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SELECTION OF MULTIPLE DEFERRED STATE MDS–1 SAMPLING PLAN FOR GIVEN ACCEPTABLE QUALITY LEVEL AND LIMITING QUALITY LEVEL INVOLVING MINIMUM RISKS USING WEIGHTED POISSON DISTRIBUTION

Abstract: *The selection principles have increased enormously in number since the first acceptance sampling plans were developed almost 80 years ago. The majority of these principles are characterized by the fact that they look upon producer and consumer as two opposing parties. However, on many occasions, e.g., in final inspection, producer and consumer represent the same party and, therefore, the used sampling plan should not make an attempt to discriminate between their interests. In this case the interest is to avoid wrong decisions, i.e., reject product of sufficient quality and accept product of insufficient quality. Thus, the natural objective in these cases is to use overall risk for a wrong decision as optimization criteria. Optimum result can be arrived further by the Weighted Poisson distribution. In this paper, a table and procedure are given for finding the Multiple Deferred State – 1 (MDS–1)(c_1, c_2) sampling plan involving minimum sum of producer's and consumer's risks for specified Acceptable Quality Level and Limiting Quality Level using Weighted Poisson distribution. This is the case with so called "Multiple Deferred State – 1 (MDS–1) (c_1, c_2) sampling plan for given Acceptable Quality Level and Limiting Quality Level involving minimum risks using Weighted Poisson distribution".*

Keywords: *Acceptable Quality Level; AQL, Attribute Plan, Limiting Quality Level; LQL, Multiple Deferred State–1 (c_1, c_2) sampling plan, Weighted Poisson Distribution*

1. Introduction

The practical performance of a sampling plan is revealed by its operating characteristic (OC) curve. Sampling plans are usually selected for two given points on the OC curve, viz. (p_1, $1-\alpha$) and (p_2, β) where p_1 is the acceptable quality level (AQL), α is the producer's risk, p_2 is the limiting quality level (LQL) and β is the consumer's risk. Due to the discreteness of the parameters of the sampling plan, the conditions of fixed

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risks are often changed to $Pa(AQL) \geq 1-\alpha$ and $Pa(p) \leq \beta$, where $Pa(p)$ is the probability of acceptance for given lot or process quality p. Golub (1953) has given a method of finding a single sampling plan involving a minimum sum of producer's and consumer's risks for given AQL and LQL where the sample size n is fixed due to the economic, administrative or practical factors. Single sample plan involving minimum sum of risks using the Binomial model can be found from (Golub, 1953) tables. Soundararajan (1981) has extended this approach to single sampling plan under the condition of Poisson model for the same. The drawback of Golub's approach is that the sampling plan in which the minimum sum of risks may still result in larger producer's and consumer's risk. Since minimizing the sum of risks is a desirable feature (as it leads to a better shouldered OC curve), one may attempt to design sampling plans involving smaller producer's and consumer's risks. Soundararajan and Govindaraju (1983) have, therefore, modified the Golub's approach of minimizing the sum of risks such that the producer's and consumer's risks are below the specified levels (e.g. 0.01, 0.05 etc.) in the case of single sampling plans. Soundararajan and Raju (1983) presented tables for selecting MDS plans for given for given p_1, p_2, α (0.05, 0.01), and β (0.10, 0.05, 0.01) for fixed values of $c_1 = 0$ and $c_2 = 2$. Soundararajan and Vijayaraghavan (1989) have modified the tables of (Soundararajan and Raju, 1983) so that the sum of risks is a minimum for the np_1 and np_2 values that yielded p_2/p_1 when $c_1 = 0$ and $c_2 = 2$. Subramani and Govindaraju (1990) have developed tables for the selection of multiple deferred state MDS-1 sampling plan with minimum sum of risks for given acceptable and limiting quality levels using Poisson distribution. The original MDS plan of (Wortham and Baker, 1976) also involving smaller producer's and consumer's risks.

