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International
Journal
Of Modern Engineering Research (IJMER)

Modified Procedure for Construction and Selection of Sampling Plans for Variable Inspection Scheme

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Abstract: *Linear Trend is Technique to generate the values for observerd frequency distribution and it will give the accuracy of the smoothing obtained depends on the number of available data sets. In this article ,an attempt was made to estimate the modified liner trend value generator for construction and selection of sampling plans for variable inspection scheme indexed through the MAAOQ over the Liner Trend .We compare the constructed sampling plans indexed through MAAOQ over Linear Trend with the basic sampling plans indexed with AOQL. And also obtain the performance of the operating characteristic curves.*

Key Words: *Sampling inspection plans, AOQL,MAAOQ etc.*

I. Introduction

A Lot Acceptance Sampling Plan (LASP) is a sampling scheme and a set of rules for making decisions. The decision, based on counting the number of defects in a sample, can be to accept the lot, reject the lot or even, for multiple or sequential sampling schemes, to take another sample and then repeat the decision process. These types of Lot Acceptance Sampling Plans are given below.

In **Single sampling plans,** one sample is selected at random from a lot and disposition of the lot is determined from the resulting information. These plans are usually denoted as (n,c) plans for a sample size n, where the lot is rejected if there are more than c defectives. These are the most common (and easiest) plans to use although not the most efficient in terms of average number of samples needed.

In **Double sampling plans,** we take two samples. After the first sample is tested, there are the following three possible decisions about the lot.

a. Accept the lot
b. Reject the lot
c. No decision

If the conclusion is 'no decision', and a second sample is taken, the procedure is to combine the results of both samples and make a final decision based on that of defects.

The **Multiple sampling plan** is an extension of the double sampling plans where more than two samples are needed for conclusion. The advantage of multiple sampling is to realise inspection of smaller sample sizes.

The **Sequential sampling plans** is the ultimate extension of multiple sampling where items are selected from a lot one at a time and after inspection of each item a decision is made to accept or reject the lot or select another unit.

The **Skip lot sampling** means that only a fraction of the submitted lots are inspected.

Making a final choice between various types of sampling plans is a matter of deciding how much sampling will be done on a day-by-day basis. While selecting the type of various acceptance plans one must consider the factors such as administrative efficiency, the type of information by the procedure, and the impact of the procedure may have on the material flow in the manufacturing organization. In the following sections the methods to design single and double sampling plans and their interpretations are discussed in detail.

The Inspection of items is broadly divided into two viz., Inspection by Attributes and Variable Inspection. Inspection by Attributes is an inspection whereby certain characteristics of units of products are inspected and classified simply as conforming or non-conforming to the specified requirements.

manufacturing firm will admit to make defective items. In Acceptance Sampling by Attributes, each item tested is classified as conforming or non-conforming. A sample is taken and if it contains too many non-conforming items, the batch is rejected, otherwise it is accepted. Here, items used to be classified as defective or non-defective but these days no self respecting Variable Inspection or Continuous sampling inspection is the

examination or testing of units of product as they move past in inspection station. Only those units of the product found by the inspector to the non-conforming are corrected or replaced with conforming units. The rest of the production uninspected unit as well as units found to be non-conforming, is allowed to continue down the production line as conforming material.

The Acceptance Sampling by Variables can be carried out by measuring a variable rather than classifying an item as conforming or non-conforming. Variables such as thickness, strength or weight might be measured. Usually it is easier and quicker to classify an item as conforming or non-conforming than to make an exact measurement. However, the information gained from an exact measurement is greater and so smaller sample sizes are required. A decision as to whether to use Attribute or Variables will depend on the particular circumstances of each case.

The average outgoing quality limit (AOQL) is designated as the worst average quality that the consumer will receive in the long run, when the defective items are replaced by non-defective items. The proportion defective corresponding to the inflection point of the OC curve denoted as P*, and it is defined as the maximum allowable percent defective (MAPD). The desirability of developing a set of sampling plans indexed with P* has been explained by Mandelson (1962) and Soundararajan (1975).

