SELECTION OF SKIP-LOT SAMPLING PLAN OF TYPE SkSP-T USING SPECIAL TYPE DOUBLE SAMPLING PLAN AS REFERENCE PLAN BASED ON FUZZY LOGIC TECHNIQUES USING R PROGRAMMING LANGUAGE

S. Suganya
•
Assistant Professor, Department of Statistics,
PSG College of Arts & Science,
Coimbatore, Tamil Nadu, India
suganstat@gmail.com

K. Pradeepa Veerakumari
•
Assistant Professor, Department of Statistics,
Bharathiar University,
Coimbatore, Tamil Nadu, India
pradeepaveerakumari@buc.ac.in

Abstract

This paper justify the scheming technique of new system of skip-lot sampling plan of type SkSP-T with Special type Double Sampling plan as Reference plan Using Fuzzy Logic Techniques. The designing methodology includes the evaluation of Acceptable Quality Level, Limiting Quality Level, Operating ratio and the Operating Characteristic (OC) Curves are constructed for using various Fuzzy parametric values. Also draw the Fuzzy OC Band for new proposed plan. FOC band specify the fuzzy probability of acceptance value with corresponding fraction of nonconforming items of this sampling plan.

Keywords: Fuzzy logic, FOC band, incoming and outgoing quality levels, STDSP, SkSP-T.

I. Introduction

Acceptance sampling plan by attributes is a familiar quality control approach for attaining quality stability in procured products. In AS, performance measures, procedures and tables are given for the preference of sampling schemes, sampling systems and sampling plans to analyze the acceptability of manufactured goods. The acceptance sampling plan have been extensively used in industries for sustain the high quality level of the product at the least inspection cost. Acceptance sampling plans specify the judgment (accept or reject) concerning the submitted lots on the system of sample information selected from the lot. Consequently, there is a possibility of rejecting a good lot is known as producer's risk and accepting a bad lot is known as consumer's risk. This new skip-lot sampling plan is designed to reduce these two (producer's and consumer's) risks. Skip-lot sampling plans have been extensively used in industries to minimize the inspection troubles when products have good quality reports. These systems are identified as economically superior and advantageous to reduce the inspection cost of the terminal lots.

The concept of skip-lot sampling plan of type SkSP-1 was initially introduced by Dodge [8]. Skip-lot sampling plan is a bulk material (or goods, components, products) made within consecutive lots. The SkSP-1 sampling procedure is a scheme that extends only the theoretical approach of the CSP-1 plan, without considering any reference plan concept. Perry [20] introduced the new skip-lot sampling plan, which is designated as SkSP-2. Perry discussed the application of SkSP-2 using the Poisson distribution with markov chain techniques. The SkSP-2 is characterized as an individual with the purpose of applying a present lot inspection plan by the method of attributes, called the Reference Plan. The idea of skip-lot sampling plan of type SkSP-3 was introduced by Soundararajan and Vijayaraghavan [26]. SkSP-3 is based on the concept of Continuous Sampling Pan of type CSP-2 of Dodge and Terry [14]. Its performance measures are derived by using power series approach. Vijayaraghavan [28] developed and extended the concept of SkSP-3 plan, then the operating characteristics functions are obtained by markov chain approach. Skip-lot sampling plan of type SkSP-V was introduced by Balamurali and Chi-Hyuck Jun (2010). In SkSP-V is based on the idea of Continuous Sampling Plan of type CSP-V. Saminathan Balamurali, Muhammad Aslam and Chi-Hyuck Jun [25] introduced new method of skip lot sampling plan of Resampling (SkSP-R) concept.

Lieberman and Solomon [11] introduced some multilevel continuous sampling plan. Derman, Littauer and Solomon [7] developed tightened multi-level continuous sampling plan using basic continuous sampling plans and Lieberman and Solomon [11] concepts. Tightened multilevel plans that include three levels designed by Fordice [10]. Kandasamy and Govindaraju [17] used Markov Chain techniques to find the characteristics function of CSP-T plan. Balamurali and Govindaraju [4] developed a modified tightened two level continuous sampling plan of MMLP-T-2. Balamurali [2] proposed Modified Tightened Three level Continuous sampling plan. Balamurali and Chi-Hyuck Jun [3] proposed a modified CSP-T sampling procedure.

