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Construction of Double Sampling Plan Indexed through average Quality Level

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Abstract

Among the probability distributions that are used to describe the chance whose observational apparatus becomes active only when at least one event occurs is Zero Truncated Poisson Distribution (ZTPD). Shanmugam (1985) has shown that a Zero Truncated Poisson Distribution (ZTPD) can be used to model such second quality lots which have the possibility of at least one defective in the sample information. In this paper the procedure for the construction of Double Sampling Plan indexed through Average Quality Level (AQL) using Truncated Binomial Distribution (TBD) as the base line distribution is presented and a table is also presented using Excel packages for the easy selection of the plans.

Keywords: Average Quality Level, Truncated Binomial Distribution, Double Sampling Plan, Operating Characteristic Curve.

Introduction

The advantages and performance measures of Double sampling plan can be seen in Shilling (1982). There are number of tables available to design a double sampling plan including Dodge and Romig (1959) which provide Double sampling plans with minimum Average Total inspection. Shilling and Johnson (1980) have developed a table for the construction and evaluation of matched sets of single, double and multiple sampling plans. Further, Soundararajan and Arumainayagam (1990a) have provided tables for easy selection of double sampling plan indexed by AQL, Average outgoing Quality Level (AOQL) and Limiting Quality Level (LQL).

Radhakrishnan (2002) constructed Double, Link, Chain and Continuous sampling plans indexed through Maximum Allowable Average Outgoing Quality (MAAOQ).

Radhakrishnan and Sampathkumar (2007a) constructed mixed sampling plans indexed through Maximum Allowable Proportion Defective (MAPD) an AQL with double sampling plan as attribute plan. Radhakrishnan and Ravisankar (2009) constructed Three-Class Attributes Double sampling plan Indexed through Fixed points on OC Surface.

Govindaraju (1989) using a sampling plan with a given Acceptable Quality Level and the producer's risk of 5%, the producer guarantees that if the incoming quality is maintained at or better than AQL, the percentage of production that will be accepted during the periods of sampling is at least 95%. Shankar and Sahu (2002) studied process control plans using AQL, LQL and Average Outgoing Deterioration Limit (AODL). Radhakrishna Rao (1977) suggested the use of Weighted Binomial Distribution in the Construction of Sampling plans. Radhakrishnan and Mohana priya (2008 a,b) constructed Single and Conditional Double Sampling Plans using Weighted Poisson distribution as the base line distribution. Radhakrishnan and Alagirisamy (2011) Constructed Group Sampling Plan using Weighted Binomial Distribution as the base line distribution. Radhakrishnan and Pratheeba (2011) Constructed Single Sampling plan using Truncated Binomial Distribution as the base line Distribution.

In this Paper a Double Sampling Plan is constructed by assuming the probability of acceptance of a lot as 0.95, (the proportion defective corresponding to this probability of acceptance in the OC (Operating Characteristic) curve is termed as Average Quality Level) using Truncated Binomial distribution as the base line distribution.

Conditions for Application

- Production is Continuous, so that results of the past, present and future lots are broadly the indicative of a continuous process.
- Lots are submitted sequentially.
- Inspection is by attributes, with the lot quality as the proportion defective.

Glossary of Symbols

p	Proportion Defective / Lot Quality
q	$1 - p$
n	Sample Size
α	Producer's Risk
$P_a(p)$	Probability of acceptance of the lot quality p
c_1	Number of defectives in first Sample
c_2	Number of defectives in second Sample

Operating procedure of Double Sampling Plan

The operating procedure of Double Sampling Plan is as follows

Step 1: Select a random sample of size n_1 from the lot (N) and count the number of non- conformities (d_1).

Step 2: If $d_1 \leq c_1$, accept the lot.

Step 3: If $d_1 > c_2$, reject the lot.

Step 4: If $c_1 < d_1 \leq c_2$, take a second sample of size n_2 from the remaining lot and count the number of non-conformities (d_2).

Step 5: If $d_1+d_2 \leq c_2$, accept the lot.

Step 6: If $d_1+d_2 > c_2$, reject the lot.