Dodge (1943) provided the concept of continuous sampling inspection and introduced the first constinuous sampling plan, originally referred to as the random order plan, and later designated as CSP-1 plan by Dodge and Torrey (1951). The continuous sampling plans represent extensions and variations in the basic procedure of Dodge (1943). Dodge (1947) outlined several sampling plans for continuous production. MIL-STD-1235C (1988) is the latest US military standard on continuous sampling plans.

ANSI/ASQC standard A2 (1987)defines acceptance sampling as the methodology that deals with the procedures through which decisions of acceptance or non-acceptance are taken based on the results of the inspection of samples. According to Dodge (1969), the general areas of acceptance sampling are :

1. Lot-by-lot sampling by the method of attributes, in which each unit in a sample is inspected on a go-not-go basis for one or more characteristics.
2. Lot-by-lot sampling by the method of variables, in which each unit in a sample is measured for a single characteristic such as weight or strength.
3. Continuous sampling of a flow of units by the methods of attributes.
   and
4. Special purpose plans, includes chain sampling, skip-lot sampling, small sample plans etc.

Inspired by the work done in this direction, an attempt was made in this Research paper to Design and Forecast of sampling plans for Variable Inspection scheme. The average outgoing quality limit (AOQL)is designated as the worst average quality that the consumer will receive in the long run,when the defective items are replaced by non-defective items .The proportion defective corresponding to the inflection point of the OC curve denoted as P^* ,and it is defined as the maximum allowable percent defective(MAPD).The desirability of developing a set of sampling plans indexed with P^*, has been explained by Mandelson(1962) and Soundararajan(1975).

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II. Methodology

A sampling plan prescribes the sample size and the criteria for accepting, rejecting or taking another sample to be used in inspecting lot. The single sampling plan is the most widely used sampling plan in the area of acceptance sampling. A single sampling plan which has acceptance number zero, with a small sample size is often employed in a situations involving costly or destructive testing by attributes. The small sample size is warranted because of costly nature of testing and a zero acceptance number arises in practice. The Operating Characteristic (OC) curves of such plans have a uniquely poor shape, such that the probability of acceptance starts decreasing rapidly, even for small values of P, where P is the percent defective. The average outgoing quality limit (AOQL) is defined as the worst average quality that the consumer will receive in the long run, when defective items are replaced by non-defective items. Dodge and Romig (1959) have proposed a procedure for the selection of a Single Sampling Plan (SSP) indexed with AOQL by reduce the average total inspection. Mandelson (1962) has explained the desirability of developing a system of sampling plans indexed through the Maximum Allowable Average Percent Defective (MAPD) and shown that P*= $\frac{c}{n}$ for an SSP with sample size 'n' and acceptance number 'c'.

One of the desirable properties of OC curve is that the decrease of Pa(P) should be slower for lesser values of P (good quality) and steeper for larger values of P, which provides a better overall discrimination. If P* is

considered as a standard quality measure, then the above property of a desirable OC curve is exactly followed. Since P* correspondents to the inflection point of an OC curve, it implies that

$$\frac{\partial^2 \log L(P)}{\partial P^2} < 0 , \quad P<P^*$$

$$\frac{\partial^2 \log L(P)}{\partial P^2} > 0 , \quad P>P^*$$

$$\frac{\partial^2 \log L(P)}{\partial P^2} = 0 , \quad P=P^*$$

Where Pa(P) is the probability of acceptance at quality level p fraction defective.

The MAAOQ of an SSP is defined as the average outgoing quality (AOQ the MAPD. Assuming Poisson conditions for quality characteristics, we have

$$AOQ = P.Pa(P) \frac{(N-n)}{N}$$
$$= P.Pa(P) \left(1 - \frac{n}{N}\right)$$
$$= P.Pa(P)$$

Then we have MAAOQ=AOQ at P*=P

This can be written as

$$MAAOQ = P^*.Pa(P^*)$$
$$= P^* \sum_{r=0}^{c} \frac{e^{-nP^*} (nP^*)^r}{r!}$$

This study provides tables and procedures for designing and forecasting of certain Acceptance sampling plans using MAPD as a quality standard and $(MAAOQ)_{LT}$ as a measure of outgoing quality. It also provides tables and procedures for the selection of SSPs, CSPs using the MAPD as a standard quality and the $(MAAOQ)_{LT}$ as an average outgoing quality and then the parameters of SSP, CSP are determined. This study considers $(MAAOQ)_{LT}$ in place of AOQL and then constructed tables through the different OC curves. It gives better measure to compare with Average Outgoing Quality Limit. This procedure protects the interests of the consumer in terms of incoming and outgoing quality.