Pradeepa Veerakumari and Suganya [21] introduced the Skip-lot sampling plan of a new type of tightened Skip-lot sampling plan, which is designated as SkSP-T. This new method is found on the approach (both theoretical and derivational) of the continuous sampling plan of type CSP-T, CSP-M, modified tightened three level continuous sampling plans and skip-lot sampling plan of type SkSP-2. Sampling levels are fixed by using CSP-M procedure; sampling fractions are taken from the CSP-T procedure and other concepts are taken by modified CSP-T and SkSP-2 procedures. The main advantage of skip-lot sampling plan of type SkSP-T is that whenever a defect is found in skipping level, there is a normal inspection in that fraction level. In SkSP-T sampling plan, the sampling frequency (*f*) is minimized by every skipping inspection level. The Operating Characteristic functions for this SkSP-T plan are also derived using the reference plan of the single sampling plan. SkSP-T plan vary among normal inspection and skipping inspection with three levels. Skip-lot sampling plan starts with the normal inspection using various reference plans. In skipping inspection entire lots in the structure of construction are continuing. The number of consecutive conforming lots or batches reaches some pre-specified clearances number *i* and continue to normal inspection. If *i* consecutive lots are cleared with normal inspection, using skipping inspection with fraction *f*, then continue the skipping inspection. If another *i* consecutive conforming lots are passed under fractional inspection, the fraction (*f*) is bisected to f/2, and then to f/4 provided no non-conforming is found. If the non-conforming lots are found in skipping inspection, then the system goes to normal inspection. Pradeepa veerakumari and Suganya [22] introduced skip-lot sampling plan of type SkSP-T with DSP as reference plan using Fuzzy techniques. Pradeepa veerakumari and Suganya [23] developed skip-lot sampling plan of type SkSP-T used special type double sampling plan as reference plan. Suganya and Pradeepa veerakumari [24] derived skip-lot sampling plan of type SkSP-T for life test based on the percentiles of Exponentiated Rayleigh Distribution.

Govindaraju [12] introduced the new attribute lot-by-lot sampling plan it is named as Special Type Double Sampling Plan, which is designated as STDSP. In special type double sampling plan in which arrangements are made to apply only small acceptance numbers c=0 and c=1, and to inspect the submitted lot by study a second sample even if the first sample contains zero defective item (or) zero nonconforming item. STDSP is better discriminating power over single sampling plan and using only the smaller acceptance numbers c=0 and c=1. Govindaraju also derived two important operating characteristic functions of STDSP. 1. Probability of acceptance ($P_a(p)$) and 2. Average Sample Number (ASN). STDSP is enforced under the common conditions 1. The manufacturing process must be balanced. 2. The lots assemble from the process are identical as possible. 3. Process fluctuation is not existing. 4. The probability of producing nonconforming units or lots are consistent. 5. Random samples are drawn from homogeneous lots resulted from a stable process.

Lotfi A. Zadeh [18] has introduced Fuzzy set theory. The fuzzy set theory proposed formation of the membership functions; it will operate over the range of real numbers 0 and 1. The approach of fuzzy probability is well defined from that of second order probability, then the probability value which is portrayed by its probability distribution. In recent years fuzzy with statistical theory (Acceptance Sampling plan) and statistical application based problems are derived by many authors, Kanagawa and Ohta [16], Tamaki, Kanagawa and Ohta [27], Hrniewicz [15], Chakraborty [6], Grzegorzewski [13], Buckley [5], Bahram Sadeghpour-Gildeh et.al [1], Ezzatallah Baloui Jamkhaneh et.al [9], Zdenek karpisek, petr stepanek and petr jurak., [29] and Malathi and Muthulakshmi [29].Application of fuzzy theory can be used in Acceptance Sampling, Artificial Intelligent (AI), Computer Science, Decision making theory, Intelligent retrieval, Machine learning, Neural Networks, Operations Research, Pattern Recognition, Robotics. Fuzzy expansion contains superior to an extremely standard and be still forthcoming nowadays.

II. Operating Procedure of STDSP

Considering a lot, select a random sample of n_1 units and the total number of defectives (damaged items) d_1. If d_1 is greater than or equal to 0 ($d1\geq0$) then the lot is rejected. If d_1 is equal to 0 ($d_1=0$), then select a second random sample of n_2 units and the number of defectives (damaged items) d_2. If d_2 less than or equal to 1 ($d_2\leq1$) then the lot is accepted. Otherwise d_2 is greater than or equal to 2 (if $d_2\geq2$), then the lot is rejected.

