SELECTION OF MIXED SAMPLING PLANS WITH CONDITIONAL DOUBLE SAMPLING PLAN AS ATTRIBUTE PLAN INDEXED THROUGH MAPD AND LQL USING IRPD

R. Sampath Kumar[1], R. Vijaya Kumar[2] and R. Radhakrishnan[3]

1. Assistant Professor, Department of Statistics, Government Arts College, Coimbatore - 18.
2. Assistant Professor, Department of Statistics, SSM College of Arts and Science,
3. Associate Professor, Department of Statistics, PSG College of Arts and Science, Coimbatore – 14.

Abstract

This paper presents the procedure for the construction and selection of mixed sampling plan (MSP) using Intervened Random effect Poisson Distribution (IRPD) as a baseline distribution. Having the conditional double sampling plan as attribute plan, the plans are constructed through limiting quality level (LQL) and maximum allowable percent defective (MAPD). Tables are constructed for easy selection of the plan.

Key Words And Phrases: intervened random effect poisson distribution, limiting quality level, mixed sampling plan, maximum allowable percent defective, operating characteristic, poisson, intervened random effect poisson distribution.

AMS (2000) Subject Classification Number: Primary: 62P30 Secondary: 62D05

1. Introduction

Mixed sampling plans consist of two stages of rather different nature. During the first stage the given lot is considered as a sample from the respective production process and a criterion by variables is used to check process quality. If process quality is judged to be sufficiently good, the lot is accepted. Otherwise the second stage of the sampling plan is entered and lot quality is checked directly by means of an attribute sampling plan. The mixed sampling plans have been designed under two cases of significant interest. In the first case, the sample size n_1 is fixed and a point on the OC curve is given. In the second case, plans are designed when two points on the OC curve are given.

There are two types of mixed sampling plans called independent and dependent plans. If the first stage sample results are not utilized in the second stage, then the plan is said to be independent otherwise dependent. The principal advantage of mixed sampling plan over pure attribute sampling plan is a reduction in sample size for a similar amount of protection.

Schilling (1967) proposed a method for determining the operating characteristics of mixed variables – attributes sampling plans, single sided specification and standard deviation known using the normal approximation. Baker and Brobst (1978) have introduced the Conditional Double Sampling Plan procedures. It has Operating Characteristic Curves identical to those of comparable Double Sampling procedures when the second sample is required to make a decision, it can be obtained from a related lot and not from the current lot. Conditional Double Sampling Plan by using sample information from related lot results in more attractive Operating Characteristic Curves and smaller sample sizes. This reduction in sample size is the Principal advantage of these procedures over traditional sampling procedures.

Devaarul (2003) has studied the mixed sampling plans and reliability based sampling plans. Radhakrishnan and Sampath Kumar (2006, 2007 and 2009) have constructed the mixed sampling plans using Poisson distribution as a baseline distribution. Sampath Kumar (2007) has constructed mixed variables – attributes sampling plans indexed through various parameters.

In the product control, the defective units are either rebuilt or replaced by new units during the sampling period. Quality engineers are always interested in improving the quality level of product to enhance the satisfaction of the customers and hence, they keep making changes in the production process. These actions trigger a change in the expected incidence of defective items in the remaining observational period. Any action for reducing the number of defectives during the sampling period is called an intervention and such intervention parameter ranges from 0 to 1.

In Intervened Random effect Poisson Distribution (IRPD), Poisson parameter is modified in two ways: one method is multiplying an intervention parameter ρ (a constant) and secondly, multiplying an unobserved random effect which follows Gamma probability distribution. The IRPD can be very useful to the quality and reliability engineers, who always make changes in the production system in the observational period of quality checking to ensure reliability of the system, because, the failure rate of the components may vary in different time intervals. The other areas of application of IRPD are queuing, demographic studies and process control and so on.

Shanmugam (1985) has used Intervened Poisson Distribution (IPD) in the place of Zero Truncated Poisson Distribution (ZTPD) for the study on cholera cases. Radhakrishnan and Sekkizhar (2007a, b, c) introduced Intervened Random effect Poisson Distribution in the place of Poisson distribution for the construction of attribute sampling plans.

