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New Weibull-Pareto Distribution in Acceptance Sampling Plans Based on Truncated Life Tests

Amer Ibrahim Al-Omari[1], Agustín Santiago[2,*], Jose M. Sautto[2], Carlos N. Bouza[3]

[1]Department of Mathematics, Faculty of Science, Al al-Bayt University, Mafraq, Jordan
[2]Facultad de Matemáticas de la Universidad Autónoma de Guerrero, México
[3]Facultad de Matemática y Computación, Universidad de La Habana, Cuba

Abstract In this study, a new acceptance sampling plan based on truncated life test is proposed for a lifetime following a New Weibull-Pareto distribution (NWPD). For various acceptance numbers, confidence levels and values of the ratio of the fixed experiment time to the particular mean lifetime as well as the minimum sample sizes required to assert the specified mean life are found. The operating characteristic function values of the suggested sampling plans and producer's risk are presented. The important tables are presented and the results are explained by a discussing the results of numerical examples.

Keywords Acceptance sampling, Operating characteristic function, New Weibull-Pareto distribution, Producer's risk, Consumer's risk, Truncated life test

1. Introduction

The acceptance sampling plans are used to locate the acceptability of a product unit, where the consumer can accept or reject the lot, based on a random sample selected from it. The process started by obtaining the minimum sample size that is necessary to emphasize a certain average life when the life test is finished at a predetermined time. Such tests are called truncated life-time tests. Indeed, nowadays the acceptance-sampling plan is an important tool in the quality control techniques because it can help manufacturers to minimize the variability and develop the outgoing quality of the products.

The concept of acceptance sampling plan based on truncated life tests is studied by many authors, as Aslam et al. (2010) and Sobel & Tischendrof (1959) for generalized exponential distribution.

Rayleigh distribution by Tsai and Wu (2006), Al-Omari (2014) studied a three parameters kappa distribution, Al-Nasser and Al-Omari (2013) proposed an acceptance sampling plan in truncated life tests for the exponentiated Fréchet distribution. Kantam et al. (2001) considered truncated life tests for the log-logistic distribution, Sriramachandran and Palanivel for Exponentiated Inverse Rayleigh distribution, Al-Omari (2015) considered the time truncated acceptance sampling plans using the generalized inverted exponential distribution.

In the present work, we do not intend to develop the Weibull-Pareto distribution, as others have done. We know that, the Weibull-Pareto distribution arises from the combination of the Pareto distribution, initiated by Vilfraddo Pareto (1896), and the family of distributions known as Weibull-G, which is a special case proposed by Alzaatreh et al. (2013b). Tair et al. (2015) makes a broad discussion of its properties and applications, and then our aim is to apply acceptance sampling plans to truncated life tests, assuming that the data fit a Weibull-Pareto distribution.

The rest of this paper is organized as follows. Section 2 provides the probability density function (pdf) and cumulative distribution function of the New Weibull-Pareto distribution as well as some other statistical properties. Section 3 is summarized the suggested sampling plans based on the New Weibull-Pareto distribution and its properties like, the minimum sample size, the operating characteristic function and the producer's risk. Discussion of the tables and some examples are given in Section 4. Our conclusions are summarized in Section 5.

2. The New Weibull-Pareto Distribution

The probability density function of the NWP random variable is defined as

$$g(x,\delta,\theta,\beta)=\frac{\delta\beta}{\theta}\left(\frac{x}{\theta}\right)^{\beta-1}e^{-\delta\left(\frac{x}{\theta}\right)^{\beta}}, \quad (1)$$

and its corresponding cumulative distribution function is given by

* Corresponding author:
asantiago@uagro.mx (Agustín Santiago)
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$$G(x,\delta,\theta,\beta) = 1 - e^{-\delta\left(\frac{x}{\theta}\right)^{\beta}}, x > 0, \beta > 0, \delta > 0, \theta > 0. \quad (2)$$

