287	3.2385	0.9203	0.7471
8	9	9.7648	7.4070	7.8495	0.8039	0.7585
8	1	2.8622	2.1647	2.7478	0.9600	0.7563
9	2	3.8172	2.9122	3.5956	0.9419	0.7629
9	3	4.7607	3.6564	4.4089	0.9261	0.7680
9	4	5.7013	4.4027	5.2007	0.9122	0.7722
9	1	3.1371	2.4194	3.0513	0.9727	0.7712
10	6	7.5841	5.9078	6.7418	0.8889	0.7790
10	2	4.1102	3.1940	3.9386	0.9582	0.7771
10	0	2.3540	1.8286	2.3354	0.9921	0.7768
10	4	6.0158	4.7244	5.6103	0.9326	0.7853
11	1	3.4079	2.6735	3.3448	0.9815	0.7845
11	4	6.3261	5.0420	6.0024	0.9488	0.7970