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A New System of SkSP-T Plan with Single Sampling Plan as Reference Plan

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Abstract

T*his paper explains the scheming procedure of a new method of skip-lot sampling plans designated as SkSP-T based on the principles of continuous sampling plan of type CSP-T. Construction and evaluation of performance measures of SkSP-T system are also derived and simulated for incoming and outgoing quality levels. Tables also have been constructed comparison of results with SkSP-2 also illustrated.*

Keywords: Skip-lot sampling plan, SkSP-T system, Incoming and outgoing quality level.

Introduction

The major branch of statistical quality control is acceptance sampling plan that includes attributes and variables characteristics. Acceptance sampling is defined as sampling inspection in which decision to accept or reject a lot or process is based on the examination of the samples.

Dodge initially presented a Skip-lot sampling plan as an expansion of CSP type continuous sampling plan[1]. It is called as Skip-lot sampling plan of type SkSP-1. SkSP-2 plan was coined by Perry using single sampling plan as reference plan with some specific parameters[2]. Vijayaraghavan and Soundararajan introduced the SkDSP-2 plan under the Poisson probability model[3]. Vijayaraghavan introduced the SkSP-3 plans and the Operating Characteristics functions are derived by the Markov Chain approach[4]. Recently, Balamurali, S and Chi-Hyuck Jun developed as skip-lot sampling plan of type SkSP-V and it is based on continuous sampling plan of type CSP-V plan[5]. Muhammad Aslam, Balamurali, S, Chi-Hyuck Jun, Munil Ahmad and Mujahid Rasool introduced an Optimal Designing of an SkSP-V Skip lot Sampling plan with Double Sampling plan as reference plan[6].

Fordice proposed a tightened three level continuous sampling plan designated as CSP-T and also derived AOQ and AFI functions for CSP-T plan using Markov Chain approach[7]. It is the modified form of Lieberman and Solomon and Derman et al. after the manner of Guthlie and Johns in that the sampling frequency *f is* cut in the half from level to level[8]. Kandasamy and Govindaraju designed performance measures of CSP-T plan used Markov Chain method[9]. Balamurali and kalyanasundaram Generalized tightened two level continuous sampling plans and the plan[10]. Balamurali, S and Govindaraju developed as MMLP-T-2 plan it is designate modified tightened two level continuous sampling plan[11]. Balamurali proposed Modified Tightened three level continuous sampling plans[12]. And the importance of "modified CSP-T sampling plan is that the process cannot go from one level of sampling inspection to another without going back to 100 % inspection. CSP-T plan alternates between two inspections with three levels. And the inspectrions are screening and sampling inspections".

In this paper the SkSP-T plan is introduced to be a new system of skip-lot sampling plan based on the working procedure of continuous sampling plan of type (CSP-T). The performance measures for this SkSP-T plan are also derived.

Operating Procedure for Sksp-T Plan

Operating procedure for the SkSP-T plan is stated as follows:
Step1: Start with the normal inspection using the reference plan.
Step2: When *i* consecutive lots are accepted on normal inspection, discontinue the normal inspection and switch to skipping inspection.
Step3: When skipping inspection, inspect only a fraction *f* of the lots selected at random, level 1.
Step4: After *i* consecutive lots in succession have been found without a non-conforming at level 1, the system then switches to skipping inspection with a fraction of *f/2*, level 2.
Step5: After *i* consecutive lots in succession have been found without a non-conforming at level 2, the system then switches to skipping inspection with a fraction of *f/4*, level 3.
Step6: If a non-conforming lot is found on either skipping level, the system reverts to normal inspection.
Step7: Exchange all non-conforming lots establish with conforming once.

Performance Measures of SkSP-T : The new system of SkSP-T skip-lot sampling plan with single sampling plan as reference plan said to have the following performance measures.