Designing Sampling Plans

In designing a sampling plan one has to accomplish a number of different purposes. According to (Hamaker, 1960), the important ones are;

1. To strike a proper balance between the consumer's requirements, the producer's capabilities, and inspector's capacity.
2. To separate bad lots from good.
3. Simplicity of procedures and administration.
4. Economy in number of observations.
5. To reduce the risk of wrong decision with increasing lot size.
6. To use accumulated sample data as a valuable source of information.
7. To exert pressure on the producer or supplier when the quality of the lots received is unreliable or not upto standard.
8. To reduce sampling when the quality is reliable and satisfactory.

Hald (1981) designed tables for the selection of single and double sampling plans for the fixed producer's risk (α=0.05) and consumer's risk (β=0.10).

In Jia-Tzer (2009) designed economic model to determine optima sampling plan that minimizing the producer's total cost while satisfying both the producr's and consumer's quality and risk requirements.

Wetherill and Chiu (1975) reviewed some major principles of acceptance scheme with emphasis on the economic aspect. In their semi-economic approach a point on the OC curve is specified. The fixed point on the OC curve can be the producer's risk point, consumer's risk point, or the point of indifference quality. The fixed point determines a relationship between acceptance number and the sample size.

Dey (1970) has introduced acceptance sampling plans for salvageable lots by minimizing the total of consumer's and producer's risk, when the sample size is prefixed.

Guenther (1969) proposed an iterative

procedure to determine the parameters of the Single Sampling plans by attributes for two points on the OC curve, namely, $(p_1, 1-\alpha)$ and (p_2, β) where p_1, p_2, α and β represent respectively producer's quality level, consumer's quality level, producer's risk and consumer's risk.

Soundararajan and Vijayaraghavan (1989) extended this approach to multiple deferred sampling plan of type MDS–1 (0, 2), limiting to the acceptance numbers at 0 and 2. Subramani and Govindaraju (1990) have presented tables for the selection of multiple deferred state MDS-1 sampling plan for given acceptable and limiting quality levels using Poisson distribution.

This paper gives table and procedure for selecting the multiple deferred state MDS–1 sampling plan of (Vaerst, 1982), involving minimum sum of risks for given AQL and LQL using Weighted Poisson distribution, so that the producer's risk and the consumer's risk does not exceed 0.10. The procedure for selection of the sampling plans given here neither assumes that the size is known and fixed given by the (Golub, 1953) nor fixes the parameters as has been done by (Soundararajan and Vijayaraghavan, 1989). Producer's and consumer's risks and their sums given in this paper are comparatively smaller than those of developed by (Subramani and Govindaraju, 1990).

MDS–1 Plan

The MDS–1 plan is applicable to the case of Type B situations where lots expected to be of the same quality are submitted for inspection seriously in the lot production. MDS–1 plans are extensions of chain sampling plans of (Dodge, 1955) type ChSP – 1. Both the MDS–1 and chain sampling plans achieve a similar reduction in sample size when compared to the unconditional plans, such as single and double sampling plans. The operating procedure of the MDS–1 plan is given below.

1. From each submitted lot, select a sample of *n* units and test each unit for conformance to the specified requirements.
2. Accept the lot if d, the observed number of nonconformities, is less than or equal to c_1; reject the lot if d is greater than c_2.
3. If $c_1 < d \leq c_2$ accept the lot, provided in each of the sample taken from the preceding or succeeding m lots, the number of nonconformities found is less than or equal to c_1. The lot otherwise rejected.

Weighted Poisson Distribution:

Rao (1965) introduced the concept of weighted distribution when the samples are recorded without a sampling frame that enables random samples to be drawn. The weight function that usually appears in the scientific and statistical literature is $\omega(X) = X$, which provide the size – biased version of the random variable. The size – biased version of order k, which corresponds to the weight $\omega(X) = X^k$, for k any real positive number has also been widely used.

Joan Del Castillo and Pérez Casany (1998) applied the weighted Poisson distribution that results from the modification of the Poisson distribution with the weight $\omega(X) = X^k$ can also considered as a mixture of the size – biased version of the Poisson distribution. They fit the weighted Poisson distribution for over dispersion (aggregation) and under dispersion (repulsion) situation.

Patil *et al*. (1986) have proved that given a random variable X, the weighted version X^k is stochastically greater or smaller than the original random variable X according as the weight function $\omega(X)$ is monotone increasing or decreasing to X.