III. Operating Characteristics Function of STDSP

Govindaraju [12] derived the Special Type Double Sampling plan operating characteristic functions. There is no defective found in the first sample of size n_1 would be e^{-n_1p}. And there exist a one defects or less than one defects found in the second sample of size n_2 would be $e^{-n_2p} + n_2pe^{-n_2p}$. When the sampling plan is accepted there is no defective found in the first sample of size n_1 and one defects or less than one defects found in the second sample of size n_2. The operating characteristics function of STDS plan is given by

$$P_a(p) = e^{-n_1p}(e^{-n_2p} + n_2pe^{-n_2p})$$
$$P_a(p) = e^{-(n_1+n_2)p} + n_2pe^{-(n_1+n_2)p}$$

After some substitutions, we get

$$P_a(p) = e^{-np}(1 + \phi np)$$

Where $\phi=n_2/n$ and $n=n_1+n_2$

Although this plan is valid under general conditions for applications of attribute sampling inspection. This will be especially useful to product characteristics involving costly or destructive testing.

Preliminary facts and definitions

Definition 1: (*fuzzy set*)

Let B be a non void set. A fuzzy set B in Y is characterized by its membership function

$$\mu_B = Y \rightarrow [0, 1]$$

Where, μ_B (y) is explained as the degree of membership of element y in fuzzy set B for each y ϵ Y.

Definition 2: (*normal fuzzy set*)

A fuzzy subset B of a classical set Y is called normal if ∃ any y ϵ Y: B(y) = 1. Otherwise B is subnormal.

Definition 3: (*α - cut*)

An α-level set of a fuzzy set B of Y is a non-fuzzy set denoted by $[B]^\alpha$ and is defined by

$$[B]^\alpha = \begin{cases} \{k \in Y \mid B(k) \geq \alpha\} & , \quad if\ \alpha > 0 \\ cl(suppB) & , \quad if\ \alpha = 0 \end{cases}$$

where *cl (suppB)* denotes the closure of the support of B.

Definition 4: (*fuzzy number*)

A fuzzy number B is a fuzzy set of the real line with a normal, (fuzzy) convex and continuous membership function of bounded support. The family of fuzzy numbers will be denoted by Ƒ.

Definition 5: (*triangular fuzzy number*)

A fuzzy set B is called triangular fuzzy number with peak (or center) c, left, width $\alpha > 0$ and right width β > 0 if its membership function has the following form

$$A(t) = \begin{cases} 1 - \frac{c-k}{\alpha} & , \quad if\ c - \alpha \leq k \leq c \\ 1 - \frac{c-a}{\beta} & , \quad if\ c \leq k \leq c + \beta \\ 0 & \quad otherwise \end{cases}$$

Let A = (c, α, β). It can easily be verified that

$$[B]^\gamma = [c - (1-\gamma)\alpha, c + (1-\gamma)\beta], \forall\, \gamma \in [0,1].$$

The support of B is $(c - \alpha, d + \beta)$.

The triangular fuzzy number with center "a" may be seen as a fuzzy quantity.

Definition 6:

Random variable X having the probability mass function of the Poisson distribution

$$P(x, \lambda) = \frac{e^{-\lambda}\lambda^x}{x!}, \text{ for x=0, 1, 2… and Poisson parameter } \lambda > 0.$$

λ is exchanged as $\tilde{\lambda}$. The fuzzy number $\tilde{\lambda}$ is greater than zero ($\tilde{\lambda} > 0$), and P (x) is exchanged by $\tilde{P}(x)$. After substituting α-cut for the fuzzy number as

$$\tilde{P}(x)[\alpha] = \{\frac{e^{-\lambda}\,\lambda^x}{x!} | \lambda \in \lambda[\alpha]\}$$

$\forall\ \alpha \in [0,1]$ Such that ∃ $\widetilde{P[\alpha]}$. The fuzzy parameter $\tilde{P}(x)[\alpha]$ is substituted by $\tilde{P}[a,b][\alpha]$.

$$\tilde{P}[a,b][\alpha] = \left\{\sum_{x=a}^{b} \frac{e^{-\lambda}\,\lambda^x}{x!} | \lambda \in \lambda[\alpha]\right.$$

IV. Operating Procedure for SkSP-T

Operating procedure of the SkSP-T plan is stated as follows:

- Initiate SkSP-T procedure with normal inspection using the special type double sampling plan as reference plan.
- When *i* successive lots are received on normal inspection, terminate the normal inspection and change to skipping inspection.
- On skipping inspection, inspect only a fraction *f* of the lots selected at random, level 1.
- After *i* consecutive lots in succession has been found without a non-conforming at level 1, the system then switches to skipping inspection with a fraction of *f/2*, level 2.
- After *i* consecutive lots in succession has been found without a non-conforming at level 2, the system then switches to skipping inspection with a fraction of *f/4*, level 3.
- If a non-conforming lot is found on either skipping level, the system reverts to normal inspection.

