Selection and Development of Double Inspection Single Sampling Plan

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Abstract

In the digital era, the quality control inspection process playing a vital role in the production. The professionals insist on the product very strict quality control measures should be adopted in order to avoid rejection and satisfying the need of the customer. In this paper Selection and Development of Double Inspection Single Sampling Plan has been proposed. The tables are constructed for the selection of sample size given AQL and acceptance numbers. The sample sizes are determined by satisfying producer and consumer risks, the efficiency of the proposed plan will be compared with the existing single sampling plan. A numerical example is presented to demonstrate the proposed plan for its applicability.

Keywords: *Single sampling plan, Double Inspection, Bivariate-Poisson distribution, OC, AOQ.*

Introduction

In Acceptance sampling plan by attributes each item tested is classified as conforming and nonconforming. A sample is taken to achieve the high quality of the product; an inspection of the product from raw material to the final product is an essential part of the manufacturing process. The inspection of a lot of the product through the sampling plan ensures accept (or) reject the lot. For the final submitted lot of the product, the supplier is often interested to know the lot acceptance probability. In the traditional acceptance sampling plan, a random sample from a lot of the product is selected and inspected for the purpose of the lot sentencing. A lot of the product is either rejected or accepted on the basis of sample information. The decision of acceptance or rejection is made under the assumption that there is no indeterminate in the data.

In a single sampling plan, the inspector is forced to make a decision concerning acceptability of a lot or batch on the basis of inspection of units in one sample taken from that lot. A single-sampling is defined by the three entities namely lot size 'N', sample size 'n' and acceptance number 'c'. Thus for a lot size of 'N' a random sample of 'n' units are inspected and the number of nonconforming items 'd' is observed. If the number of nonconforming items'd' is less than or equal to acceptance number c, the lot will be accepted. On the other hand, if 'd' is greater than c, then the lot will be rejected, which is the most user friendly in the shop floor situations Sarwat Zahara Khan, Muhammad Khalid Pervaiz and Mueen-ud-Din Azad, (2005), have developed "Selection of Single Sampling Plan on the Basis of AQL, AOQL, ATI and LTPD".

A sampling plan in which a decision about the acceptance or rejection of a lot is based on two samples that have been inspected is known as a double sampling plan. The double sampling plan is used when a clear decision about acceptance or rejection of a lot cannot be taken on the basis of a single sample. In double sampling plan, generally, the decision of acceptance or rejection of a lot is taken on the basis of two samples. If the first sample is bad, the lot may be rejected on the first sample and a second sample need not be drawn. If the first sample is good, the lot may be accepted on the first sample and a second sample is not needed. But if the first sample is neither good nor bad and there is a doubt about its results, we take a second sample and the decision of acceptance or rejection of a lot is taken on the basis of the evidence obtained from both the first and the second samples.

Kazutomo Kawamura (1973) has developed the Structure of Bivariate Poisson distribution. Senthilkumar and Esha Rafiee (2013) have designed six sigma single sampling plan variable plan indexed by six sigma quality levels and tables are constructed for easy selection of sampling plans. Senthilkumar and Esha Rafiee (2016) have studied six sigma single sampling plan indexed by six sigma AQL and AOQL. Quality inspection plays vital role in production process. Both of the consumer and producer are need quality products.