The mean and the variance of the NWPD are

$$E(X) = \theta\delta^{-\frac{1}{\beta}}\Gamma\left(\frac{\beta+1}{\beta}\right), \quad (3)$$

and

$$Var(X) = 2\theta\delta^{-\frac{2}{\beta}}\Gamma\left(\frac{\beta+2}{\beta}\right) - \left[\theta\delta^{-\frac{1}{\beta}}\Gamma\left(\frac{\beta+1}{\beta}\right)\right]^2. \quad (4)$$

The corresponding hazard rate function $H(x)$ of the NWP random variable is defined by

$$H(x,\delta,\theta,\beta) = \frac{\delta\beta}{\theta}\left(\frac{x}{\theta}\right)^{\beta-1}; \quad (5)$$

see Aljarrah at al., (2015) for more details about the New Weibull-Pareto distribution.

3. The Suggested Acceptance Sampling Plans

In this section, we explained the suggested acceptance sampling plans based on the New Weibull-Pareto distribution. Acceptance sampling plans based on New Weibull-Pareto distribution have not been studied previously.

An acceptance sampling plan based on truncated life tests consists of the following quantities:

(1) The number of units (*n*) on test.
(2) An acceptance number (*c*), where if *c* or less failures happened within the test time (*t*), the lot is accepted.
(3) The maximum test duration time, *t*.
(4) The ratio t/μ_0, where μ_0 is the specified average life.

3.1. Minimum Sample Size

Assume that the lot size is sufficiently large to be considered infinite to obtain the probability of accepting a lot using the binomial distribution. Here, the problem is to determine the smallest sample size *n* essential to satisfy the inequality

$$\sum_{i=0}^{c}\binom{n}{i}p^i(1-p)^{n-i} \le 1 - P^*, \quad (6)$$

up to an acceptance number *c* for given values of $P^* \in (0,1)$, where $p = F(t;\, \mu_0)$ is the probability of a failure observed within the time *t* which depends only on the ratio t/μ_0.

If the number of observed failures within the time *t* is at most *c*, then from Inequality (6) we can confirm with probability P that $F(t;\, \mu) \le F(t;\, \mu_0)$, which implies $\mu_0 \le \mu$.

The smallest sample sizes satisfying the Inequality (6) for $t/\mu_0 = 0.628$, 0.942, 1.257, 1.571, 2.356, 3.141, 3.927, 4.712, P^* =0.75, 0.9, 0.95, 0.99 and $c = 0, 1, 2, \ldots, 10$ are presented in Table 1. The values of t/μ_0 and P^* considered in this study are the same values which are considered in Gupta and Groll (1961), Baklizi and El Masri (2004), Kantam and Rosaiah (2001), and Al-Nasser and Al-Omari (2013).

3.2. Operating Characteristic of the Sampling Plan $(\boldsymbol{n}, \boldsymbol{c}, \boldsymbol{t}/\boldsymbol{\mu_0})$

The operating characteristic function of the sampling plan $(n, c, t/\mu_0)$ is the probability of acceptance the lot. The operating characteristic function can be considered as a source for choosing the minimum sample size, *n*, or the acceptance number, *c*. It is defined as

$$L(p) = P(Acepting\ a\ lot) = \sum_{i=0}^{c}\binom{n}{i}p^i(1-p)^{n-i}$$
$$= 1 - B_p(c+1, n-c), \quad (7)$$

where $p = F(t;\, \mu)$ is considered as a function of μ (the lot quality parameter), and $I_p(c+1, n-c)$ is the incomplete beta function defined as

$$I_\vartheta(a,b) = \frac{1}{B(a,b)}\int_0^\vartheta \omega^{a-1}(1-\omega)^{b-1}\, d\omega, a, b > 0,$$

where $B(a,b) = \frac{(a-1)!(b-1)!}{(a+b-1)!}$. The operating characteristic function values as a function of $\mu \ge \mu_0$ for the sampling plan $(n, c = 2, t/\mu_0)$ when the parameters of the NWPD are $\beta = 2$ and $\delta = 3$ are reported in Table 2. Also, for fixed time *t*, the operating characteristic is a decreasing function in the probability p, while p itself is a monotonically decreasing function in $\mu \ge \mu_0$.