V. Skip Lot Sampling Plan of Type SkSP-T with Fuzzy Poisson Distribution

The Operating Characteristic function for SkSP-T plan is given as

$$\mathrm{Pa\ (p)} = \frac{\mathrm{P^i(f_2f_3(1-P^i)+f_1f_3P^i(1-P^i)+f_1f_2P^{2i})}}{\mathrm{f_1f_2f_3(1-P^i)+P^i(f_2f_3(1-P^i)+f_1f_3P^i(1-P^i)+f_1f_2P^{2i})}}$$

Where, i-clearance number, f-sampling fraction and P- Special Type Double Sampling Plan as reference plan using fuzzy parameters. From STDSP, n_1 is the first random sample size, n_2 is the second random sample size, d- represented the number of defective in the sample, and p- proportion defective. Considering a lot, select a random sample of n_1 units and the total number of defectives (damaged items) d_1. If d_1 is greater than or equal to 0 (d1≥0) then the lot is rejected. If d_1 is equal to 0 (d_1=0), then select a second random sample of n_2 units and the number of defectives (damaged items) d_2. If d_2 less than or equal to 1 (d_2≤1) then the lot is accepted. Otherwise d_2 is greater than or equal to 2 (if d_2≥2), then the lot is rejected. Poisson distribution parameter λ = np. The Probability of acceptance of STDSP is as follows

$$P_a\,(p) = e^{-n_1p}(e^{-n_2p} + n_2pe^{-n_2p})$$
$$P_a\,(p) = e^{-(n_1+n_2)p} + n_2pe^{-(n_1+n_2)p}$$
$$P_a\,(p) = e^{-(n_1+n_2)p}(1+n_2p)$$

After some substitutions, we get

$$P_a(p) = e^{-np}(1+\phi np)$$

Where $\phi=n_2/n$ and $n=n_1+n_2$

If the sample size is large then the proportion defective items are not easily calculated. In these situations fuzzy parameters with fuzzy number $\tilde{P}$ is introduced as $\tilde{P} = (a_1, a_2, a_3)$. After Poisson distribution parameters are converted into fuzzy parameters, the poisson parameter λ is modified as $\tilde{\lambda}$ such that $\tilde{\lambda} = n\tilde{p}$. Fuzzy probability with fuzzy number is used in STDSP and the function is modified and as follows

$$\tilde{P}\,[\alpha] = [P^L[\alpha]P^U[\alpha]]$$
$$P^L[\alpha] = min\{e^{-\lambda}(1+\phi\lambda) \mid \lambda \in \tilde{\lambda}\,[\alpha]\}$$
$$P^U[\alpha] = max\{e^{-\lambda}(1+\phi\lambda) \mid \lambda \in \tilde{\lambda}\,[\alpha]\}$$

Also the probability of acceptance $P_a(p)$ is defined by fuzzy probability of acceptance $\widetilde{P_a}(p)$ and it is given as

$$\widetilde{P_a}(p) = \{e^{-\lambda}(1+\phi\lambda) \mid \lambda \in \tilde{\lambda} = n\tilde{p}[\alpha]\}$$
$$\widetilde{P_a}(p) = [P^L[\alpha]P^U[\alpha]]$$
$$P^L[\alpha] = min\{e^{-\lambda}(1+\phi\lambda) \mid \lambda \in \tilde{\lambda} = n\tilde{p}[\alpha]\}$$
$$P^U[\alpha] = max\{e^{-\lambda}(1+\phi\lambda) \mid \lambda \in \tilde{\lambda} = n\tilde{p}[\alpha]\}$$

I. R programming

R (programming language) is an open source programming language and software environment for statistical computing and graphical techniques, including linear and nonlinear modeling, classical statistical tests, classification and others. Also R has stronger Object-Oriented Programming facilities than most statistical computing languages. In this paper, R-programming is used to construct the table of Upper and Lower limit of Fuzzy OC Band and draw the Fuzzy Operating characteristic curve and Fuzzy Probability of Acceptance curve.

II. Numerical illustration

The following illustrations derive the new system of skip lot sampling plan of type SkSP-T with Special type Double Sampling Plan as reference plan using Fuzzy Parameters of Fuzzy

Probability of Acceptance, Fuzzy Operating Characteristic (FOC) Curve, Fuzzy Average Sample Number (FASN), Fuzzy Average Outgoing Quality (FAOQ) and Fuzzy Average Total Inspection (FATI). The Fuzzy, SkSP-T and STDSP parameters n_1-the first random sample size, n_2-the second random sample size, i – clearance interval, f- sampling frequency, N- lot size, p - proportion or fraction defective, $P_a(p)$ - Probability of Acceptance and m – fuzzy proportion defective.