In this paper, using the operating procedure of mixed sampling plan (independent case) with conditional double sampling plan as attribute plan, tables are constructed using IRPD as a baseline distribution. The tables are constructed for mixed sampling plan (MSP) indexed through i) LQL ii) MAPD. The plan indexed through MAPD is compared with the plan indexed through LQL.

2. Conditions For Applications Of IRPD - Mixed Sampling Plan

- Production process is modified during the sampling inspection by an intervention.
- Lots are submitted substantially in the order of their production.
- Inspection is by variable in the first stage and attribute in the second stage with quality defined as the fraction defective.
- Lot quality variation exists.

3. Glossary of symbols:

The symbols used in this paper are as follows:

p : submitted quality of lot or process

$P_a(p)$: probability of acceptance for given quality ' p '

p_2 : submitted quality such that $P_a(p_2)$ = 0.10 (also called LQL)

p_* : maximum allowable percent defective (MAPD)

n : sample size for each lot

$n_{1,1}$: first sample size for variable sampling plan

$n_{1,2}$: first sample size for attribute sampling plan

$n_{2,2}$: second sample size for attribute sampling plan

c_1 : first attributes acceptance number

c_2 : second attributes acceptance number

c_3 : third attributes acceptance number

d_i : number of defectives in the i^{th} sample (j=1,2,3,…..)

β_j : probability of acceptance for the lot quality ' p_j '

β_j' : probability of acceptance under variables plan for percent defective ' p_j '(with sample size n_1)

β_j'' : probability of acceptance under attributes plan for percent defective ' p_j '(with sample size n_2)

z (j) : 'z' value for the j^{th} ordered observation

k : variable factor such that a lot is accepted if $\bar{X} \geq A = L + k\sigma$

4. Operating Procedure Of Mixed Sampling Plan Having Conditional Double Sampling Plan As Attribute Plan

Schilling (1967) has given the following procedure for the independent mixed sampling plan with lower specification limit (L) and standard deviation (σ).

Determine the parameters of the mixed sampling plan $n_{1,1}$, $n_{1,2}$, $n_{2,2}$, k, c_1, c_2 and c_3

- Take a random sample of size $n_{1,1}$ from the lot
- If a sample average $\bar{X} \geq A = L + k\sigma$, accept the lot
- If a sample average $\bar{X} < A = L + k\sigma$ take a second sample of size $n_{1,2}$ (ie., $n_{1,2} = n_{1,1}$)
- Inspect all the articles included in the sample. Led 'd_i' be the number of defectives in the sample
- If $d_i \leq c_1$, accept the lot
- If $d_i > c_2$, reject the lot
- If $c_1+1 \leq d_i \leq c_2$, then take a second sample of size $n_{2,2}$ from the preceding (i-1) lot or the next (i+1) lot
- Find the number of defectives d_{i-1} or d_{i+1}. Then find $d = d_i + d_{i-1}$ or $d = d_i + d_{i+1}$
- If $d \leq c_3$, accept the lot otherwise reject the lot.

5. Construction of mixed sampling plan having conditional double sampling plan as attribute plan using irpd.

Schilling (1967) has given the OC function of mixed sampling plan as

$$L(p) = \mathrm{Pn}_1(\bar{X} \leq \mathrm{A}) + \mathrm{Pn}_1(\bar{X} > \mathrm{A}) \sum_{j=0}^{c} p(j; n_2) \quad (1)$$

The above expression is given as

$$\beta_j = \beta_j' + (1-\beta_j')\,\beta_j'' \quad (2)$$

The operation of mixed sampling plans can be properly assessed by the OC curve for given values of the fraction defective. The development of mixed sampling plans and the subsequent discussions are limited only to the upper specification limit 'U'. By symmetry, a parallel discussion can be made for lower specification limits.

The procedure for the construction of mixed variables – attributes sampling plans is provided by Schilling (1967) for a given '$n_{1,1}$' , 'k' and a point 'p_j' on the OC curve is given below.