The Expected average number of lots in Normal Inspection is

$$U=\frac{(1-P^i)}{p^i(1-P)} \quad (1)$$

The skipping inspection passed the average number of lots is

$$V=\frac{f_2f_3(1-P^i)+f_1f_3p^i(1-P^i)+f_1f_2P^{2i}}{f_1f_2f_3(1-P)} \quad (2)$$

The average fraction of total submitted lots inspected in the long run is

$$F=\frac{f_1f_2f_3}{f_1f_2f_3(1-P^i)+P^i(f_2f_3(1-P^i)+f_1f_3P^i(1-P^i)+f_1f_2P^{2i})} \quad (3)$$

The probability of acceptance under SKSP-T plan is

$$P_a(p)=\frac{P^i(f_2f_3(1-P^i)+f_1f_3P^i(1-P^i)+f_1f_2P^{2i})}{f_1f_2f_3(1-P^i)+P^i(f_2f_3(1-P^i)+f_1f_3P^i(1-P^i)+f_1f_2P^{2i})} \quad (4)$$

Where, $P_a(p)$ = Probability of Acceptance of the single sampling plan.

The probability of acceptance under the SSP plan is $P_a(p) = \sum_{d=0}^{c}\frac{e^{-np}(np)^d}{d!}$,

n =sample size and c=acceptance number

The average outgoing quality (AOQ) is

$$AOQ=\frac{p(P^i(f_2f_3(1-f_1)(1-P^i)+f_1(1-f_2)f_3P^i(1-P^i)+f_1f_2P(1-f_3)^{2i}))}{f_1f_2f_3(1-P^i)+P^i(f_2f_3(1-P^i)+f_1f_3P^i(1-P^i)+f_1f_2P^{2i})} \quad (5)$$

The average total inspection (ATI) is

$$ATI=\frac{[n+(N-n)(1-P)](f_1f_2f_3)}{f_1f_2f_3(1-P^i)+P^i(f_2f_3(1-P^i)+f_1f_3P^i(1-P^i)+f_1f_2P^{2i})} \quad (6)$$

The average sample number (ASN) is

$$ASN=\frac{n(f_1f_2f_3)}{f_1f_2f_3(1-P^i)+P^i(f_2f_3(1-P^i)+f_1f_3P^i(1-P^i)+f_1f_2P^{2i})} \quad (7)$$