III. Example 1: Calculating the Fuzzy Probability of Acceptance

Skip lot sampling plan of type SkSP-T with special type double sampling plan as reference plan using fuzzy parameters. The proportion of defective items is calculated by using fuzzy number $\tilde{p} = [0.0001, 0.005, 0.01]$. Also consider the sample sizes (n1, n2), and fuzzy poisson parameter $(\tilde{\lambda})$ as follows:

n1=30, n2=60 $\tilde{p} = [0, 0.005, 0.01]$

$\tilde{\lambda}_1 = n_1\tilde{p}$, $\tilde{\lambda}_2 = n_2\tilde{p}$. Then the proportion defective $\tilde{p}$ take three values.

Hence $\tilde{\lambda}_1 = [30 * \tilde{p}, 30 * \tilde{p}, 30 * \tilde{p}]$ and $\tilde{\lambda}_2 = [60 * \tilde{p}, 60 * \tilde{p}, 60 * \tilde{p}]$

After using α – cut it becomes

$$\tilde{\lambda}[\alpha] = \tilde{\lambda}_1[\alpha] + \tilde{\lambda}_2[\alpha]$$

$$\tilde{\lambda}[\alpha] = [(a_2 - a_1)\alpha + a_1, a_3 - (a_3 - a_2)\alpha]$$

Hence $$\tilde{\lambda}[\alpha] = [0.441\alpha + 0.009, 0.9 - 0.45\alpha]$$

The probability of acceptance

$$\widetilde{P_a}(p) = \{e^{-\lambda}(1 + \phi\lambda) | \lambda \in \tilde{\lambda} = n\tilde{p}[\alpha]\}$$

The probability of acceptance $\widetilde{P_a}(p)$ is defined by upper and lower bound values. $\widetilde{P_a}(p)$ is calculated by the sustaing formula

$$\tilde{\lambda}[\alpha] = [\, e^{-((a_3-(a_3-a_2)\alpha))}\,(1 + \phi * (a_3 - (a_3 - a_2)\alpha))), \\ e^{-((a_2-a_1)\alpha+a_1)}(1 + \phi * ((a_2 - a_1)\alpha + a_1))]$$

Put different values of α in [0, 1]. For $\alpha = 0$,

$$\widetilde{P_a}(p) = [0.99, 1]$$

$\widetilde{P_a}(p)$ values of acceptance special type double sampling plan with fuzzy parameter using poisson distribution are compared that of STDSP plan using fuzzy parameters. It is concluded that SkSP-T with STDSP as reference plan using fuzzy logic is better than the other. Figure 1 and Table 1 represent the fuzzy probability of acceptance values of skip-lot sampling plan of type SkSP-T with STDSP as reference plan using fuzzy parameters. $\widetilde{P_a}(p) = [0.99, 1]$, it is expected that for every 100 lots in such a process, 99 to 100 lots will be accepted. For acceptance STDSP with fuzzy poisson process 98 to 100 is accepted. The skip lot sampling plan of type SkSP-T with STDSP fuzzy set gives the better result. Also it minimizes the producer's and consumer's risk.

IV. Example 2: Calculating the Fuzzy Operating Characteristic Curve

The operating characteristic curve is drawn for SkSP-T with STDSP as reference plan using fuzzy parameter. The Operating Characteristics curve represents the Probability of Acceptance (P_a (p)) and proportion defective (p). Operating Characteristics Curve is used in Discriminant of sampling plan among good lots and bad lots. An ideal Operating Characteristics Curve can be attained through 100% inspection. Usually the OC Curve considers certain level of risks. The consumer reject a product that satisfies the established conditions (i.e., the product quality is good). In this risk is called as producer's risk. The consumer accept a product that does not meet the conditions (i.e., the product quality is bad). In this risk is called consumer's risk. For calculating the proportion defective, a fuzzy parameter of the upper and lower band may be used. If the Upper and Lower band values are equal, then it is called as superior state. Consider the fuzzy number $\tilde{p}$ and the proportion defective p to defined

$$\widetilde{P_a} = (m, a_2 + m, a_3 + m)$$

Consider, $\tilde{\lambda} = n\tilde{p}$, then

$$n\tilde{p} = (\,nm, na_2 + nm, na_3 + nm)$$

Where, m is the domain of [0, 1-a_3]. Then OC band is calculated as

$$\tilde{p}[\alpha] = [p_1[\alpha], p_2[\alpha]]$$

$$\big[p_1[\alpha], p_2[\alpha]\big] = [m + a_2\alpha, a_3 + m - (a_3 - a_2)\alpha]$$

The above fuzzy probability condition is extended to $\tilde{\lambda}[\alpha]$ and $\tilde{P}_a[\alpha]$. For the above example, define a_2 = 0.001, a_3 = 0.002 and α = 0. These values are substituted in the fuzzy poisson upper and lower band equation and find these values are tabulated below. Characteristic curve used for the purpose of Probability of Acceptance depends upon the fraction defective and also conclude the producer risk (α) and consumer risk (β). From Figure 2 it is observed that has proportion defective (p) increases as the Probability value (P_a (p)) decreases. It is concluded that as sample size increase, producer risk is minimized and consumer risk maximized. However, sample size is minimized thus safeguarding the consumer.