3.3. Producer's Risk

The probability of rejecting the lot when $\mu > \mu_0$ in known as the producer's risk and it is defined as

$$P(Rejecting\ a\ lot) = \sum_{i=c+1}^{n}\binom{n}{i}p^i(1-p)^{n-i}$$
$$= I_p(c+1, n-c). \quad (8)$$

For a given value of the producer's risk, say λ, under a given sampling plan, one may be interested in knowing what smallest value of μ/μ_0 that will assert the producer's risk is at most λ. The value of μ/μ_0 is the minimum positive number for which $p = F\left(\frac{t}{\mu_0}\frac{\mu_0}{\mu}\right)$ satisfies the inequality

$$PR(p) = \sum_{i=c+1}^{n}\binom{n}{i}p^i(1-p)^{n-i} \le \lambda. \quad (9)$$

For a given acceptance sampling plan $(n, c, t/\mu_0)$ based on the NWPD at a given confidence level P^* the smallest values of μ/μ_0 satisfying Inequality (9) are given in Table 3.

4. Illustration of the Tables

The smallest sample sizes necessary to ensure that the mean life exceeds μ_0 with probability P^* or greater, and acceptance number c for $\beta = 2$ and $\delta = 3$ in the *NWPD* distribution are given in Table (1). To illustrate the procedure, when $P^* = 0.99$, $t/\mu_0 = 1.571\ (t = 1571, \mu_0 = 1000)$ and $c = 3$, the corresponding table value is $n = 8$ units, which are should be put on test. This implies that out of 8 units, if 3 items fail before the time *t*, then a 0.99% upper confidence interval for the mean μ is $(t/\mu_0 = 1.571, \infty)$. That is if out 8 items, three or less are fail before time *t*, then the lot can be accepted with probability 0.99. Based on the suggested acceptance sampling plan for the NWPD it turns out that the minimum samples sizes obtained in this paper are less than that their counterparts in Baklizi and El Masri (2004), and Al-Nasser and Al-Omari (2013).

The operating characteristic function values for the proposed sampling plan for the time truncated acceptance sampling plan calculated from Table (1) for various values of t/μ_0 and P^* with acceptance number $c = 2$. From Table 2 the operating characteristic values for the sampling plan $(n, c, t/\mu_0) = (6, 2, 1.571)$ are as follows:

μ/μ_0	2	4	6	8	10	12
OC	0.58136	0.97762	0.99749	0.99951	0.99986	0.99995

This implies that if the true mean life is twice the specified mean life ($\mu/\mu_0 = 2$) the producer's risk is about 0. 418635, and the producer's risk is about almost equal zero when the true mean is greater than or equal to 4 ($\mu/\mu_0 \geq 4$) times the specified mean.

From Table 3 we can get the value of the minimum ratio of the true mean lifetime to the specified one for various choices of the acceptance $c, t/\mu_0$ such that the producer's risk may not exceed 0.05. Thus, for $c = 2$, $t/\mu_0 = 1.571$, and $P^* = 0.95$ the table entry is $\mu/\mu_0 = 3.03$. This shows that the product can have an average life of 3.03 times the specified average lifetime of 1000 hours in order that with $c = 2, n = 8$ the product is accepted with a probability of at least 0.95.