Patil and Rao (1978) pointed out that the importance of the size-biased version of a random variable X. They show that many classical discrete distributions have a size-biased version of the same form with the variable reduced by unity.

In the construction of acceptance sampling plan, size- biased version of random variable about defectives play an important role. The weighted distributions are more suitable distributions than the classical distributions like Binomial, Poisson and Negative Binomial.

The weighted Poisson distribution plays an important role in acceptance sampling, mainly in the construction of sampling plans. Each outcome (number of defectives) is specific but can be assigned different weights based on its importance or usage.

The probability mass function of weighted Poisson distribution is given by:

$$P(X;\lambda,k)=\frac{X^k P(X;\lambda)}{\sum X^k P(X;\lambda)}\ ;X=0,1,2...$$

where

$$P(X;\lambda)=\frac{e^{-\lambda}\lambda^d}{d!}\qquad ;d=1,2,3,...$$

Here X^k is the corresponding weight for each outcome and 'k' is a constant. The Poisson distribution can be seen as the particular case of the weighted Poisson distribution when k = 0.

The probability mass function of the weighted Poisson distribution for k = 1 is

$P(X,\lambda) = P(X;\lambda, k)$, k= 1

$$=\frac{e^{-np}(np)^{d-1}}{(d-1)!}\ ;d=1,2,3....$$

The probability mass function of the weighted Poisson distribution for k = 2 is

$P(X,\lambda) = P(X;\lambda,k)$; k= 2

$$=\frac{e^{-np}\ (np\ )^{d-1}}{(d-1)!}\frac{d}{1+np};d=1,2,3...$$

(Cameron and Johansson, 1997) instead used polynomial weights, where the weights are squared to avoid the possibility of their being negative. i.e. k= 2.

Subramani and Haridoss (2012) have constructed table for selecting Repetitive Group Sampling (RGS) plan for given AQL and LQL with minimum sum of risks using Weighted Poisson distribution.

Subramani and Haridoss (2013) have constructed table for selecting single sampling attributes plan for given AQL and LQL with minimum sum of risks using Weighted Poisson distribution.

Subramani and Haridoss (2012) have constructed table for selecting MDS-(c_1, c_2) sampling attributes plan for given AQL and LQL with minimum sum of risks using Weighted Poisson distribution.

Subramani and Haridoss (2012) have constructed table for selecting Selection of Tightened–Normal–Tightened System using the Weighted Poisson Distribution for given AQL and LQL with minimum sum of risks using Weighted Poisson distribution.

2. Selection of Minimum Risk MDS–1 Plan

Table 1 is used to select an MDS–1 Plan system using Weighted Poisson Distribution for given AQL (p_1) and LQL (p_2) which involves minimum sum of risks. For the plan of Table-1, producer's and consumer's risk will be at most 10% each against fixed values of the operating ratio p_2/p_1. Table-1 gives the parameters c_1 and c_2 and m of the MDS–1 plan and the associated producer's risk and consumer's risk (α & β respectively) in the body of the table against the product of sample size (n) and AQL (np_1). With the given p_1, p_2 α and β one can find MDS–1 as follows.

1. Compute the operating ratio p_2/p_1
2. With the computed value of p_2/p_1, refer to the row of Table-1 headed by the value of p_2/p_1 which is equal to or just smaller than the computed ratio.
3. The parameters c_1 *and* c_2 and m of the MDS–1 plan are obtained from the table 1, one proceeds from left to right in the row identified in step 2 such that the tabulated producer's and consumer's

risks are equal to or just smaller than the desired values.

Example

If one fixes p_1 = 1% (0.01), p_2 = 45% (0.045) with α = 1% (0.01) and β = 5% (0.05, one obtains a MDS–1 plan (Weighted Poisson Model) using Table-1 as follows:

1) $p_2/p_1 = 0.045/0.01 = 4.5$.
2) Tabulated $p_2/p_1 = 4.5$.
3) Corresponding to c_1 =6 and c_2 = 10 and m = 1 given in the body of the table of Table-1, one obtains α = 1% (0.01) and β = 2 %(0.02) against the desired α = 1% and β = 5%.
4) $n = np_1/p_1 = 2.5/ 0.01 = 250$.