Table 1: *Comparison of SkSP-T with Special Type Double Sampling Plan as reference plan using fuzzy parameters with Acceptance single sampling plan with fuzzy parameter with the using of Poisson distribution [fuzzy probability of acceptance table]*

M	$\tilde{p}$	$\tilde{P}_a$ [Acceptance special type double sampling plan with fuzzy parameter with the using of poisson distribution]	$\tilde{P}_a$ [SkSP-T with STDSP as reference plan using Fuzzy parameters]
0	[0,0.01]	[0.8889,0.9851]	[0.9950,1]
0.01	[0.01,0.02]	[0.7683,0.8889]	[0.9823, 0.9950]
0.02	[0.02,0.03]	[0.6505,0.7683]	[0.9513, 0.9823]
0.03	[0.03,0.04]	[0.5421,0.6505]	[0.9028, 0.9513]
0.04	[0.04,0.05]	[0.4462,0.5421]	[0.8345, 0.9028]
0.05	[0.05,0.06]	[0.3636,0.4462]	[0.7483, 0.8345]
0.06	[0.06,0.07]	[0.2938,0.3636]	[0.6504, 0.7483]
0.07	[0.07,0.08]	[0.2358,0.2938]	[0.5497, 0.6504]
0.08	[0.08,0.09]	[0.1860,0.2358]	[0.4540,0.5497]
0.09	[0.09,0.10]	[0.1476,0.1860]	[0.3645,0.4540]
0.10	[0.10,0.11]	[0.1166,0.1476]	[0.2921,0.3645]

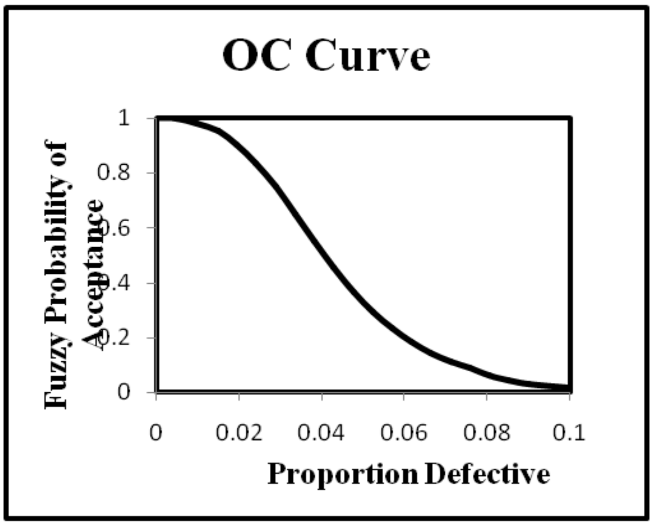

Figure 1: Curve for Probability of Acceptance of SkSP-T with STDSP as reference plan using Fuzzy Parameters

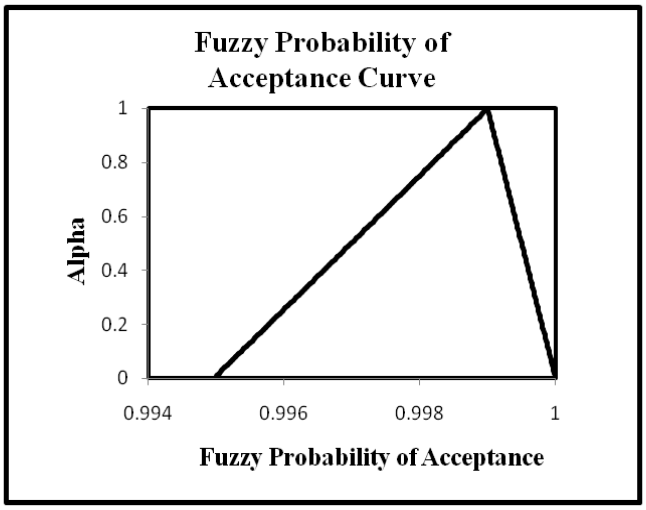

Figure 2: Operating Characteristic Curve for of SkSP-T with STDSP as reference plan using Fuzzy Parameters