Table 1. Minimum sample sizes to be tested for a time *t* to assert the average life exceeds a given value μ_0 with probability P^* and acceptance number *c* for NWPD with $\beta = 2$ and $\delta = 3$

		t/μ_0							
P^*	c	0.628	0.942	1.257	1.571	2.356	3.141	3.927	4.712
0.75	0	5	3	2	1	1	1	1	1
	1	10	5	3	3	2	2	2	2
	2	14	7	5	4	3	3	3	3
	3	19	10	6	5	4	4	4	4
	4	23	12	8	6	5	5	5	5
	5	27	14	10	8	6	6	6	6
	6	31	16	11	9	7	7	7	7
	7	36	18	13	10	8	8	8	8
	8	40	21	14	11	9	9	9	9
	9	44	23	16	12	10	10	10	10
	10	48	25	17	14	11	11	11	11
0.90	0	8	4	2	2	1	1	1	1
	1	14	7	4	3	2	2	2	2
	2	19	9	6	5	3	3	3	3
	3	24	12	8	6	4	4	4	4
	4	29	14	9	7	5	5	5	5
	5	33	17	11	8	6	6	6	6
	6	38	19	13	10	7	7	7	7
	7	42	21	14	11	9	8	8	8
	8	47	24	16	12	10	9	9	9
	9	51	26	17	14	11	10	10	10
	10	56	28	19	15	12	11	11	11
0.95	0	10	5	3	2	1	1	1	1
	1	16	8	5	4	2	2	2	2
	2	22	11	7	5	3	3	3	3
	3	27	13	9	6	5	4	4	4
	4	32	16	10	8	6	5	5	5
	5	37	18	12	9	7	6	6	6
	6	42	21	14	10	8	7	7	7
	7	47	23	15	12	9	8	8	8
	8	52	26	17	13	10	9	9	9
	9	56	28	19	14	11	10	10	10
	10	61	30	20	16	12	11	11	11

		t/μ_0							
P^*	c	0.628	0.942	1.257	1.571	2.356	3.141	3.927	4.712
0.99	0	15	7	4	3	2	1	1	1
	1	23	11	6	5	3	2	2	2
	2	29	14	8	6	4	3	3	3
	3	35	17	10	8	5	4	4	4
	4	40	19	12	9	6	5	5	5
	5	46	22	14	10	7	6	6	6
	6	51	25	16	12	8	7	7	7
	7	56	27	18	13	9	8	8	8
	8	61	30	19	15	10	9	9	9
	9	66	33	21	16	11	10	10	10
	10	71	35	23	17	13	11	11	11

Table 2. Operating characteristic function values for the sampling plan $(n, c = 2, t/\mu_0)$ with a given probability P^* under the NWPD with $\beta = 2$ and $\delta = 3$

			μ/μ_0					
P^*	n	t/μ_0	2	4	6	8	10	12
0.75	14	0.628	0.920125	0.997850	0.999791	0.999961	0.999990	0.999997
	7	0.942	0.914776	0.997662	0.999772	0.999958	0.999989	0.999996
	5	1.257	0.879749	0.996361	0.999637	0.999933	0.999982	0.999994
	4	1.571	0.840785	0.994663	0.999457	0.999898	0.999973	0.999991
	3	2.356	0.710727	0.986662	0.998543	0.999720	0.999924	0.999974
	3	3.141	0.377024	0.944290	0.992864	0.998544	0.999593	0.999859
	3	3.927	0.140931	0.852288	0.977062	0.994965	0.998543	0.999485
	3	4.712	0.038937	0.710727	0.944262	0.986662	0.995975	0.998543
0.90	19	0.628	0.837615	0.994670	0.999460	0.999899	0.999973	0.999991
	9	0.942	0.839488	0.994737	0.999467	0.999900	0.999973	0.999991
	6	1.257	0.805721	0.993124	0.999293	0.999867	0.999964	0.999988
	5	1.571	0.712980	0.987785	0.998695	0.999751	0.999933	0.999977
	3	2.356	0.710727	0.986662	0.998543	0.999720	0.999924	0.999974
	3	3.141	0.377024	0.944290	0.992864	0.998544	0.999593	0.999859
	3	3.927	0.140931	0.852288	0.977062	0.994965	0.998543	0.999485
	3	4.712	0.038937	0.710727	0.944262	0.986662	0.995975	0.998543
0.95	22	0.628	0.779758	0.991881	0.999159	0.999841	0.999957	0.999986
	11	0.942	0.751208	0.990298	0.998983	0.999807	0.999948	0.999982
	7	1.257	0.724134	0.988629	0.998794	0.999771	0.999938	0.999979
	5	1.571	0.712980	0.987785	0.998695	0.999751	0.999933	0.999977
	3	2.356	0.710727	0.986662	0.998543	0.999720	0.999924	0.999974
	3	3.141	0.377024	0.944290	0.992864	0.998544	0.999593	0.999859
	3	3.927	0.140931	0.852288	0.977062	0.994965	0.998543	0.999485
	3	4.712	0.038937	0.710727	0.944262	0.986662	0.995975	0.998543
0.99	29	0.628	0.635407	0.982543	0.998091	0.999633	0.999900	0.999966
	14	0.942	0.611103	0.980534	0.997850	0.999585	0.999887	0.999961
	8	1.257	0.640210	0.982801	0.998119	0.999638	0.999902	0.999966
	6	1.571	0.581365	0.977621	0.997491	0.999513	0.999867	0.999955
	4	2.356	0.416846	0.956136	0.994669	0.998934	0.999705	0.999898
	3	3.141	0.377024	0.944290	0.992864	0.998544	0.999593	0.999859
	3	3.927	0.140931	0.852288	0.977062	0.994965	0.998543	0.999485
	3	4.712	0.038937	0.710727	0.944262	0.986662	0.995975	0.998543