The selection of sampling plans with this procedure is more advantageous to the producer and the consumer than the procedure adopted through AOQL. These procedures reduces the cost of inspection for the producer and the consumer gets quality items.

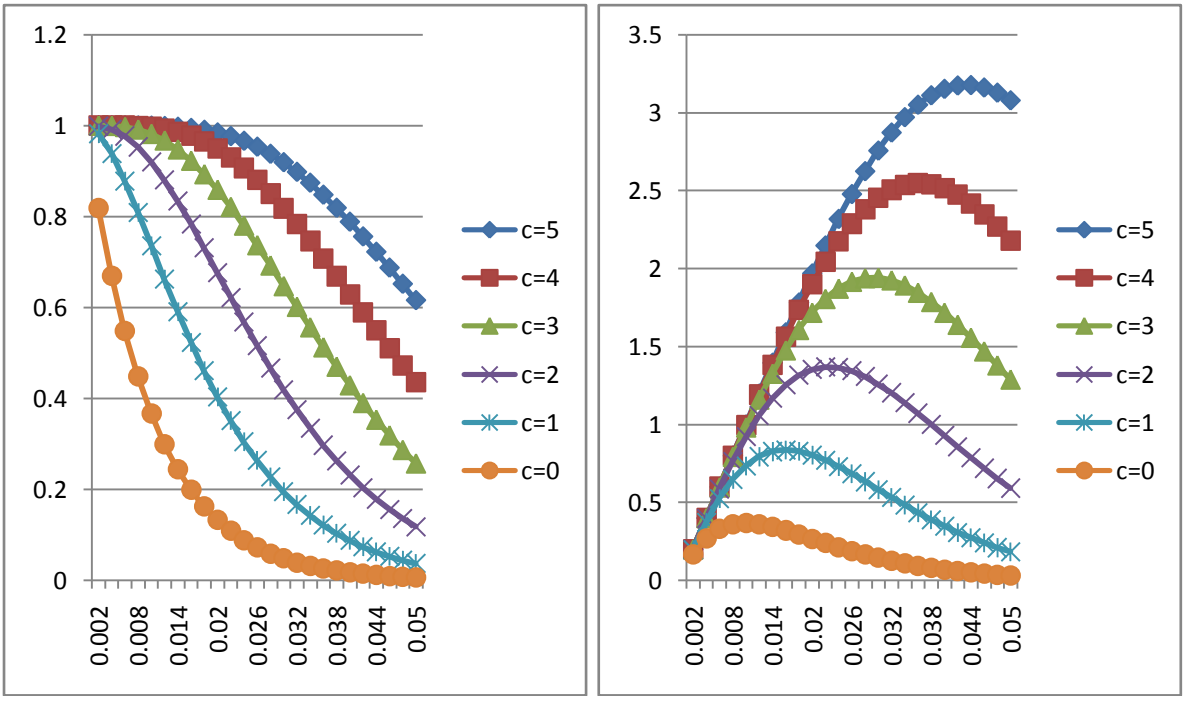
III. Tables and Discussions

For variable inspection scheme, we construct the possible tables indexed through the AOQL and also construct the tables indexed through the MAAOQ over Linear Trend. And also drawn the OC curves in the following manner.