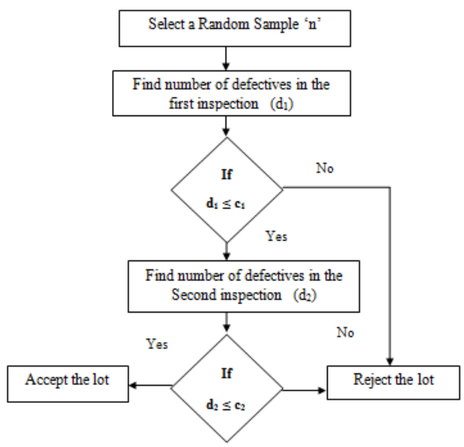
In normal way the a product have a basic quality to use (in other hand) costliest and mass production situation we need more caution about the products. Abraham Golub (1953) has developed for determining best single sampling inspection plan when the sample size is fixed. Ksenija Dumicic, Vlasta Bahovec and Natasa Kurnoga Zivadinovic, (2006) have Studied an OC Curve of an Acceptance Sampling Plan. Erdal Aydemir and Mehmet Onur Olgun (2010) have developed an Application of Single and Double Acceptance Sampling Plans for a Manufacturing System. Senthilkumar and Sabarish (2020) have developed the construction and selection of Double Inspection Single Sampling Plan [DISSP (0, 1)]

Operating Procedure

The steps involved in the operating procedure are as follows;

1. Draw a random sample of size 'n' units from the lot and test each unit for conformance to the specified attribute requirements.
2. Count the number of defectives in the first inspection 'd_1' then go to next step.
3. If $d_1 \leq c_1$ go to second inspection for the same sample of size 'n' otherwise ($d_1 > c_1$) reject the lot.
4. Count the number of defectives in second inspection for the same sample, d_2 then go to next step.
5. If $d_1 \leq c_1$ and $d_2 \leq c_2$ accept the lot otherwise ($d_1 > c_1$ and/or $d_2 > c_2$) reject the lot.

Figure.1



Operating Characteristics function of Double Inspection Single Sampling Plan is given by

$$\mathrm{Pa(p)} = \left(\sum_{k=0}^{c1} \frac{e^{-np} \quad np^k}{k!}\right) \left(\sum_{k=0}^{c2} \frac{e^{-np} \quad np^k}{k!}\right)$$

Average Outgoing Quality of Double Inspection Single Sampling Plan (DISSP)

Waiver (1987) defines AOQ as "The expected quality of outgoing product following the use of an acceptance sampling plan for a given value of incoming product quality".

$$AOQ = p * (Pa(p))$$

Illustration and Discussions

In the modern era usage of smart phone will increases day by day, so the smart phone manufacturing company produce mass unit of the phones per day, it's are all very costliest in that kind of situation we have more caution about the product and also the smart phones have lot of quality characteristics and are mention below,

- Audio Device (Speaker, Mice, Ringer)
- Screen (Touch, Display, Sensor, Camera)
- Buttons (Power, Volume)
- Panel body and so on

In DISSP two inspectors checking two different quality Characteristics,
c_1= Checking quality of the buttons and c_2 = Checking the usage of the display, both the quality characteristics are independent Table 1 gives the probability of acceptance of first inspection for the sample of size n=79 and acceptance number c_1=2, the probability of acceptance of second inspection for the sample of size n=79, and the acceptance number c_2=3 and the probability of acceptance of double inspection single sampling plan size n=79; c_1=2 and c_2=3 also it provides the values of Average Outgoing Quality for the first inspection, second inspection and DISPP. Table 2 gives the comparison of Double Inspection Single Sampling with existing Single Sampling Plan in two different inspections separately.

For example, Double Inspection Single Sampling (n: c_1=2, c_2=3) compared with two Single Sampling Plans [(n: c=2) (n, c=3)]. Here we observed that the proposed sampling plan gives the minimum sample size compare with other two single sampling plans. Plan determined by this method for smaller sample size provide the required information to accept or reject the lot for given c_1=2 and c_2= 3. It is advantageous to apply the bivariate attribute plan in industries for reducing the inspection cost and time. Table 3 shows the entries of values n. They are indexed by the parameters of c_1 and c_2 by Pa (p).

Figure2 shows the OC curves of single sampling plan 1 (n=79, c=2), single sampling plan 2 (n=79, c=3) and Double inspection single sampling plan (n=79, c_1=2 and c_2=3) We can observe that the slope of the double inspection single sampling plan Operating Characteristic curve becomes steeper than other two (SSP-1 and SSP-2) OC Curves. Figure 3 Shows the Average Outgoing Quality Curves for single sampling plan 1, single sampling plan 2 and double inspection single sampling plan.