VI. CONCLUSION

In this paper, designing for a skip lot sampling plan of type SkSP-T with Special Type Double Sampling Plan as Reference plan using Fuzzy Parameters. In general skip lot sampling plans are reducing the frequency of sampling inspection and overall inspection cost. Comparison of STDSP with Fuzzy Poisson and skip-lot sampling plan of type SkSP-T with STDSP using Fuzzy Parameter, it concludes that SkSP-T with STDSP using Fuzzy logic has a high probability of acceptance and good quality level. From these illustrations it is noted that the sample size is more for an optimum plan (SkSP-T plan), then the producer and consumer risks are reduced while compared with traditional SSP that is a crucial objective for any good sampling plans.

References

[1] Bahram Sadeghpour-Gideh, Gholamhossein Yari and Ezzatallah Baloui Jamkhaneh (2008): Acceptance Double Sampling plan with fuzzy parameter, *Proceedings of the 11th joint conference in information sciences*.
[2] Balamurali, S., (2002). Modified Tightened Three level Continuous sampling plan, *Economic Quality Control*, 17: 221-234.
[3] Balamurali, S., and Chi-Hyuck Jun, (2004). Modified CSP-T sampling procedures for continuous production process, *Quality Technology and Quantitative Management* 1(2):175-188.
[4] Balamurali S. and Govindaraju (2000). Modified Tightened two-level continuous sampling plans, *Journal of Applied Statistics,* 27(4):397-409.
[5] Buckley, J. J. (2003): Fuzzy probability: New approach and application, physica-velage, Heidelberg, Germany.
[6] Chakraborty T.K. (1992): A class of single sampling plan based on fuzzy Optimization, *Opsearch*, 29(1):108-126.
[7] Derman, C., Littauer, S and Solomon, H. (1957). Tightened multi-level continuous sampling Plans, *Annals of Mathematical Statistics*, 28(2):395-404.
[8] Dodge H.F, (1955): Skip-Lot sampling plan, *Industrial Quality Control*, 11(5):3-5.
[9] Ezzatallah Baloui Jamkhaneh et. Al., (2009): Acceptance Single Sampling Plan with fuzzy parameter with the using of Poisson distribution, *International journal of mathematical, computational, physical, electrical and Computer Engineering*, 3(1).

[10] Fordice, J.J. (1972). A Tightened Multi-Level Continuous Sampling Plan CSP-T, Report No.QEM 21230-10, *Ammunition Procurement and Supply Agency*, Joliety, Illinois.

[11] G. J. Lieberman and H. Solomon (1954). Multi-level continuous sampling plans, *Technical Report No. 17, Applied Mathematics and Statistics Laboratory*, Stanford University.

[12] Govindaraju. K (1984): Contributions to the study of certain special purpose plans, *PhD Thesis*, Bharathiar University, Coimbatore.

[13] Grzegorzewski P. (1998): A soft design of acceptance sampling by attributes, Proceedings of the VIth International Workshop on Intelligent statistical quality control. Wurzburg, September 14-16:29-38.

[14] H. F. Dodge and M. N. Torrey (1951). Additional continuous sampling inspection plans, *Industrial Quality Control*, 7 (1951): 7-12.

[15] Hrniewicz. O.,(1994): Statistical acceptance sampling with uncertain information from a sample and fuzzy quality criteria, Working Paper of SRI PAS, Warsaw,(in Polish).

[16] Kanagawa A. And Otha H. (1990): A design for single sampling attribute plan based on Fuzzy Set Theory, *Fuzzy Sets and Fuzzy system*, 37: 173-181.

[17] Kandasamy, C. and Govindaraju, K., (1993). Selection of CSP-T plans, *Communication in Statistics - Simulation and Computation*, 22(1): 265-283.

[18] L.A Zadeh (1965), Fuzzy Sets, *Information and Control*, 8:338-353.

[19] Malathi and Muthulakshmi (2012): Special Double Sampling Plan with Fuzzy Parameter, *Indian Journal of Applied Research*, 2(1).

[20] Perry. R. L, (1973): Skip lot Sampling Plans, *Journal of Quality Technology*, 5 (3):123-130.

[21] Pradeepa Veerakumari. K and Suganya. S (2016). A New System of SkSP-T with Single Sampling Plan as Reference Plan, *Research Journal of Mathematics and Statistics*, 4 (4):1-6.

[22] Pradeepa veerakumari and Suganya (2017): SkSP-T with Double Sampling Plan (DSP) as Reference Plan using Fuzzy Logic Optimization Techniques, *International Journal of Pure and Applied Mathematics*, 117(12):409-418.