- Assume that the mixed sampling plans are independent
- Split the probability of acceptance (β_j) determining the probability of acceptance that will be assigned to the first stage. Let it be β_j'
- Decide the sample size $n_{1,1}$ (for variable sampling plan) to be used
- Calculate the acceptance limit for the variable sampling plan as $\mathrm{A} = L + k\sigma = L + [z(p_j) + \{z(\beta_j')/\sqrt{n_{1,1}}\}]\sigma$, where L is the lower specification limit and z (t) is the standard normal variate corresponding to 't' such that $t = \int_{z(t)}^{\infty} \left(\frac{1}{\sqrt{2\pi}}\right) e^{-u^2/2}\, du$
- Determine the sample average $\bar{X}$. If a sample average $\bar{X} < \mathrm{A} = L + k\sigma$, take a second stage sample size '$n_{1,2}$' using attribute sampling plan.
- Split the probability of acceptance β_j as β_j' and β_j'', such that $\beta_j = \beta_j' + (1-\beta_j')\,\beta_j''$ and fix the value of β_j'.
- Now determine β_j'', the probability of acceptance assigned to the attributes plan associated with the second stage sample as $\beta_j'' = (\beta_j - \beta_j')/(1-\beta_j')$
- Determine the appropriate second stage sample size '$n_{1,2}$' from $P_a(p) = \beta_j''$ for $p = p_j$

Using the above procedure, tables can be constructed to facilitate easy selection of mixed sampling plan with conditional double sampling plan as attribute plan using IRPD as a baseline distribution indexed through MAPD and LQL.

Radhakrishnan and Sekkizhar (2007a, b and c) suggested the probability mass function of the CDSP using IRPD as a baseline distribution for $n = n_{1,2} = 2n_{2,2}$ is

$$P_a(p) = \sum_{i=0}^{c_1} p_i + p_{c_1+1} \sum_{i=0}^{c_3-c_1-1} q_i + p_{c_1+2} \sum_{i=0}^{c_3-c_1-2} q_i + \ldots\ldots\ldots\ldots\ldots + p_{c_2} \sum_{i=0}^{c_3-c_2} q_i \quad (3)$$

where
$$p_i = \left[\frac{e^{-m\theta}(m\theta)^i}{(1+\rho m\theta)^{\alpha}} \sum_{l=0}^{i} \left(\frac{\rho}{1+\rho m\theta}\right)^l \frac{(\alpha+l-1)!}{l!(i-l)!(\alpha-1)!}\right]$$

$$q_i = \left[\frac{e^{-\theta}\theta^i}{(1+\rho\theta)^{\alpha}} \sum_{l=0}^{i} \left(\frac{\rho}{1+\rho\theta}\right)^l \frac{(\alpha+l-1)!}{l!(i-l)!(\alpha-1)!}\right] \text{ and } \theta = \left(\frac{np}{1+\rho}\right)$$

The tables furnished in this paper are for the case when α=1, m=2 and $n = n_{1,2} = 2n_{2,2}$.

6. Construction Of Mixed Sampling Plans Indexed Through MAPD And MAAOQ

MAPD, introduced by Mayer (1967) and studied by Soundararajan (1975) is the quality level corresponding to the inflection point of the OC curve. The degree of sharpness of inspection about this quality level ' p_* ' is measured by ' p_t ', the point at which the tangent to the OC curve at the inflection point cuts the proportion defective axis for designing, Soundararajan (1975) proposed a selection procedure for single sampling plan indexed with MAPD and K= $\frac{p_t}{p_*}$.

Using the probability mass function of the IRPD, given in expression (3), the inflection point (p_*) is obtained by using $\frac{d^2P_a(p)}{dp^2} = 0$ and $\frac{d^3P_a(p)}{dp^3} \neq 0$. The $n_{1,2}$MAPD values are calculated for different values of c_1, c_2, c_3 and ρ=0.7 for $\beta_*' = 0.04$ using c++ program and presented in Table 1.

The MAAOQ (Maximum Allowable Average Outgoing Quality) of a sampling plan is defined as the Average Outgoing Quality (AOQ) at the MAPD.