3. Comparison with K. Govindaraju and K.Subramani's Procedure of Selecting MDS–1 plans

Soundararajan and Raju (1983) presented tables for selecting MDS plans for given for given p_1, p_2, α (0.05, 0.01), and β (0.10, 0.05, 0.01) for fixed values of c_1 = 0 and c_2 = 2.Their selection procedure presupposes c_1 and c_2 values. In practice, there will be difficulties in fixing the parameters of the plan, particularly the acceptance numbers. Soundararajan and Vijayaraghavan (1989) have modified the tables of (Soundararajan and Raju, 1983) so that the sum of risks is a minimum for the np_1 and np_2 values that yielded p_2/p_1 when c_1 = 0 and c_2 = 2. Subramani and Govindaraju (1990) have developed tables for the selection of multiple deferred state MDS–1 sampling plan with minimum sum of risks for given acceptable and limiting quality levels using Poisson distribution. The table presented in this paper relates to the generalized MDS–1 plan using Weighted Poisson distribution and makes no assumption of the parameters of the plan. Further the table gives rounded values of p_2/p_1 without any fractions.

For Example, if one fixes p_1 = 0.01, p_2 = 0.05, α = 0.05, and β = 0.05, one gets the following MDS–1 plan using (Subramani and Govindaraju, 1990)'s table (Poisson distribution).

n = 150, c_1 =2, c_2 =6 and m = 1 with α = 0.04 (4%) and β = 0.03 (3%), $\alpha+\beta$ = 7%.

For the same conditions one obtains, the following MDS–1 plan from Table–1 using Weighted Poisson distribution.

n = 150, c_1 =4, c_2 =7 and m = 1 with α = 0.02 and β = 0.03, $\alpha+\beta$ = 5%.

Table-2 illustrates the comparison between these two models for more values of α and β

Selecting a Plan when the Sample Size is fixed:

Table–1 can be used to select an MDS–1 Plan when sample size is fixed for practical or administrative reasons. For example, if one fixes x = 60, AQL = 0.01 and LQL = 0.12, one gets np_1 = 60 (0.01) = 0.60 and p_2/p_1 = 0.12/0.01 = 12. Corresponding to the value of np_1 = 0.60 and p_2/p_1, one obtains the following MDS–1 plan involving minimum sum of risks from (Subramani and Govindaraju, 1990)'s table (Poisson distribution):

n = 60, c_1 =1, c_2 =4 and m = 1 with α = 0.02 and β = 0.01.

For the same conditions one obtains, the following MDS–1 plan from Table–1 using Weighted Poisson distribution.

n = 60, c_1 =3, c_2 =6 and m = 1 with α = 0 and β = 0.01.

Construction of the Table 1:

The OC curve of the MDS–1 plan based on Weighted Poisson model when k = 2 is given by

$$P_a(p) = L(np/c_1) + [L(np/c_2) - L(np/c_1)][L(np/c_1)]^m \quad (1)$$

where

$$L(np/c_1) = \sum_{d=1}^{c_1} \frac{e^{np}(np)^{d-1}}{(d-1)!}\frac{d}{1+np};\ d = 1, 2, 3, \ldots \quad (2)$$

$$L(np/c_2) = \sum_{d=1}^{c_2} \frac{e^{np}(np)^{d-1}}{(d-1)!} \frac{d}{1+np} \text{ ; d} = 1, 2, 3, \ldots\ldots \quad (3)$$

The expression for the sum of the producer's and consumer's risks is given by

$$\alpha + \beta = 1 - P_a(p_1) + P_a(p_2) \quad (4)$$

If the operating ratio p_2/p_1 and np_1 are known, then the expression for np_2 can be written as

$$np_2 = (p_2/p_1)(np_1) \quad (5)$$

Thus, the expression (4) for the minimum sum of risks can be rewritten in terms of p_2/p_1 and np_1 as

$$\alpha + \beta = 1 - \{L(np_1/c_1) + [L(np_1/c_2) - L(np_1/c_1)][L(np_1/c_1)]^m\} + \{L(np_1)(p_2/p_1)/c_1 + [L(np_1)(p_2/p_1)/c_2] - L[(np_1)(p_2/p_1)/c_1]\, L[(np_1)(p_2/p_1)/c_1]^m \quad (6)$$