Table 3. Minimum ratio of μ/μ_0 for the acceptance of a lot with producer's risk of 0.05 under the NWPD when $\beta = 2,\ \delta = 3$ and $c = 0, 1, 2, \ldots, 10$

		t/μ_0							
P^*	c	0.628	0.942	1.257	1.571	2.356	3.141	3.927	4.712
0.75	0	5.478	6.364	6.934	6.128	9.19	12.251	15.317	18.379
	1	2.867	2.951	2.912	3.639	4.137	5.516	6.896	8.274
	2	2.210	2.242	2.425	2.596	3.071	4.094	5.118	6.141
	3	1.983	2.064	1.974	2.143	2.601	3.468	4.336	5.202
	4	1.809	1.863	1.901	1.886	2.332	3.109	3.886	4.663
	5	1.696	1.733	1.847	1.941	2.154	2.872	3.590	4.308
	6	1.617	1.642	1.693	1.794	2.027	2.702	3.378	4.053
	7	1.583	1.574	1.678	1.684	1.930	2.573	3.216	3.859
	8	1.534	1.570	1.579	1.598	1.853	2.470	3.089	3.706
	9	1.494	1.523	1.577	1.528	1.791	2.387	2.984	3.581
	10	1.462	1.484	1.506	1.588	1.739	2.318	2.898	3.477
0.9	0	6.928	7.349	6.934	8.666	9.190	12.251	15.317	18.379
	1	3.418	3.553	3.465	3.639	4.137	5.516	6.896	8.274
	2	2.602	2.595	2.724	3.030	3.071	4.094	5.118	6.141
	3	2.250	2.299	2.399	2.467	2.601	3.468	4.336	5.202
	4	2.052	2.045	2.064	2.148	2.332	3.109	3.886	4.663
	5	1.894	1.951	1.974	1.941	2.154	2.872	3.590	4.308
	6	1.809	1.827	1.909	1.963	2.027	2.702	3.378	4.053
	7	1.723	1.734	1.772	1.835	2.263	2.573	3.216	3.859
	8	1.677	1.707	1.744	1.735	2.157	2.470	3.089	3.706
	9	1.622	1.646	1.651	1.768	2.072	2.387	2.984	3.581
	10	1.593	1.596	1.639	1.694	2.001	2.318	2.898	3.477
0.95	0	7.746	8.216	8.492	8.666	9.190	12.251	15.317	18.379
	1	3.663	3.819	3.938	4.331	4.137	5.516	6.896	8.274
	2	2.811	2.905	2.991	3.030	3.071	4.094	5.118	6.141
	3	2.396	2.407	2.583	2.467	3.214	3.468	4.336	5.202
	4	2.164	2.211	2.214	2.375	2.828	3.109	3.886	4.663
	5	2.015	2.019	2.094	2.134	2.577	2.872	3.590	4.308
	6	1.910	1.940	2.008	1.963	2.398	2.702	3.378	4.053
	7	1.832	1.833	1.860	1.972	2.263	2.573	3.216	3.859
	8	1.772	1.792	1.820	1.859	2.157	2.470	3.089	3.706
	9	1.708	1.723	1.788	1.768	2.072	2.387	2.984	3.581
	10	1.670	1.665	1.702	1.791	2.001	2.318	2.898	3.477
0.99	0	9.487	9.721	9.806	10.613	12.996	12.251	15.317	18.379
	1	4.414	4.521	4.359	4.922	5.458	5.516	6.896	8.274
	2	3.246	3.314	3.236	3.404	3.893	4.094	5.118	6.141
	3	2.746	2.799	2.755	2.998	3.214	3.468	4.336	5.202
	4	2.436	2.439	2.485	2.580	2.828	3.109	3.886	4.663
	5	2.263	2.268	2.312	2.308	2.577	2.872	3.590	4.308
	6	2.120	2.147	2.190	2.256	2.398	2.702	3.378	4.053
	7	2.014	2.015	2.100	2.097	2.263	2.573	3.216	3.859
	8	1.932	1.951	1.963	2.079	2.157	2.470	3.089	3.706
	9	1.867	1.900	1.914	1.971	2.072	2.387	2.984	3.581
	10	1.813	1.828	1.874	1.882	2.205	2.318	2.898	3.477