By definition AOQ = $p\ P_a(p)$ and

MAAOQ = $p_*\ P_a(p_*)$

The values of MAPD and MAAOQ are calculated for different values of c_1, c_2, c_3 and ρ for $\beta_*' = 0.30$ and the ratio $R = \frac{MAAOQ}{MAPD}$ is presented in Table 1.

Table 1: $n_{1,2}$MAPD and $n_{1,2}$MAAOQ values for a specified values of c_1, c_2, c_3 and different values of ρ for mixed sampling plan when $\beta_*' = 0.04$

ρ	c_1	c_2	c_3	β_*	β_*''	$n_{1,2}$MAPD	$n_{1,2}$MAAOQ	$R = \frac{MAAOQ}{MAPD}$
0.8	3	6	10	0.5970	0.5802	3.0373	1.7622	0.5802
			11	0.5916	0.5745	3.1474	1.8081	0.5745
			12	0.5879	0.5707	3.2213	1.8383	0.5707
			13	0.5853	0.5680	3.2704	1.8575	0.5680
	3	7	10	0.5944	0.5775	3.2913	1.9006	0.5775
			11	0.5879	0.5707	3.4784	1.9851	0.5707
			12	0.5833	0.5659	3.6171	2.0469	0.5659
			13	0.5799	0.5623	3.7172	2.0901	0.5623
	6	7	10	0.6075	0.5911	3.5044	2.1162	0.5911
			11	0.6066	0.5902	3.5802	2.1130	0.5902
			12	0.6045	0.5880	3.6438	2.1425	0.5880
			13	0.6015	0.5848	3.6964	2.1616	0.5848
			14	0.5981	0.5813	3.7387	2.1733	0.5813
			15	0.5947	0.5778	3.7729	2.1510	0.5778
			16	0.5916	0.5745	3.8005	2.1833	0.5745
	6	8	10	0.6075	0.5911	3.6546	2.1602	0.5911
			11	0.6065	0.5901	3.8083	2.2472	0.5901
			12	0.6036	0.5870	3.9475	2.3171	0.5870
			13	0.5995	0.5828	4.0650	2.3690	0.5828
			14	0.5996	0.5829	4.0482	2.3596	0.5829
			15	0.5946	0.5777	4.2141	2.4344	0.5777
			16	0.5890	0.5718	4.2820	2.4484	0.5718
0.7	3	6	10	0.5577	0.5392	3.1080	1.6758	0.5392
			11	0.5520	0.5333	3.2963	1.7579	0.5333
			12	0.5481	0.5292	3.3761	1.7866	0.5292

			13	**0.5452**	**0.5262**	**3.4292**	**1.8044**	**0.5262**
	3	**7**	**10**	**0.5560**	**0.5375**	**3.4287**	**1.8429**	**0.5375**
			11	**0.5489**	**0.5489**	**3.5514**	**1.9493**	**0.5489**
			12	**0.5440**	**0.5250**	**3.7765**	**1.9826**	**0.5250**
			13	**0.5405**	**0.5213**	**3.8828**	**2.0241**	**0.5213**
	6	**7**	**15**	**0.4799**	**0.4582**	**4.3490**	**1.9927**	**0.4582**
			16	**0.4744**	**0.4525**	**4.3954**	**1.9889**	**0.4525**
	6	**8**	**10**	**0.5680**	**0.4875**	**4.0860**	**1.9919**	**0.4875**
			11	**0.5644**	**0.5465**	**3.9768**	**2.1733**	**0.5465**
			12	**0.5622**	**0.5439**	**4.1224**	**2.2421**	**0.5439**
0.5	**3**	**6**	**10**	**0.4813**	**0.4596**	**3.4175**	**1.5706**	**0.4596**
			11	**0.4759**	**0.4540**	**3.5452**	**1.6095**	**0.4540**
			12	**0.4717**	**0.4496**	**3.6332**	**1.6334**	**0.4496**
			13	**0.4688**	**0.4466**	**3.6897**	**1.6478**	**0.4466***
	3	**7**	**10**	**0.4801**	**0.4584**	**3.6635**	**1.6793**	**0.4584**
			11	**0.4737**	**0.4517**	**3.8760**	**1.7507**	**0.4517**
			12	**0.4688**	**0.4466**	**4.0378**	**1.8032**	**0.4466**