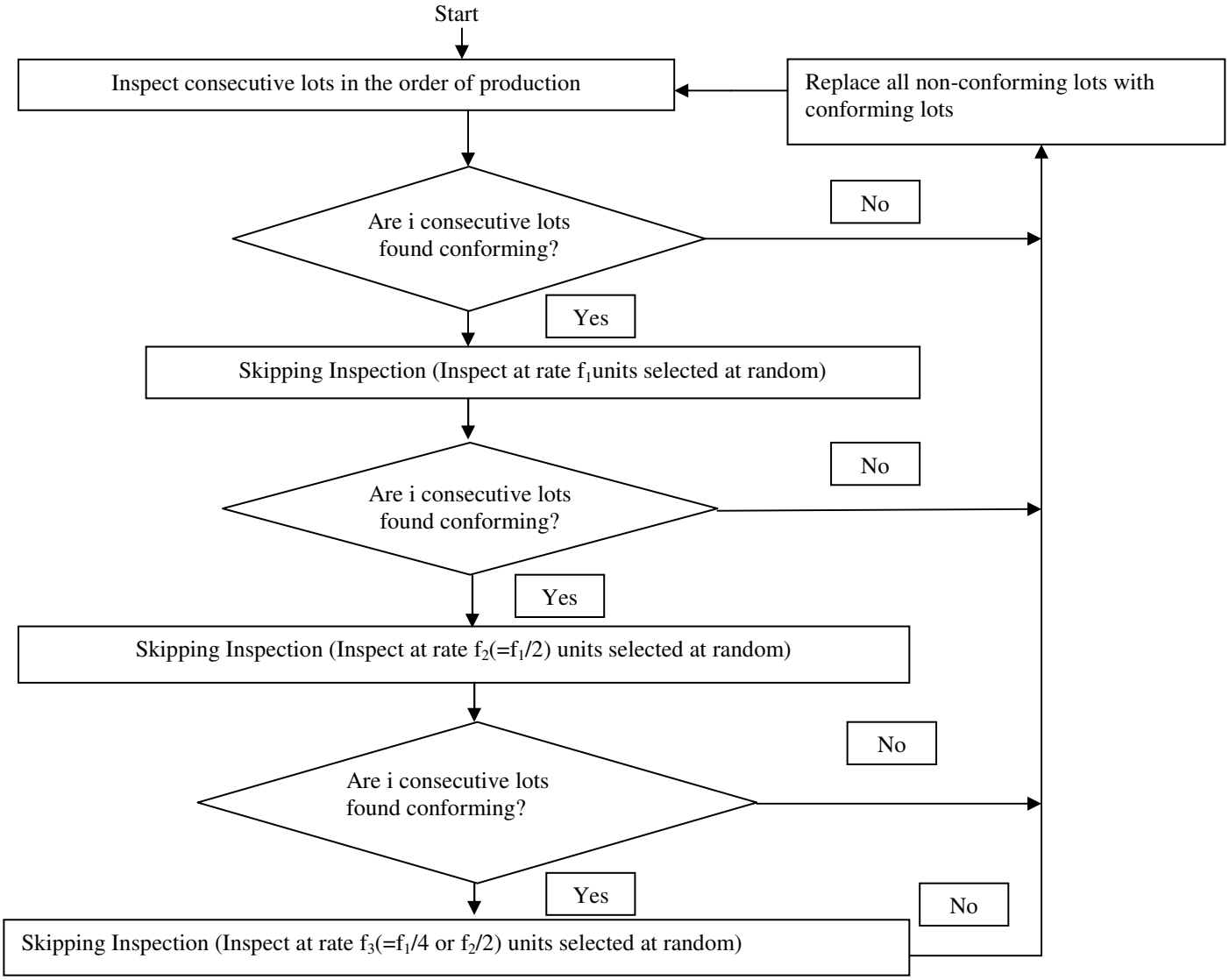

Figure-1
Flow Chart of SkSP-T Skip Lot Sampling Plan

Comparative Study

In this section the new system of SkSP-T plan is compared with SkSP-2 plan in terms of OC, ASN, ATI and AOQ. And the values of SkSP-T with Parameters (n=50, N=1000, i=1, f_1=0.5 f_1=0.25 f_3=0.125) and the parameter values of SkSP-2 plan is (n=50, N=1000, i=1, k=1, x=1, f=.5). For Operating Characteristic curve, it is noticed that for new system of SkSP-T plan probability of acceptance increases compared with SkSP-2 for same parametric values of SkSP-2 and SkSP-T. Therefore, SkSP-T is better than the SkSP-2. It implicit that SkSP-T plan producer's risk is lesser. It is observed for SkSP-T plan as p increases P_a (p) decreases.

From Figure-3 and 4 and Table-1 it noted that the lot quality is good, minimization in ASN as well as ATI for SkSP-T plan and maximization for SkSP-2. And figure 4 show that the average outgoing curve it is lesser for SkSP-T compared to SkSP-2. New system of SkSP-T plan shows high point of determination in minimising producer's risk at various quality levels. This study features the comparison of SkSP-T sampling over the SkSP-2 plan. Using the calculated the Probability of acceptance, ASN, AOQ and ATI values of SkSP-T plan, sample size is compared for SkSP-2 plan for different values of p_1 and p_2. Then the SkSP-T sampling plan provides much smaller sample size in comparison to SkSP-2 plan. For example, when p_1=0.005 andp_2=0.075, then the proposed plan SkSP-T required sample size n=15 and the SkSP-2 sample size n=36. Therefore, the proposed plan SkSP-T shows more efficiency than SkSP-2 based on minimum sample size and risk minimization.

Construction of Tables

The Operating Characteristic function of SkSP-T plan with single sampling plan stated as

$$P_a(p) = \frac{p^i(f_2f_3(1-p^i)+f_1f_3p^i(1-p^i)+f_1f_2f_3p^{2i})}{f_1f_2f_3(1-p^i)+p^i(f_2f_3(1-p^i)+f_1f_3p^i(1-p^i)+f_1f_2p^{2i})} \quad (1)$$

Where; P_a (p) = probability of Acceptance of the single sampling plan. The expression (1) is following for various values of f_1, f_2, f_3, i and c. The performance measures are calculated and tabulated in Table-1. Let $f_1 = 1/2$, $f_2 = 1/4$, $f_3 = 1/8$, $i = 1$ and $c = 0$ then the operating characteristic curve , AOQ curve, ASN curve and ATI curve are drawn for the following set of values.