Table 1

p	Operating Characteristics			Average Out Going Quality		
	SSP-1	**SSP-2**	**DISSP**	**SSP-1**	**SSP-2**	**DISSP**
0.01	0.954	0.9913	0.9457	0.0095	0.0099	0.0095
0.02	0.7885	0.9239	0.7285	0.0158	0.0185	0.0146
0.03	0.5776	0.785	0.4534	0.0173	0.0235	0.0136
0.04	0.3883	0.6114	0.2374	0.0155	0.0245	0.0095
0.05	0.2455	0.4433	0.1088	0.0123	0.0222	0.0054
0.06	0.1483	0.3034	0.045	0.0089	0.0182	0.0027
0.07	0.0865	0.1983	0.0172	0.0061	0.0139	0.0012
0.08	0.0491	0.1249	0.0061	0.0039	0.01	0.0005
0.09	0.0273	0.0762	0.0021	0.0025	0.0069	0.0002
0.1	0.0149	0.0453	0.0007	0.0015	0.0045	0.0001

Figure.2

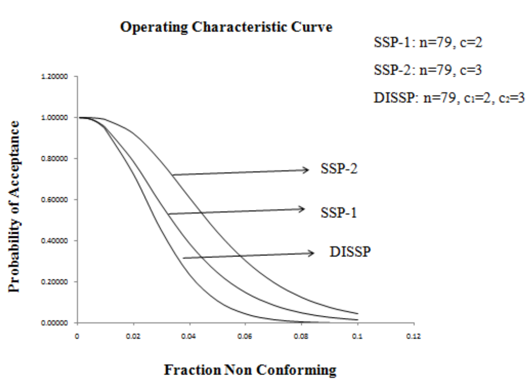


Figure.3

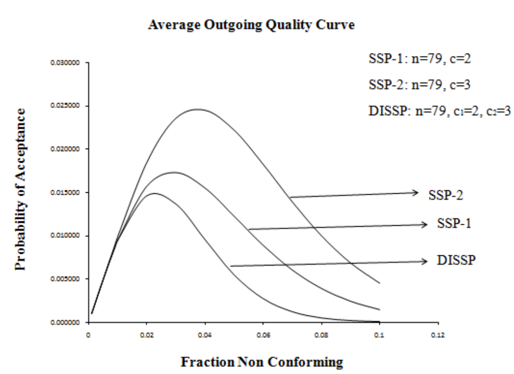


Table.2

p		0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.01
SSP	c = 2	818	409	273	205	164	136	117	103	91	82
SSP	c = 3	1366	683	455	342	273	228	195	171	152	137
DISSP	$c_1 = 2$, $c_2 = 3$	765	381	255	191	153	114	109	95	85	79

Table 3: Entries of values 'n' they are indexed by the parameters of c_1 and c_2 by Pa (p).