Selection of the plan

For the given values of ρ, β_*', MAPD and MAAOQ, the ratio $R = \dfrac{MAAOQ}{MAPD}$ is found and the nearest value of R is located in Table 1. The corresponding value of c_1, c_2, c_3 and $n_{1,2}$MAPD values are noted and the value of $n_{2,2}$ is obtained using $n_{1,2} = \dfrac{n_{1,2}MAPD}{MAPD}$.

Example 1: Given ρ=0.8, $\beta_*' = 0.04$, MAPD=0.092 and MAAOQ=0.041, the ratio $R = \dfrac{MAAOQ}{MAPD} = \dfrac{0.041}{0.092}$ =0.4456 is computed. In Table 1 the nearest R value is 0.4466 which is corresponding to c_1=3, c_2=6, c_3=13. The value of $n_{1,2}$MAPD=3.6897 is found and hence the value of $n_{1,2}$ is determined as $n_{1,2} = \dfrac{n_{1,2}MAPD}{MAPD} = \dfrac{3.6897}{0.092} = 40$. Thus $n_{1,2}$=40, $n_{2,2}$=20, c_1=3 , c_2=6 and c_3=13 are the parameters of mixed sampling plan having CDSP as attribute plan using IRPD as a baseline distribution for the given values of ρ=0.8, MAPD=0.092 and MAAOQ=0.041.

Practical problem: Suppose the plan $n_{1,1}$=17, k=2g is the lot by lot acceptance inspection of a health drink product with carbohydrate specification 62g (500g pack) with known S.D(σ)=1.25g. In this example L=62g, σ =1.25g and k=2g, $\mathrm{A} = L + k\sigma$ = 62 + 2(1.75)=64.5g

Now by applying the variables inspecting first, take random sample of size $n_{1,1}$=17 from the lot. Record the sample results and find $\bar{X}$. If $\bar{X} \geq \mathrm{A} = L + k\sigma$ =64.5g, then accept the lot. If $\bar{X} < \mathrm{A}$, take a random sample of size $n_{1,2}$ and apply the attribute inspection.

Under attributes inspection, by using Conditional double sampling plan as attribute plan using intervened Random effect Poisson Distribution (IRPD) as a baseline distribution, if the manufacturer fixes the values MAPD= 0.092(9.2 non conformities out of 100), MAAOQ=0.041(41 non conformities out of 100) and $\beta_*' = 0.04$, take a sample of size $n_{1,2}$ =40 and observe the number of defectives d_i . If $d_i \leq 3$, accept the lot and if $d_i > 6$, reject the lot. If $4 \leq d_i \leq 6$, take a second sample of size $n_{2,2}$ =20 from the remaining lot and find the number of defectives (d). If d≤13 accept the lot otherwise reject the lot and inform the management for further action.

7. Construction Of Mixed Sampling Plans Indexed Through LQL

The procedure given in section 5 is used for constructing the mixed sampling plan indexed through LQL (p_2). By assuming the probability of acceptance of the lot be β_2 =0.10 and β_2' =0.14, the $n_{1,2}\, p_2$ values are calculated for different values of c_1, c_2, c_3 and 'ρ' using c++ program and is presented in Table 2.

Table 2: $n_{1,2}$ LQL values for a specified values of c_1, c_2, c_3 and ρ of mixed sampling plan when β_2 =0.10 and β_2' =0.04