Table 4. Descriptive statistics of the lifetime in months to first failure of 20 small electric carts

n	Mean	Variance	Median	Kurtosis	Skewness	Q_1	Q_3
20	14.675	186.697	10.75	4.27993	1.34871	4.45	20.95

Table 5. The AIC, CAIC, BIC, HQIC, W, A, K-S, and -2MLL for the electric carts data

AIC	BIC	CAIC	HQIC	W	A-D	-2MLL	K-S	P-Value
153.1055	156.0927	154.6055	153.6886	0.0086	0.0799	73.5528	0.0526	0.9999

5. An Application

Now we will explain the suggested acceptance sampling plan using the lifetime (in months) to first failure of 20 small electric carts used for internal transportation and delivery in a large manufacturing facility. The data are 0.9, 1.5, 2.3, 3.2, 3.9, 5.0, 6.2, 7.5, 8.3, 10.4, 11.1, 12.6, 15.0, 16.3, 19.3, 22.6, 24.8, 31.5, 38.1, 53.0, and its descriptive statistics are given in Table 4. The same data are investigated by Zimmer et al. (1998) and Lio et al. (2010), and it is asymmetrical distributed.

We used the following criteria to fit the data for the NWPD, which are the Akaike information (AIC), Bayesian information (BIC), consistent Akaike information (CAIC), and Hannan-Quinn information (HQIC), Kolmogorov-Smirnov (K-S), and the Anderson-Darling (A-D) statistic. The values of these criteria are summarized in Table 5 and they indicate that the NWPD fitted these data.

The maximum likelihood estimators (MLE) of the NWPD parameters with standard deviation (Std. Dev.) and the Inf. 95% CI and Sup. 95% CI are given in Table 6.