Table 1 is constructed using expression (6), searching for the minimum value of the sum of risks with the help of the computer program for $c_1 = 0(1)30$, $c_2 = c_1 + 1(1)\ c_1 + 15$ and $m = 0(1)10$ for fixed values of np_1 and p_2/p_1. The producer's and consumer's risks are then obtained corresponding to c_1, c_2 and m values for which the sum of risks is minimum.

5. Conclusion

The main objective of this paper is the consideration of overall risk for a wrong decision as optimization criteria. The plans tabulated here refer to the operating ratios which are often encountered in practice. The sum of risks may be minimized rather than fixed them at given levels, when the "producer" and the "consumer" belong to the same company or interest. Table-1 presented in this paper has been developed using the weighted Poisson distribution for selecting Multiple Deferred State-1(c_1, c_2) plan. Based on the analysis carried out, we can arrive at a conclusion that the weighted Poisson distribution further reduces the sum of risks when compared to Poisson distribution (See Table 2). The OC curve of the Multiple Deferred State-1(c_1, c_2) plan using the weighted Poisson model has better shoulder in comparison with Poisson model (See figure 1).

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Table 1. Parameters of MDS–1 Plan for given p_2/p_1 and np_1 using Weighted Poisson Distribution

p_2/p_1	np_1							
	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0
2.25							8 : 12 : 1 5 : 10	9 : 14 : 1 6 : 6
2.50						7 : 13 : 2 7 : 7	8 : 13 : 1 5 : 5	10 : 18 : 2 3 : 4
2.75					6 : 11 : 2 5 : 10	7 : 11 : 1 4 : 5	9 : 13 : 1 1 : 5	10 : 18 : 1 2 : 2
3.0				5 : 8 : 1 3 : 8	6 : 11 : 2 4 : 6	7 : 12 : 1 4 : 3	9 : 14 : 1 2 : 2	11 : 16 : 1 0.7 : 2
3.25				5 : 9 : 1 4 : 6	6 : 10 : 1 3 : 5	8 : 12 : 1 1 : 3	9 : 15 : 1 1 : 1	11 : 17 : 1 0.7 : 0.8
3.50			5 : 9 : 2 3 : 9	5 : 9 : 1 4 : 4	6 : 11 : 1 3 : 3	8 : 13 : 1 1 : 1	10 : 15 : 1 0.6 : 1	12 : 17 : 1 0 : 0.7
4.0		4 : 8 : 2 4 : 8	5 : 10 : 2 2 : 5	6 : 12 : 2 2 : 3	7 : 13 : 2 0.9 : 2	9 : 17 : 2 0 : 1	10 : 19 : 1 0 : 0	12 : 19 : 1 0 : 0
4.5	3 : 4 : 1 4 : 10	4 : 7 : 1 2 : 8	5 : 8 : 1 2 : 2	6 : 10 : 1 1 : 2	7 : 11 : 1 0.6 : 1	9 : 16 : 1 0 : 0	11 : 18 : 1 0 : 0	13 : 21 : 1 0 : 1
5.0	3 : 5 : 1 4 : 10	4 : 7 : 1 2 : 3	5 : 9 : 1 1 : 1	6 : 11 : 1 0.8 : 0.7	7 : 12 : 1 0.5 : 0	10 : 18 : 2 0 : 0	11 : 18 : 1 0 : 0	14 : 22 : 1 0 : 0