c_1	c_2	c_3	ρvalues								
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3	**6**	**10**	**5.2156**	**5.3555**	**5.5233**	**5.7037**	**5.8894**	**6.0771**	**6.2646**	**6.4508**	**6.6350**
		11	**5.4061**	**5.5541**	**5.7304**	**5.9190**	**6.1127**	**6.3079**	**6.5026**	**6.6957**	**6.8865**
		12	**5.5506**	**5.7069**	**5.8918**	**6.0886**	**6.2902**	**6.4928**	**6.6947**	**6.8945**	**7.0918**
		13	**5.6541**	**5.8189**	**6.0124**	**6.2174**	**6.4268**	**6.6368**	**6.8457**	**7.0522**	**7.2558**
3	**7**	**10**	**5.4281**	**5.5720**	**5.7452**	**5.9316**	**6.1237**	**6.3178**	**6.5116**	**6.7041**	**6.8944**
		11	**5.7003**	**5.8537**	**6.0374**	**6.2344**	**6.4368**	**6.6408**	**6.8442**	**7.0458**	**7.2449**
		12	**5.9235**	**6.0866**	**6.2805**	**6.4876**	**6.6998**	**6.9133**	**7.1259**	**7.3362**	**7.5437**
		13	**6.0990**	**6.2717**	**6.4756**	**6.6923**	**6.9140**	**7.1364**	**7.3576***	**7.5763**	**7.7918**
6	**7**	**10**	**5.9484**	**6.1517**	**6.3931**	**6.6517**	**6.9183**	**7.1883**	**7.4591**	**7.7293**	**7.9980**
		11	**6.0411**	**6.2441**	**6.4854**	**6.7442**	**7.0111**	**7.2815**	**7.5529**	**7.8237**	**8.0929**
		12	**6.4105**	**6.3437**	**6.5854**	**6.8445**	**7.1120**	**7.3829**	**7.6549**	**7.9262**	**8.1960**
		13	**6.2334**	**6.4378**	**6.6806**	**6.9407**	**7.2091**	**7.4809**	**7.7536**	**8.0257**	**8.2963**
		14	**6.3116**	**6.5183**	**6.6806**	**7.0251**	**7.2349**	**7.5681**	**7.8421**	**8.1153**	**8.3869**
		15	**6.3717**	**6.5818**	**6.8297**	**7.0942**	**7.3662**	**7.6414**	**7.9171**	**8.1919**	**8.4649**
		16	**6.4143**	**6.6285**	**6.8801**	**7.1479**	**7.4228**	**7.7005**	**7.9785**	**8.2553**	**8.5301**
6	**8**	**10**	**6.0153**	**6.2187**	**6.4607**	**6.7202**	**6.9878**	**7.2589**	**7.5310**	**7.8024**	**8.0723**
		11	**6.1758**	**6.3791**	**6.6215**	**6.8818**	**7.1505**	**7.4229**	**7.6964**	**7.9693**	**8.2407**
		12	**6.3564**	**6.5604**	**6.8040**	**7.0657**	**7.4662**	**7.6100**	**7.8851**	**8.1596**	**8.4326**
		13	**6.5334**	**6.7396**	**6.9855**	**7.2495**	**7.5220**	**7.7982**	**8.0753**	**8.3518**	**8.6266**
		14	**6.6915**	**6.9013**	**7.1507**	**7.4179**	**7.6934**	**7.9723**	**8.2521**	**8.5309**	**8.8080**
		15	**6.8229**	**7.0377**	**7.2916**	**7.5630**	**7.8423**	**8.1246**	**8.4075**	**8.6892**	**8.9689**
		16	**6.9253**	**7.1462**	**7.4058**	**7.6822**	**7.9659**	**8.2524**	**8.5389**	**8.8240**	**9.1069**

Selection of the plan

Table 2 is used to construct the plans when p_2, ρ, c_1, c_2 and c_3 are given. For any given values of p_2, ρ, c_1, c_2 and c_3 one can determine $n_{1,2}$ value using $n_{1,2} = \frac{n_{1,2} p_2}{p_2}$.

Example 2: Given ρ=0.7, p_2 =0.10194, c_1=3, c_2=7, c_3=13 and β_2' =0.04. Using Table 2, find $n_{1,2} = \frac{n_{1,2} p_2}{p_2} = \frac{7.3576}{0.10194} = 72$.

For a fixed $\beta_*' = 0.04$, the mixed sampling plan with CDSP as attribute plan is $n_{1,2}$=72, $n_{2,2}$=36, ρ=0.7, c_1=3, c_2=7 and c_3=13.

