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DESIGN AND EVALUATION OF REPETITIVE GROUP SAMPLING PLANS

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ABSTRACT

The quality of lots has been conservatively evaluated based on attribute properties such as the proportion or number of non-conforming items in the lot. On the other hand, Taguchi proposed a concept of quality loss as a measure to evaluate the quality of items based on variable properties instead of attribute properties. Incidentally, Robert proposed the attribute repetitive group sampling plan on operating characteristics instead of the attribute single sampling plan on operating characteristics. In this way, the attribute repetitive group sampling plan can be understood as a more efficient sampling plan from the viewpoint of comparison of the required number of samples, since the required number of samples in this plan is less on average than that of the traditional attribute single sampling plans. In this article, for the purpose of improving the efficiency of the variable sampling plan based on quality loss proposed by Arizono et al., the variable repetitive group sampling plan is considered. Specifically, we show the design procedure for finding out inspection criterions and sample size under the desired operating characteristics indexed by quality loss. By illustrating that average sample number in the inspection is reduced, the effectiveness of the proposed sampling plans is verified.

INTRODUCTION

In the manufacturing industries, acceptance sampling plan has been widely used for inspection purposes. It has played an important role on the inspection of raw materials, semi-finished products and finished products from product manufacture to marketing. Derman, C., Littauer, S., and Solomon, H. (1957) [1]Acceptance sampling plans provide the producer and the consumer an acceptance or non-acceptance criteria meeting both of their requirements for product quality, in which the decision is made on the sample information taken from the submitted lot. Dodge, H. F. (1969) [2]Because of human error and fatigue during the sampling inspection, there is a chance of making errors. The chance of rejecting a good lot is called the producer's risk, and the chance of accepting a bad lot is called the consumer's risk.

Farnum, N. R. (2006) [3]One purpose of an acceptance sampling plan is to minimize the sample size so as to reduce the cost and time of the experiment while satisfying the producer's risk as well as the consumer's risk at the specified quality levels. So the use of an acceptance sampling plan earns good reputation of the organization and increases the profit.

Govindaraju, K. (1984), [4]Sampling is widely used in industry and government for controlling the quality of shipment of components, supplies and final products. In general, the number marking the boundary between "a few" and "too many" defectives, (the maximum acceptable number of defectives) varies depending on the situation. Calvin, T.W. (1977) [5]This number depends on the lot size, cost of inspecting and testing a part and an assembly, cost of dismantling and repairing an assembly, loss associated with the possible failure to meet customer requirements, etc.

Cameron, J. M. (1952) [6]In order to control the quality of purchased lot, two major alternatives are open to a buyer. One, complete inspection: every single item in the lot is inspected and tested.Carr, W. E. (1982) [7]Two, partial inspection: a sample of items is taken, the sampled items are inspected and tested, and the lot as a whole is accepted or rejected depending on whether few or many defective items which are found in the sample. Chakraborty, T. K. (1992) [8] observed that, this type of sampling, one of many used to control the quality of manufacturing processes or lots, is known as acceptance sampling.

REVIEW OF REPETITIVE DEFERRED SAMPLING PLAN

The RDS plan has been developed by Sankar and Mahopatra (1991) and this plan is essentially an extension of the multiple deferred sampling plan MDS - (c1, c2) which was proposed by Rambert Vaerst (1980).

In this plan the acceptance or rejection of a lot in deferred state is dependent on the inspection results of the preceding or succeeding lots under repetitive group sampling (RGS) inspection. RGS is theparticular case of RDS plan. Wortham and Baker (1976) [9]have developed multiple deferred state sampling (MDS) plans and also provided tables for construction of plans. Suresh (1992) [10]has proposed procedures to select deferred state sampling plan indexed through AQL and LQL. Suresh (1993) has proposed procedures to select Multiple Deferred State plan of type MDS and MDS - 1 indexed through producer and consumer quality levels considering filter and incentive effects.

Vedaldi (1986) [11] has studied the two principal effects of sampling inspection which are filter and incentive effect for attribute Single Sampling plan and also proposed a new criterion based on the (AQL, $1 - \alpha$) point of the OC curve and an incentive index.

Lilly Christina (1995) [12] has given the procedure for the selection of RDS plan with given acceptablequality levels and also compared RDS plan with RGS plan with respect to operating ratio (OR) and ASN curve. Santhiya (2004) has given the procedure for the selection of RDS plan indexed with MAAOQ.

CONDITIONS FOR THE APPLICATION OF RDS PLAN

1. Production is steady so that result of past, current and future lots are broadly indicative of a continuing process.

2. Lots are submitted substantially in the order of their production.

3. A fixed sample size, n from each lot is assumed.

4. Inspection by attributes with quality defined as fraction non-conforming.

Operating Procedure for RDS Plan

Draw a random sample of size n from the lot and determine the number of defectives (d) found therein.