Operating Characteristic function

The Operating Characteristic (OC) function of the Double Sampling Plan (DSP) is given by

$$Pa(p) = \sum_{i=0}^{c_1} p_i + \sum_{j=c_1+1}^{c_2} p_j \sum_{i=0}^{c_2-j} q_i \quad \dots\dots\dots\dots\dots\dots\dots. \qquad (1)$$

Where $$P_i = \frac{\binom{n_1}{x} p^x q^{n_1-x}}{(1-q^{n_1})} \quad , \quad q_i = \frac{\binom{n_2}{x} p^x q^{n_2-x}}{(1-q^{n_2})} \quad ; \quad (n_1 = n_2)$$

Construction of Double Sampling Plan Indexed through AQL

By fixing the probability of acceptance of the lot, Pa(p) as 0.95 with Truncated Binomial Distribution as the basic distribution and from equation (1), the values of the AQL are obtained for the various combinations of 'n' , 'c_1' and 'c_2' using a Excel package and are presented in Table 1. The parameters of the double sampling plan, n, c_1 and c_2 are recorded for various combinations of AQL.

Table 1: Parameters of DSP for a specified AQL

n	c_1	c_2	AQL
200	1	2	0.0199842
200	2	3	0.0574860
200	3	4	0.1009006
200	4	5	0.0996165
200	5	6	0.1199621
175	1	2	0.0071836
175	2	3	0.0802580
175	3	4	0.1371379
175	4	5	0.1890886
175	5	6	0.1593492
150	1	2	0.0083653
150	2	3	0.0926661
150	3	4	0.1584347
150	4	5	0.1702701
150	5	6	0.1845069
125	1	2	0.0100489
125	2	3	0.4588265
125	3	4	0.1544293

125	4	5	0.1391742
125	5	6	0.2690713
100	1	2	0.0125592
100	2	3	0.1463474
100	3	4	0.1659702
100	4	5	0.2028125
100	5	6	0.4608510
75	1	2	0.0167425
75	2	3	0.8268638
75	3	4	0.2454486
75	4	5	0.2699769
75	5	6	0.3064234

Example

For a given AQL = 0.09, the value of n, c_1 and c_2 are obtained from table 1 as n = 200, $c_1 = 4$ and $c_2 = 5$. Hence the parameters of Double Sampling Plan are n = 200, $c_1 = 4$ and $c_2 = 5$ with the specified AQL = 0.09. The OC curve for this plan is presented in figure 1**.**

Practical Application

In a drug supplying company, if the distributor fixes the AQL as 0.09 (9 non-confirming items out of 1 hundred drugs) for a lot, then take a sample 200 items/drugs from the manufactured lot of a particular day/week and count the number of non-confirming items (d_1). If $d_1 \leq 4$ accept the items supplied in that day/week and if $d_1 > 5$, reject the items supplied in that day/week and suggest for an improvement in the quality. If $d_1 = 5$, take a second sample of 200 items from the remaining lot and count the number of non-confirming items (d_2). If $d_1+d_2 \leq 5$ accept the lot, supplied in the same day/week, otherwise reject the lot and inform the management for the quality improvement.

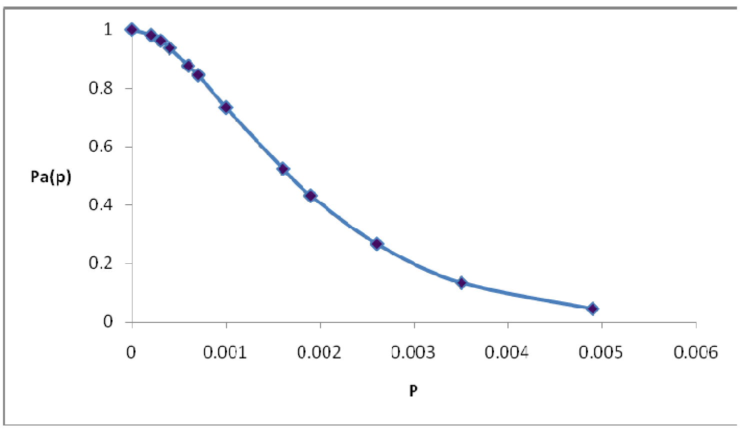

Figure 1: OC curve for the plans $n_1 = 200$, $n_2 = 200$, $c_1 = 4$ and $c_2 = 5$

Conclusion

In this paper a procedure is given for constructing a Double Sampling Plan indexed through AQL using Truncated Binomial Distribution, Truncated at x = 0 and a table is also provided for the easy selection of the plans. These plans are very useful for the companies such as manufacturing, supply chain, logistic etc., which can decide in front of their clients about the acceptance or rejection of their lots.

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