Risk less than 0.1% is tabulated as 0%

Table 1. (Continued)

p_2/p_1	np_1					
	7.0	8.0	9.0	10.0	12.0	14.0
1.75					16 : 22 : 1 5 : 10	18 : 25 : 1 6 : 6
2.0	11 : 17 :2 4 : 12	11 : 16 :1 7 : 6	13 : 18 :1 4 : 7	14 : 20 : 1 4 : 5	18 : 27 : 2 1 : 5	19 : 27 : 1 3 : 2
2.25	11 : 16 :1 3 : 16	12 : 18 : 1 3 : 4	14 : 19 : 1 1 : 4	15 : 21 : 1 2 : 2	18 : 25 : 1 1 : 2	21 : 28 : 1 0.6 : 1
2.50	11 : 17 : 1 2.7 : 2.7	13 : 19 : 1 1 : 2	14 : 21 : 1 1 : 1	16 : 22 : 1 0.8 : 2	19 : 26 : 1 0 : 0.8	21 : 31 : 1 0 : 0
2.75	12 : 17 :1 1 : 2	13 : 20 : 1 1 : 0.9	15 : 22 : 1 0.5 : 0.9	16 : 24 : 1 0.6 : 0	20 : 28 : 1 0 : 0	21 : 33 : 1 0 : 0
3.0	12 : 19 : 1 0.9 : 0.8	14 : 21 : 1 0 : 0.7	16 : 22 : 1 0 : 0.6	18 : 29 : 2 0 : 0	21 : 29 : 1 0 : 0	21 : 35 : 1 0 : 0
3.25	13 : 19 : 1 0 : 0	15 : 21 : 1 0 : 0	16 : 24 : 1 0 : 0	18 : 26 : 1 0 : 0	21 : 31 : 0 0 : 0	21 : 36 : 1 0 : 0
3.50	13 : 20 :1 0 : 0	15 : 23 : 1 0 : 0	17 : 28 : 2 0 : 0	19 : 27 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 36 : 1 0 : 0
4.0	14 : 22 : 1 0 : 0	16 : 25 :1 0 : 0	18 : 27 : 1 0 : 0	20 : 30 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 38 : 1 0 : 0
4.5	15 : 24 : 1 0 : 1	18 : 39 :2 0 : 0	19 : 30 : 1 0 : 0	21 : 32 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 38 : 1 0 : 0
5.0	19 : 36 :1 0 : 0	18 : 28 :1 0 : 0	21 : 31 : 2 0 : 0	21 : 33 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 38 : 1 0 : 0

Table 1. (Continued)

p_2/p_1	np_1										
	0.15	0.20	0.25	0.40	0.50	0.60	0.75	1.0	1.5	2.0	2.5
5.5							2 : 5 : 1 10 : 4	3 : 6 : 1 3 : 5	4 : 8 : 1 2 : 2	5 : 10 : 1 1 : 0.7	7 : 11 : 1 0 : 0.8
6.0							3 : 5 : 1 1 : 10	3 : 6 : 1 3 : 3	5 : 10 : 2 0.5 : 2	6 : 10 : 1 0 : 1	7 : 12 :1 0 : 0
6.5						2 : 4 : 1 7 : 4	3 : 5 : 1 1 : 8	3 : 5 : 1 3 : 1	5 : 10 : 2 0 : 1	6 : 10 : 1 0 : 0.5	7 : 12 :1 0 : 0
7.0						2 : 5 : 1 6 : 4	3 : 5 : 1 1 : 5	4 : 8 : 2 0.5 : 3	5 : 8 : 1 0 : 1	6 : 11 : 1 0 : 0	7 : 13 : 1 0 : 0
8.0					2 : 4 : 1 4 : 4	2 : 5 : 1 6 : 2	3 : 5 : 1 1 : 3	4 : 8 : 2 0.5 : 1	5 : 9 : 1 0 : 0	7 : 11 : 1 0 : 0	8 : 14 : 1 0 : 0
9.0					2 : 5 : 1 4 : 3	3 : 5 : 1 0.5 : 4	3 : 6 : 1 1 : 2	4 : 7 : 1 0 : 0.8	5 : 10 : 1 0 : 0	7 : 12 : 1 0 : 0	9 : 15 : 2 0 : 0
10.0			2 : 4 : 2 1 : 14	2 : 4 : 1 2 : 4	2 : 5 : 1 4 : 1	3 : 5 : 1 0.5 : 3	3 : 6 : 1 0.9 : 0.7	4 : 8 : 1 0 : 0	6 : 10 : 1 0 : 0	7 : 13 : 1 0 : 0	9 : 16 :1 0 : 0
12.0		1 : 3 : 1 10 : 3	2 : 4 : 2 1 : 9	2 : 4 : 1 2 : 2	3 : 5 : 1 0 : 2	3 : 6 : 1 0 : 1	4 : 8 : 2 0 : 0.7	5 : 10 : 2 0 : 0	6 : 12 : 1 0 : 0	8 : 15 : 1 0 : 0	10 : 18: 2 0 : 0
15.0		2 : 4 : 2 0 : 9	2 : 5 : 2 1 : 4	2 : 5 : 1 1 : 0.5	3 : 6 : 1 0 : 0.7	3 : 7 : 1 0 : 0	4 : 8 : 1 0 : 0	5 : 10 : 1 0 : 0	7 : 13 : 1 0 : 0	9 : 16 : 1 0 : 0	11 : 19:1 0 : 0
17.0	1 : 3 : 1 6 : 3	2 : 4 : 2 0 : 6	2 : 5 : 2 1 : 2	3 : 5 :1 0 : 1	3 : 6 : 1 0 : 0	4 : 7 : 1 0 : 0	4 : 8 : 1 0 : 0	5 : 10 : 1 0 : 0	8 : 14 : 2 0 : 0	10 :18 :2 0 : 0	12 : 22: 2 0 : 0
20.0	1 : 3 : 1 6 : 2	2 : 4 : 2 0 : 3	2 : 4 : 1 0.5 : 1	3 : 5 : 1 0 : 0	3 : 7 : 1 0 : 0	4 : 7 : 1 0 : 0	5 : 9 : 1 0 : 0	6 : 11 : 1 0 : 0	8 : 15 : 1 0 : 0	11 :19 :2 0 : 0	14 : 23: 2 0 : 0