C_1	C_2	p=0.001			p=0.002			p=0.003			p=0.004			p=0.005		
		0.99	0.95	0.9	0.99	0.95	0.9	0.99	0.95	0.9	0.99	0.95	0.9	0.99	0.95	0.9
0	1	15	50	100	7	25	50	5	18	35	3	12	25	3	12	20
	2	15	52	103	7	25	52	5	18	35	3	14	26	3	14	21
	3	15	52	110	8	27	52	5	19	36	3	14	26	3	14	22
	4	15	53	110	8	27	53	5	21	36	3	14	27	3	14	22
	5	15	54	110	8	28	53	5	21	36	3	14	27	3	14	22
1	1	102	360	360	51	122	180	34	81	163	25	61	90	20	48	72
	2	106	478	491	72	168	245	48	113	165	36	84	123	29	67	98
	3	108	491	523	74	173	262	49	117	175	36	88	131	29	70	105
	4	114	337	531	86	175	265	49	118	177	37	88	132	29	71	106
	5	122	355	547	92	187	273	50	118	182	37	88	133	30	71	107
2	2	330	621	835	169	311	413	112	207	275	84	155	206	66	124	165
	3	409	765	1029	210	381	504	140	255	336	104	191	252	84	153	201
	4	134	808	1079	217	404	539	145	268	359	106	202	268	87	161	215
	5	429	816	1098	218	408	549	155	272	366	108	204	274	87	163	219
3	3	672	1094	1318	330	547	689	229	364	459	168	273	344	133	218	275
	4	789	1274	1595	395	637	798	263	424	532	197	318	399	158	254	319
	5	817	1343	1698	410	671	848	273	477	535	204	335	424	163	267	399
4	4	1018	1629	1985	536	814	992	357	543	661	269	407	496	215	325	396
	5	1192	1836	2229	611	918	1114	407	612	743	305	450	557	243	367	445
5	5	1334	2208	2630	769	1104	1315	513	736	876	384	552	656	307	440	526

Table.3 Continued.

C_1	C_2	p=0.006			p=0.007			p=0.008			p=0.009			p=0.010		
		0.99	**0.95**	**0.9**	**0.99**	**0.95**	**0.9**	**0.99**	**0.95**	**0.9**	**0.99**	**0.95**	**0.9**	**0.99**	**0.95**	**0.9**
0	1	3	12	17	2	11	15	2	11	13	1	1 1	11	1	10	10
	2	3	11	17	2	11	15	2	11	13	1	10	11	1	10	10
	3	3	11	18	2	11	15	2	11	13	1	10	11	1	9	10
	4	5	11	18	2	11	15	2	11	13	1	10	12	1	9	11
	5	5	11	18	2	11	15	2	11	13	1	10	12	1	9	11
1	1	17	40	60	14	34	51	12	30	45	11	27	40	10	24	36
	2	24	56	81	20	48	70	18	42	60	16	37	54	14	33	49
	3	25	59	87	21	50	75	18	44	64	16	39	58	16	34	52
	4	27	60	88	22	51	77	18	44	65	17	40	59	16	34	53
	5	27	60	91	22	51	77	19	45	65	17	40	59	16	35	53
2	2	55	103	137	48	88	118	42	77	103	37	69	91	33	62	82
	3	70	114	168	60	109	144	51	95	126	46	85	112	42	79	100
	4	71	134	179	61	115	154	54	101	135	47	89	119	43	80	108
	5	72	135	182	64	116	155	56	104	137	48	91	125	43	88	109
3	3	112	182	229	96	156	196	84	136	172	75	121	153	67	109	137
	4	131	212	266	112	185	228	98	159	199	83	141	177	77	127	159
	5	135	223	282	117	191	242	102	168	212	80	149	188	79	134	169
4	4	179	271	330	153	232	283	134	203	248	120	181	220	108	163	198
	5	204	306	371	174	262	318	153	229	278	136	204	247	121	183	223
5	5	256	368	438	215	315	375	192	276	328	170	245	292	154	221	263

Applicable and Advantages of Double Inspection Single Sampling Plan

Compare to other sampling plans (SSP-1 and SSP-2) the sample size is very small in DISSP. In other words DISSP provides minimum of sample size with maximum of acceptance. In this plan we inspect two different and important quality characteristics of the same product, so that the product gets more quality. This finest plan was applicable for Mass and Costliest product Production Process and also it decrease the consumer risk.

Conclusion

The proposed Double Inspection Single Sampling Plan (n; c_1, c_2) is suitable, when there is a possibility of producing costlier products and mass production, with the aim to produce good products under the OC function for Double Inspection Single Sampling Plan of bivariate Poisson distribution. This plan provides protection to both producer and consumers. It can be applicable for manufacturing industries like Foods, Smart phones, Gold ornament and so on where the human intervention is much involved.

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