p	Pa						AOQ					
	c=5	c=4	c=3	c=2	c=1	c=0	c=5	c=4	c=3	c=2	c=1	c=0
0.002	1	0.999998	0.999946	0.998881	0.982608	0.818567	0.2	0.2	0.199989	0.199776	0.196522	0.163713
0.004	0.999996	0.999944	0.999261	0.992245	0.938772	0.669783	0.399999	0.399978	0.399704	0.396898	0.375509	0.267913
0.006	0.999966	0.999635	0.996783	0.977301	0.878497	0.547821	0.599979	0.599781	0.59807	0.586381	0.527098	0.328692
0.008	0.999836	0.998685	0.991257	0.953272	0.809084	0.447886	0.799868	0.798948	0.793005	0.762617	0.647267	0.358309
0.01	0.999465	0.996568	0.981626	0.920627	0.735762	0.366032	0.999465	0.996568	0.981626	0.920627	0.735762	0.366032
0.012	0.998639	0.992689	0.967173	0.880541	0.662193	0.299016	1.198367	1.191227	1.160607	1.056649	0.794632	0.358819
0.014	0.997073	0.986464	0.947549	0.834529	0.590861	0.24417	1.395902	1.381049	1.326568	1.168334	0.827205	0.341837
0.016	0.994434	0.977379	0.922749	0.784202	0.523368	0.199301	1.591094	1.563806	1.476398	1.254724	0.837389	0.318882
0.018	0.990366	0.965034	0.893053	0.731118	0.460675	0.162611	1.782659	1.737061	1.607496	1.316012	0.829215	0.292699
0.02	0.984516	0.94917	0.858962	0.676686	0.403272	0.13262	1.969033	1.898339	1.717923	1.353371	0.806543	0.265239
0.022	0.976559	0.929675	0.821121	0.622124	0.351318	0.108115	2.148429	2.045284	1.806467	1.368673	0.7729	0.237853
0.02	0.96	0.9065	0.7802	0.568	0.304	0.0881	2.31892	2.1757	1.872	1.3642	0.731	0.2114

4	6218	81	68	443	743	01	2	94	642	64	384	43
0.026	0.953281	0.880051	0.73717	0.516446	0.263325	0.071762	2.478532	2.288133	1.916642	1.342761	0.684644	0.186582
0.028	0.937615	0.850357	0.69259	0.466744	0.226742	0.058429	2.625322	2.380998	1.939252	1.306884	0.634878	0.16366
0.03	0.919163	0.817855	0.647249	0.419775	0.194622	0.047553	2.757489	2.453564	1.941748	1.259325	0.583866	0.142658
0.032	0.897948	0.782966	0.601808	0.375829	0.166567	0.038684	2.873434	2.505499	1.925787	1.202651	0.533013	0.12379
0.034	0.87407	0.746148	0.556852	0.335069	0.142174	0.031457	2.971837	2.536903	1.893296	1.139234	0.483391	0.106953
0.036	0.847692	0.707877	0.512881	0.297558	0.121052	0.025568	3.051692	2.548358	1.846371	1.071209	0.435787	0.092046
0.038	0.819038	0.668633	0.470311	0.263277	0.10283	0.020773	3.112345	2.540792	1.787182	1.000451	0.390756	0.078939
0.04	0.788375	0.628864	0.429476	0.232143	0.087163	0.01687	3.153499	2.515456	1.717902	0.92857	0.348653	0.067481
	0.756003	0.589012	0.390628	0.204028	0.073734	0.013695	3.175214	2.473852	1.640637	0.856916	0.309682	0.057518
0.044	0.722246	0.549469	0.35395	0.17877	0.062255	0.011112	3.177885	2.417665	1.557379	0.786589	0.273921	0.048892
0.046	0.687438	0.510587	0.319559	0.156188	0.052468	0.009012	3.162216	2.348701	1.469972	0.718464	0.241353	0.041457
0.048	0.651913	0.472672	0.287517	0.136085	0.044145	0.007306	3.129185	2.268824	1.380084	0.65321	0.211894	0.035007
0.05	0.615999	0.435981	0.257839	0.118263	0.037081	0.005921	3.079996	2.179907	1.289193	0.591315	0.185406	0.029603

IV. OC CURVES and AOQ CURVES



V. Conclusions

From the above tables **and curves,**, we observe that the procedure for construction and selection of sampling plans through MAAOQ over the Linear Trend is also applicable in variable inspection scheme. The performance of the operating characteristic curve is also agreeable. This procedure is the modified procedure for selection of sampling plans through MAAOQ over Linear Trend.

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