[23] Pradeepa veerakumari and Suganya (2019), Characteristic Evaluation of SkSP-T with special type double sampling plan as reference plan, *International Journal of Productivity and Quality Management*, 28(3):360-371.

[24] Suganya and Pradeepa veerakumari (2020), Skip-lot sampling plan of type SkSP-T for life tests based on percentiles of exponentiated Rayleigh distribution, *Life cycle Reliability and Safety Engineering*, 9:247-251.

[25] Saminathan Balamurali, Muhammad Aslam, and Chi-Hyuck Jun (2014). A New System of Skip-Lot Sampling Plans including Resampling, The *Scientific World Journal*, 1-6.

[26] Soundararajan, V and Vijayaraghavan, R (1989): A new system of skip-lot inspection plans of type SkSP-3, *Quality for Process and Development, Wiley Eastern*.

[27] Tamaki f., Kanagawa a. And Ohta h., (1991): A Fuzzy Design of Sampling Inspection plans by Attributes, *Japanese journal of fuzzy theory and systems*, 315-327.

[28] Vijayaraghavan R (2000). Design and evaluation of skip-lot sampling plans of type SkSP-3, *Journal of Applied Statistics*, 27 (7): 901-908.

[29] Zdenek karpisek, petr stepanek and petr jurak.,(2010): Weibull fuzzy probability distribution for reliability of concrete structures, *Engineering MECHANICS*, 17(5/6): 363-372.

Selection of Skip-Lot Sampling Plan of Type SkSP-T Using Special Type Double Sampling Plan as reference Plan Based on Fuzzy Logic Techniques Using R programming Language

R CODING

```
> n1=30;
> n1
> n2=60;
> n2
> n= n1+n2;
> n
> p1=0.001;
> p1
> p2=0.005;
> p2
> p3=0.01;
> p3
> lam1=n1*p1;
> lam 1
> lam2=n1*p2;
> lam2
> lam3=n1*p3;
> lam3
> lam11=n2*p1;
> lam11
> lam12=n2*p2;
> lam12
> lam13=n2*p3;
> lam13
> alpha=seq(0.01,1,length=100);
> alpha
> a1=lam1+lam11
> a2=lam2+lam12
> a3=lam3+lam13
> phi=n2/(n)
> phi
> lambda1(alpha)=exp^(-(a3-((a3-a2)*alpha)));
> lambda1(alpha)
> lambda11(alpha)=1+(phi*((a3-((a3-a2)*alpha))));
> lambda11(alpha)
> value(P1)=lambda1(alpha)*lambda11(alpha);
> value(P1)
> lambda2=exp^(-((a2-a1)*alpha)+alpha);
> lambda2
> lambda22=1+(phi*((a2-a1)*alpha)+a1);
> lambda22
> value(P2)=lambda2*lambda22;
> value(P2)
> i=1
> f1=1/2
> f2=(f1/2)
> f3=(f1/4)
>uppernum=(f2*f3*(1-(value(P1)^i))*(value(P1)^i))+(f1*f3*(value(P1)^i)*(1-(value(P1)^i))*(value(P1)^i))+(f1*f2*(
value(P1)^(3*i)));
> uppernum
> upperden=(((f1*f2*f3*(1-( value(P1)^i)))+uppernum));
> upperden
> upperbound=cbind(uppernum/upperden)
>lowernum=(f2*f3*(1-(value(P2)^i))*(value(P2)^i))+(f1*f3*(value(P2)^i)*(1-(value(P2)^i))*( value(P2)^i))+(f1*f2*(
value(P2)^(3*i)));
```

```
> lowernum
> lowerden=(((f1*f2*f3*(1-( value(P2)^i)))+lowernum));
> lowerden
> lowerbound=cbind(lowernum/lowerden)
> cbind(alpha,ubin,lbin);
> plot(alpha, lowerbound,upperbound)
```

Using the code for combinations of OC Curves

```
plot(p, Pa(p),type = 'l',lty=2,lwd=3,pch=2,lend=0,ljoin=2,lmitre=2,bg="black", lab ="Proportion defective,p", ylab="Probability of acceptance Pa(p)",main="OC Curve");
lines(p, Pa(p)(changing n value),ity=3,lwd=3,pch=2,bg="black");
lines(p, Pa(p)(changing n value),ity=3,lwd=3,pch=2,bg="black");
```

n1- first sample of size
n2-second sample of size
n-combined sample of size
P1-special type double sampling upper bound value
P2-special type double sampling lower bound value
exp-expectation
phi=ϕ
num=numerator
den=denominator
cbind-column representation