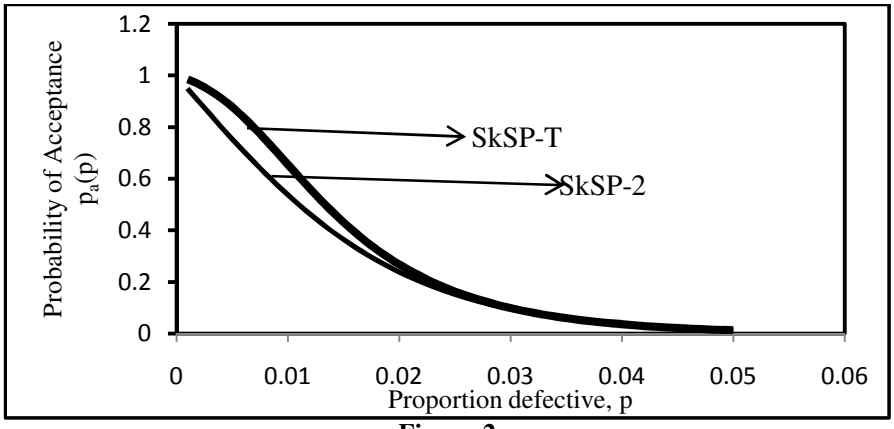

Figure-2
Operating Characteristics curve for SkSP-T and SkSP - 2

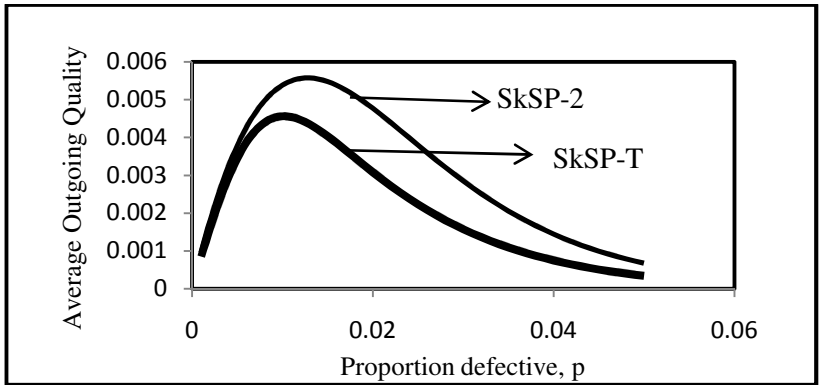

Figure-3
AOQ curve for SkSP-T and SkSP - 2

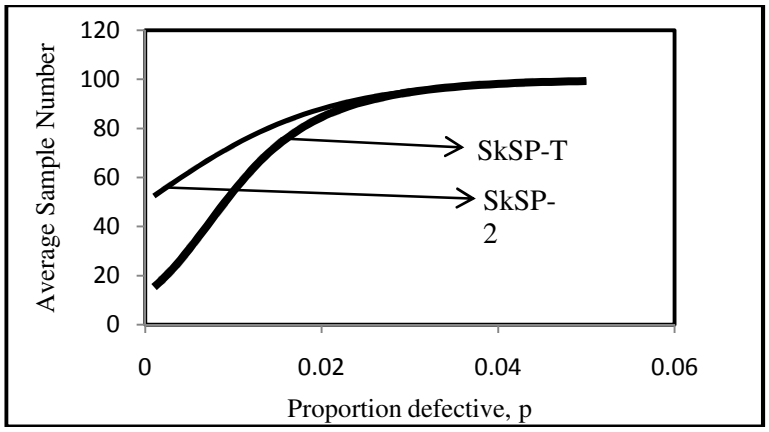

Figure-4
ASN curve for SkSP-T and SkSP - 2

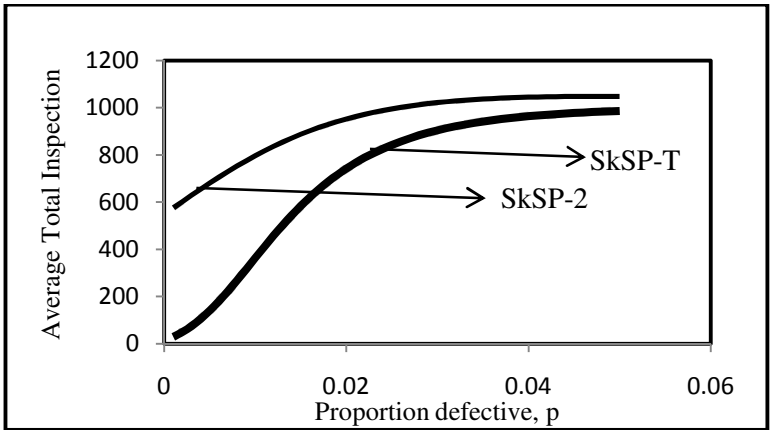

Figure-5
AOQ curve for SkSP-T and SkSP - 2

Table-1
Comparison of SkSP-T and SkSP-2 plan

i	f_1	f_2	f_3	*c*	$P_a(p)$		AOQ		ASN		ATI	
					SkSP-2	**SkSP-T**	**SkSP-2**	**SkSP-T**	**SkSP-2**	**SkSP-T**	**SkSP-2**	**SkSP-T**
					0.950	0.985	0.00095	0.00098	52.49	15.37	577.00	28.53
					0.900	0.966	0.00180	0.00193	54.98	18.67	603.82	49.14
					0.851	0.941	0.00255	0.00282	57.44	22.39	630.33	74.64
					0.802	0.912	0.00321	0.00365	59.86	26.49	656.40	105.12
					0.755	0.878	0.00377	0.00439	62.24	30.91	681.90	140.38
					0.708	0.839	0.00425	0.00503	64.56	35.55	706.73	179.94
					0.663	0.796	0.00464	0.00557	66.81	40.32	730.79	223.04
1	**1/2**	**1/4**	**1/8**	**0**	0.620	0.751	0.00496	0.00601	68.99	45.12	754.00	268.77
					0.578	0.704	0.00520	0.00633	71.09	49.85	776.28	316.09
					0.537	0.656	0.00537	0.00656	73.10	54.41	797.58	363.99
					0.499	0.608	0.00549	0.00668	75.02	58.75	817.85	411.52
					0.462	0.561	0.00555	0.00673	76.85	62.81	837.07	457.88
					0.482	0.515	0.00556	0.00670	78.58	66.57	855.22	502.46
					0.395	0.472	0.00553	0.00661	80.21	70.01	872.29	544.78
					0.364	0.431	0.00547	0.00647	81.75	73.14	888.29	584.56

Table-2
Various Parametric values for SkSP-T with Single Sampling Plan as Reference Plan