Table 1. (Continued)

p_2/p_1	np_1 3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0
5.5	8 : 13 : 1 0 : 0	10 : 18 : 1 0 : 0	12 : 20 : 1 0 : 0	15 : 25 : 1 0 : 0	17 : 28 : 2 0 : 0	19 : 30 : 1 0 : 0	21 : 32 : 1 0 : 0	21 : 33 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 38 : 1 0 : 0
6.0	8 : 14 : 1 0 : 0	10 : 18 : 1 0 : 0	13 : 20 : 1 0 : 0	15 : 25 : 1 0 : 0	18 : 30 : 2 0 : 0	20 : 30 : 2 0 : 0	21 : 33 : 1 0 : 0	21 : 33 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 38 : 1 0 : 0
6.5	8 : 14 : 1 0 : 0	11 : 18 : 1 0 : 0	13 : 22 : 1 0 : 0	16 : 26 : 2 0 : 0	19 : 28 : 2 0 : 0	21 : 32 : 2 0 : 0	21 : 34 : 1 0 : 0	21 : 33 : 1 0 : 0	21 : 34 : 1 0 : 0	↑
7.0	9 : 15 : 1 0 : 0	11 : 19 : 1 0 : 0	14 : 23 : 2 0 : 0	17 : 28 : 2 0 : 0	19 : 31 : 2 0 : 0	21 : 34 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 33 : 1 0 : 0	21 : 34 : 1 0 : 0	↑
8.0	9 : 16 : 1 0 : 0	12 : 20 : 1 0 : 0	15 : 24 : 2 0 : 0	18 : 28 : 2 0 : 0	20 : 22 : 1 0 : 0	21 : 35 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 33 : 1 0 : 0	21 : 34 : 1 0 : 0	↑
9.0	10 : 18 : 1 0 : 0	13 : 23 : 2 0 : 0	16 : 25 : 2 0 : 0	19 : 30 : 1 0 : 0	21 : 33 : 1 0 : 0	21 : 35 : 1 0 : 0	21 : 34 : 1 0 : 0	21 : 33 : 1 0 : 0	↑	↑
10.0	11 : 19 : 2 0 : 0	14 : 23 : 2 0 : 0	17 : 28 :2 0 : 0	20 : 32 : 1 0 : 0	21 : 35 : 1 0 : 0	21 : 35 : 1 0 : 0	21 : 34 : 1 0 : 0	↑	↑	↑
12.0	12 : 21 : 2 0 : 0	16 : 25 : 2 0 : 0	19 : 30 : 2 0 : 0	21 : 35 : 1 0 : 0	21 : 35 : 1 0 : 0	21 : 35 : 1 0 : 0	↑	↑	↑	↑
15.0	14 : 23 : 2 0 : 0	18 : 28 : 2 0 : 0	21 : 35 : 1 0 : 0	21 : 35 : 1 0 : 0	21 : 35 : 1 0 : 0	↑	↑	↑	↑	↑
17.0	15 : 24 : 2 0 : 0	19 : 31 : 2 0 : 0	21 : 35 : 1 0 : 0	↑	↑	↑	↑	↑	↑	↑
20.0	16 : 26 : 2 0 : 0	21 : 30 : 2 0 : 0	21 : 35 : 1 0 : 0	↑	↑	↑	↑	↑	↑	↑