8. Comparison Of Mixed Sampling Plan Indexed Through MAPD And LQL

In this section MSP indexed through MAPD is compared with MSP indexed through IQL by fixing the parameters c_1, c_2, c_3 and β_j'.

For the specified values of ρ, MAPD and MAAOQ with the assumption for $\beta_*' = 0.04$ one can find the values of c_1, c_2 and c_3 indexed through MAPD. By fixing the values of c_1, c_2 and c_3 find the value of p_2 by equating $P_a(p) = \beta_2$ =0.10. For β_2' =0.04, c_1, c_2 and c_3 one can find the values of $n_{2,2}$ using $n_{1,2} = \frac{n_{1,2} p_2}{p_2}$ from Table 2. For different combinations of ρ, MAPD and MAAOQ the values of c_1, c_2, c_3 and $n_{1,2}$ (indexed through MAPD) and c_1, c_2, c_3 and $n_{1,2}$ (indexed through LQL) are calculated and presented in Table 3.

Construction of OC curve

The OC curves for the plan ρ=0.8, $n_{1,2}$=40, $n_{2,2}$=20, c_1=3, c_2=6, c_3=13 (indexed through MAPD) and $n_{1,2}$=44, $n_{2,2}$=22, c_1=3, c_2=6, c_3=13 (indexed through LQL) based on the different values of ‘ $n_{1,2}\,p_2$ ’ and $P_a(p)$ are presented in Figure 1.

Table 3: Comparison of the Plans

Given Values			Indexed Through MAPD					Indexed Through LQL				
MAPD	**MAAOQ**	**ρ**	c_1	c_2	c_3	$n_{1,2}$	$n_{2,2}$	c_1	c_2	c_3	$n_{1,2}$	$n_{2,2}$
0.092	**0.041***	0.8	3	6	13	40	20	3	6	13	44	22
0.112	**0.063**	0.7	3	7	13	66	33	3	7	13	72	36
0.069	**0.039**	0.5	3	7	12	52	26	3	7	12	57	29
0.156	**0.092**	0.8	6	7	12	23	12	6	7	12	25	13

*OC curves are drawn

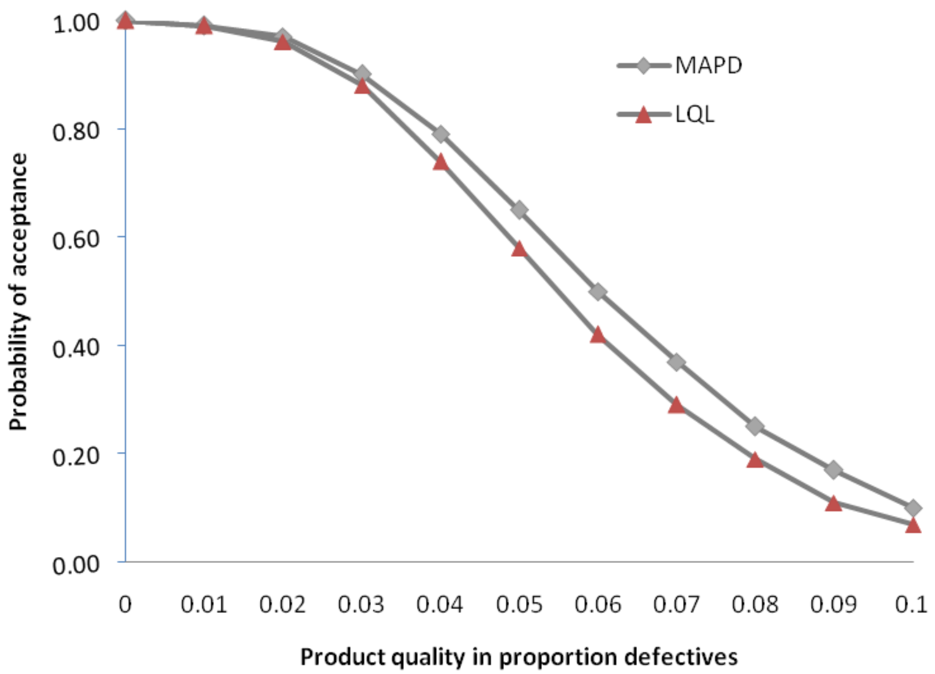

Fig1: OC curves for the plans (ρ=0.8, c_1=3, c_2=6, c_3=13, $n_{1,2}$=40, $n_{2,2}$=20) and (ρ=0.8, c_1=3, c_2=6, c_3=13, $n_{1,2}$=44, $n_{2,2}$=22)