i	f_1	f_2	f_3	c	Probability of Acceptance						OR		
					0.99	**0.95**	**0.50**	**0.10**	**0.05**	**0.01**	**α=0.01 β=0.01**	**α=0.05 β=0.05**	**α=0.05 β=0.10**
1	**1/2**	**1/4**	**1/8**	0	0.05	0.25	1.3	2.95	3.65	5.25	105	14.6	11.8
				1	0.4	1.9	2.6	4.7	5.55	7.4	18.5	6.16	5.2
				2	0.9	1.65	3.8	6.25	7.2	9.25	10.27	4.36	3.78
				3	1.5	2.45	5	7.75	8.75	10.95	7.3	3.57	3.16
				4	2.15	3.3	6.15	9.15	10.25	12.55	5.83	3.10	2.77
				5	2.8	4.1	7.3	10.5	11.65	14.1	5.03	2.84	2.6
1	**2/3**	**2/6**	**2/12**	0	0.05	0.2	1.15	2.7	3.4	5	100	17	13.5
				1	0.35	0.8	2.4	4.4	5.25	7.1	20.28	6.56	5.5
				2	0.75	1.5	3.55	5.9	6.85	8.9	17.8	4.56	3.93
				3	1.35	2.25	4.7	7.35	8.35	10.55	7.81	3.71	3.26
				4	2	3.05	5.85	8.7	9.8	12.15	6.07	3.21	2.85
				5	2.65	3.85	6.9	10.05	11.2	13.7	5.16	2.90	2.6
1	**2/5**	**2/10**	**2/20**	0	0.1	0.3	1.45	3.15	3.9	5.5	55	13	10.5
				1	0.45	1.05	2.8	4.95	5.8	7.65	17	5.52	4.71
				2	1	1.8	4.05	6.55	7.5	9.5	9.5	4.16	3.63
				3	1.65	2.6	5.25	8.05	9.05	11.25	6.81	3.48	3.09
				4	2.3	3.45	6.45	9.45	10.55	12.9	5.60	3.05	2.73
				5	2.95	4.35	7.6	10.85	12	14.45	4.89	2.75	2.49
2	**1/2**	**1/4**	**1/8**	0	0.05	0.15	0.65	1.45	1.8	2.65	53	12	9.6
				1	0.25	0.6	1.6	2.8	3.3	4.3	17.2	5.5	4.6
				2	0.7	1.2	2.6	4.1	4.65	5.8	8.28	3.87	3.41
				3	1.2	1.9	3.6	5.3	5.9	7.2	6	3.10	2.78
				4	1.75	2.6	4.6	6.5	7.15	8.55	4.88	2.75	2.42
				5	2.35	3.35	5.55	7.65	8.4	9.9	4.21	2.50	2.28
2	**1/3**	**1/6**	**1/12**	0	0.05	0.15	0.75	1.65	2	2.85	12	13.3	13.5
				1	0.35	0.7	1.8	3.05	3.55	4.55	5.5	5.07	3.78
				2	0.8	1.35	2.85	4.4	4.9	6.1	3.87	3.62	3.5
				3	1.35	2.1	3.9	5.65	6.25	7.5	3.10	2.97	2.88
				4	1.95	2.85	4.9	6.85	7.5	8.9	2.75	2.63	2.53
				5	2.6	3.6	5.95	8.05	8.75	10.25	2.50	2.43	2.3
2	**2/5**	**2/10**	**2/20**	0	0.05	0.15	0.7	1.6	1.95	2.75	55	13	10.6
				1	0.35	0.65	1.75	2.95	3.4	4.45	12.71	5.23	4.53
				2	0.75	1.3	2.75	4.25	4.8	5.95	7.93	3.69	3.26
				3	1.25	2	3.75	5.5	6.1	7.4	5.92	3.05	2.75
				4	1.9	2.75	4.75	6.7	7.35	8.75	4.60	2.67	2.43
				5	2.5	3.5	5.8	7.85	8.6	10.1	4.04	2.45	2.24
3	**1/2**	**1/4**	**1/8**	0	0.05	0.1	0.4	1	1.2	1.75	35	12	10
				1	0.2	0.5	1.25	2.1	2.45	3.2	16	4.9	4.2
				2	0.6	1	2.1	3.25	3.65	4.5	7.5	3.65	3.25
				3	1.05	1.65	3	4.35	4.8	5.75	5.47	2.90	2.63
				4	1.55	2.3	3.9	5.4	5.95	7	4.51	2.58	2.34
				5	2.15	3	4.85	6.5	7.05	8.2	3.81	2.35	2.16
3	**1/3**	**1/6**	**1/12**	0	0.05	0.15	0.5	1.1	1.35	1.85	37	9	7.3
				1	0.25	0.55	1.4	2.3	2.65	3.35	13.4	4.81	4.18
				2	0.65	1.15	2.3	3.45	3.85	4.7	7.23	3.34	3
				3	1.2	1.8	3.25	4.6	5.05	6	5	2.80	2.5
				4	1.75	2.5	4.2	5.7	6.2	7.25	4.14	2.48	2.28
				5	2.35	3.25	5.15	6.8	7.35	8.5	3.61	2.16	2.09

Conclusion

In this paper, a new procedure of skip-lot sampling plan of type SkSP-T with single sampling plan (SSP) as reference plan has-been proposed. The new proposed plan gives better protection to the both producer and consumer. The main feature of this new plan is probability of acceptance is high at good quality levels. The important feature of the SkSP-T plan is that one level of skipping inspection to another skipping level without going back to normal inspection. The performance measures and tables developed in this paper can be used for the selection of SkSP-T plan.

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