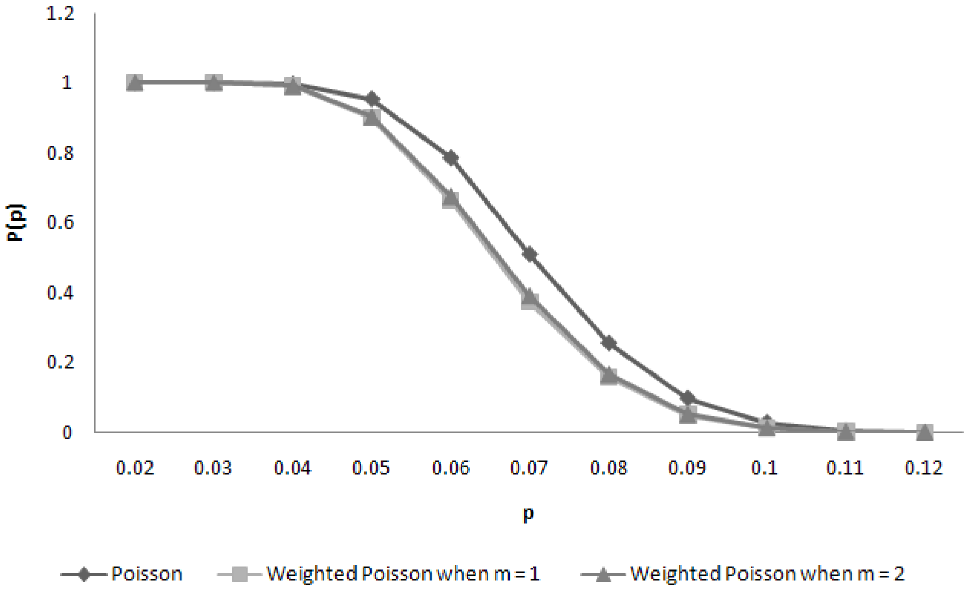
Key : $c_1 : c_2 : m$

$\alpha : \beta$ (%)

↓ - use the plan below; ↑ - use the plan above.

Table 2. Comparison of MDS-1(c_1, c_2) Sampling Plans

Given Values				Poisson Distribution K.Govindaraju and K.Subramani (1990)					Weighted Poisson distribution k = 2				
p_1	p_2	α	β	c_1	c_2	m	α	β	c_1	c_2	m	α	β
0.01	0.05	0.01	0.01	5	11	2	0(<0.1%)	0.02	6	11	1	0.008	0.007
0.01	0.05	0.05	0.05	2	6	1	0.04	0.03	4	7	1	0.02	0.03
0.01	0.06	0.05	0.05	2	5	2	0.01	0.06	3	6	1	0.03	0.03
0.01	0.06	0.01	0.01	8	8	1	0(<0.1%)	0.01	6	10	1	0(<0.1%)	0.01



Comparison of OC curves of MDS–1 Plan (Weighted Poisson Model) with Minimum Risks K.Subramani's MDS–1 Plan (Poisson Model)

Figure 1. Operating Characteristic Curve