9. Conclusion

In this paper the construction of mixed sampling plan with conditional double sampling plan as attribute plan indexed through the parameters MAPD and LQL are presented by taking IRPD as a baseline distribution. Further the plan indexed through MAPD is compared with the plan indexed through LQL. It is concluded from the study that the second stage sample size required for conditional double sampling plan indexed through MAPD is less than that of second stage sample size of the conditional double sampling plan indexed through LQL. If the floor engineers know the levels of MAPD or LQL, they can have their sampling plans on the floor itself by referring to the tables. This provides the flexibility to the floor engineers in deciding their sampling plans. Various plans can also be constructed to make the system user friendly by changing the first stage probabilities (β_*' , β_2') and can also be compared for their efficiency.

References

1. R.C. Baker, and R.W. Brobst, 1978, Conditional Double Sampling Plan, *Journal of Quality Technology*, Vol. 10, No. 4, pp.150-154.
2. Devaarul, S., 2003, Certain Studies Relating to Mixed Sampling Plans and Reliability Based Sampling Plans, Ph.D., Dissertation, Bharathiar University, Coimbatore, Tamil Nadu, India.
3. P.L. Mayer, 1967, A note on sum of Poisson probabilities and an application, *Annals of Institute of Statistical Mathematics*, Vol.19, pp.537-542.
4. R. Radhakrishnan, and R. Sampath Kumar, 2006, Construction of mixed sampling plan indexed through MAPD and AQL with chain sampling plan as attribute plan, STARS, Vol.7, No.1, June 2006, pp.14-22. .
5. R. Radhakrishnan, and R. Sampath Kumar, 2007, Construction and comparison of mixed sampling plans having repetitive group sampling plan as attribute plan, *National Journal of Technology*, Vol. 4, No. 3. pp. 1-6.
6. R. Radhakrishnan, and R. Sampath Kumar, 2009, Construction and comparison of mixed sampling plans having ChSP-(0,1) plan as attribute plan, *The International Journal of Statistics and Management System,* Vol.4, No.1-2, pp. 134-149.
7. R. Radhakrishnan, and J. Sekkizhar, 2007a, Construction of sampling plans using intervened random effect Poisson distribution. *The International Journal of Statistics and Management Systems*, Vol.2, 1-2, pp 88-97.
8. R. Radhakrishnan, and J. Sekkizhar, 2007b, Construction of conditional double sampling plans using intervened random effect Poisson distribution, Proceedings volume of *SJYSDNS-2005, Acharya Nagarjuna University, Guntur.* Pp.57-61.
9. R. Radhakrishnan, and J. Sekkizhar, 2007c, Application of intervened random effect Poisson distribution in process control plans, *International Journal of Statistics and Systems.* Vol. 2. No.1. pp.29-39.
10. Sampath Kumar, R., 2007, Construction and Selection of Mixed Variables – Attributes Sampling Plans, Ph.D., Dissertation, Bharathiar University, Coimbatore, Tamil Nadu, India.
11. Schilling, E.G., 1967, A General Method for Determining the Operating Charateristics of Mixed Variables – Attribute Sampling Plans Single Side Specifications, S.D. known, Ph.D Dissertation – Rutgers – The State University, New Brunswick, New Jersy.
12. R. Shanmugam, 1985, An intervened Poisson distribution and its medical applications, *Biometrics*, 41, 1025-1029.
13. V. Soundararajan, 1975, Maximum allowable percent defective (MAPD) single sampling inspection by attributes plan, *Journal of Quality Technology*, Vol.7, No.4, pp.173-182.