Table 6. MLEs, Std. Dev. and the CI for the NWPD parameters based on the electric carts data

Parameter	MLEs	Std. Dev.	Inf. 95% CI	Sup. 95% CI
δ	0.15426	3.75292	-7.20132	7.50985
θ	2.83389	62.1381	-118.95458	124.62236
β	1.10970	0.19310	0.73123	1.48817

The MLEs of the parameters are $\hat{\delta} = 0.15426$, $\hat{\theta} = 2.83389$, and $\hat{\beta} = 1.10970$ and hence $\hat{\mu} = \frac{\hat{\theta}}{\sqrt[\hat{\beta}]{\hat{\delta}}} \Gamma\left[\frac{\hat{\beta}+1}{\hat{\beta}}\right] = 5.185$. Suppose that the lifetime of a product follows a NWWD. Also, assume that the specified mean life is $\mu_0 = 6$ months and the testing time $t_0 = 7.542$ months. This leads to the ratio $t_0/\mu_0 = 1.257$. Therefore, from Table (1) the sampling plan for $P^* = 0.95$ is $(n = 20, c = 10, t/\mu_0 = 1.257)$. Thus, we accept the lot if only the number of failures before $t_0 = 6$ months is less than or equal 10. Because the number of failures before $t_0 = 6$ months is 6, then we can accept the lot.

6. Conclusions

In this paper, we proposed the time truncated acceptance sampling plan for the New Weibull-Pareto distribution. The tables for the minimum sample size required to assure a certain average life of the experimental items were derived and are given. The operating characteristic function values and the associated producer's risks are also provided. Practitioners can use the results obtained in this paper and also it can be used for other distributions which can be converted to New Weibull-Pareto distribution.

REFERENCES

[1] ALJARRAH, M.A., FAMOYE, F., and LEE, C. (2015): A New Weibull-Pareto distribution. Communications in Statistics—Theory and Methods, 44, 4077–4095.

[2] AL-NASSER, A.D. and AL-OMARI, A.I. (2013): Acceptance sampling plan based on truncated life tests for exponentiated Frechet distribution. Journal of Statistics and Management Systems, 16, 13-24.

[3] AL-OMARI, A.I. (2014): Acceptance sampling plan based on truncated life tests for three parameter kappa distribution. Economic Quality Control, 29, 53-62.

[4] AL-OMARI, A.I. (2015): Time truncated acceptance sampling plans for generalized inverted exponential distribution. Electronic Journal of Applied Statistical Analysis, 8, 1-12.

[5] ASLAM, M. KUNDU, D., and M. (2007): Time truncated acceptance sampling plans for generalized exponential distribution. Journal of Applied Statistics, 37, 555-556.

[6] BAKLIZI, A., and EL MASRI, A. (2004): Acceptance sampling based on truncated life tests in the Birnbaum Saunders model. Risk Analysis, 24, 1453-1457.

[7] GUPTA, S. S. and GROLL, P. A. (1961): Gamma distribution in acceptance sampling based on life tests. Journal of American Statistical Association 56, 942–970.

[8] KANTAM, R.R.L., ROSAIAH, K. and RAO, G.S. (2001): Acceptance sampling based on life tests, log-logistic model. Journal of Applied Statistics, 28, 121–128.

[9] LIO, Y.L., TSAI, T.R. and WU, S.J. (2010): Acceptance sampling plans from truncated life tests based on the Burr type XII percentiles. Journal of the Chinese Institute of Industrial Engineers, 27, 270-280.

[10] SHANKER, R., SHARMA, S., SHANKER, U. and SHANKER, R. (2013): New Weibull-Pareto distribution and its application to waiting times data. International Journal of Business Management, 3, 1-11.

[11] SRIRAMACHANDRAN and PALANIVEL, (2014): acceptance sampling plan from truncated life tests based on exponentiated inverse Rayleigh distribution. American Journal of Mathematical and Management Sciences, 33, 20–35, 2014.

[12] SOBEL, M. and TISCHENDROF, J.A. (1959): Acceptance sampling with new life test objectives. Proceedings of Fifth National Symposium Reliability and Quality Control, Philadelphia, Pennsylvania, 108–118.

[13] TSAI, T., and WU, S. (2006): Acceptance sampling based on truncated life tests for generalized Rayleigh distribution. Journal of Applied Statistics, 33, 595-600.

[14] ZIMMER, W.J., J.B. KEATS and F.K. WANG, (1998): The Burr XII distribution in reliability analysis. Journal of Quality Technology, 30, 386-394.