Accept the lot if $d \leq c1$. Reject the lot if $d > c2$.

If $c1 < d < c2$, accept the lot provided "i" proceeding or succeeding lots are accepted under RGS inspection plan, otherwise reject the lot.

Hear c1 and c2 are acceptance number such that $c1 < c2$. When $i = 1$ this plan reduces to RGS plan.

Repetitive Group Sampling Plans with Small Acceptance Numbers forIsolated Lots

Schilling (1978) has pointed out that in the area of compliance testing and especially for safety-related items an acceptance number zero is particularly desirable, and proposed a special purpose plan, called lot sensitive plan. The lot sensitive plan is regarded as a consumer-oriented single sampling plan with zero acceptance number and is applicable for an individual isolated lots giving protection in terms of limiting quality level (LQL).

A major disadvantage of such a zero acceptance number plan is that a possible rejection of good lot could be realized due to the severity of the acceptance criterion involved in the plan. Moreover, the OC curves of all single sampling plans with zero acceptance number have uniquely poor shape in that the probability of acceptance drops rapidly for smaller fraction nonconforming values [Dodge (1955a)]. These shortcomings can be overcome when single sampling plans with larger acceptance number, say, one or more are adopted. However, such plans may require larger sample sizes.

Sample sizes required for inspection

In order to compare the sample sizes required for inspection in the RGS plan and the single plan with different values of AQL p and LQL p , the AQL p value is fixed at 0.05 and the LQL p value increases from 0.06 to 0.25 when the risks are α =0.05, β =0.10. The results are showed in Fig.3 (θ =1) and Fig. 4 (θ =3). From Figs. 3-4, we can note that the sample sizes required for both sampling plans decreases as the value of LQL p rises from 0.06 to 0.25. Clearly, the sample size required is larger as the value of LQL p is closer to the value of AQL p . Moreover, it is obvious that the proposed RGS plan requires smaller sample size for inspection than the single sampling plan when LQL p takes any value between 0.06 and 0.25. Therefore, the RGS sampling plan is a more cost-effective plan while the single plan is relatively uneconomical.

On the other side, we also list the sample sizes required for the single sampling plan and RGS plan in Table 4 with commonly used values of AQL p and LQL p when $\beta\alpha(,)$ =(0.05, 0.10), (0.10, 0.05) and (0.10, 0.10) assuming θ =1.97. From Table 4, it is obvious that the sample size required by the RGS plan is fewer than required by the single sampling plan for all cases. For example, when AQL p =0.02, LQL p βα=0.03, (,) =(0.10, 0.05), the sample size of the RGS plan is 38.264, while the single plan is 51. Therefore, the proposed sampling plan will give the desired protection with the less required sample size so that the RGS plan is economically superior to the single sampling plan.

CONCLUSION AND RESULTS

This paper provides a detailed summary of results arrived and discussed in the preceding chapters.

Acceptance sampling is a branch of statistical quality control and is a methodology that deals with procedures by which decisions to accept or not to accept the lots are made based on the examination of sample items drawn randomly from the respective lots. Various inspection procedures, called sampling plans, are followed for drawing inferences about one or more lots of finished products based on the results of the inspection of one or more random samples drawn from the lot(s). Sampling plans are classified into four major types namely, lot-by-lot sampling by attributes, lot-by-lot sampling by variables, sampling plans for continuous production and special purpose plans.

When the quality characteristic under consideration is an attribute, the sampling plan that is used to make a decision on the disposition of the lots of manufactured products is known as lot-by-lot sampling by attributes. When the quality characteristic is measurable on a continuous scale, the associated sampling plan is known as lot-by-lot sampling by variables. When production is continuous, the formation of lots for lot-by-lot inspection may be impracticable or somewhat artificial. Inspection procedures which have been developed for such situations are termed as continuous sampling plans. Special purpose plans are the sampling inspection procedures defined under the conditions that (a) the production is steady so that the results of past, current and future lots are broadly indicative of acontinuing process, (b) the lots are submitted substantially in the order of their production; and (c) inspection is by attributes with quality defined in terms of a fraction nonconforming.

A sampling plan is usually specified by one or more parameters such as sample size(s) and acceptance number(s), with which it is operated for making a decision on the lot. A sampling scheme or system is designated by a set of specified switching rules besides the sample size(s) and acceptance number(s). The discriminatory power of a sampling plan or a scheme or a system is revealed by its operating characteristic (OC) curve. Average outgoing quality limit, average sample number and average total inspection are other measures of assessing the performance of sampling plans. The determination of the parameters of a sampling plan or a scheme subject to certain conditions providing protection to the producer as well as to the consumer is called designing a sampling plan or scheme. It is essential to ensure that the producer is protected from the rejection of the submitted lots which according to his production process are satisfactory ones and the consumer is safeguarded from receiving lots which consist of poor quality items.

Hence, sampling plans should be generally derived with the objective of providing protection to the producer and the consumer.

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