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Time Truncated Group Sampling Plan using Weighted Binomial for Various Distributions

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ABSTRACT

In this paper, Group Sampling Plan using Weighted Binomial is developed for a truncated life test when the life time of an item follows different distributions. The parameters of the proposed plan such as minimum number of testers and probability of lot acceptance are determined when the consumer's risk and test termination time are specified. The results are discussed with the help of tables and examples.

Keywords: Truncated life test, Generalized Exponential distribution, Marshall – Olkin extended Lomax distribution, Marshall – Olkin extended exponential distribution, Weibull Distribution, Rayleigh Distribution, Inverse Rayleigh Distribution, Group sampling plan, Operating characteristics, Consumer's risk.

1. INTRODUCTION:

Acceptance sampling plans are used for the quality control purposes in firms and industries. Keeping in view two basic factors of time and cost, it is not possible to check the life time of each and every product. Often it is implicitly assumed that a single item is put in a tester. However, in practice more than one tester can be used to test the multiple number of items at a time because testing time and cost can be saved by testing items simultaneously. The items in a tester can be regarded as a group and the number of items in a group is called the group size. A sampling plan is called group acceptance sampling plan when multiple items are inspected at a time by availability of the testers. The method of determining the minimum number of testers for a predetermined number of groups is followed as they are very important in a group to save the time and cost. This type of testers is frequently used in sudden death testing.The sudden death tests are discussed by Pascual and Meeker (1998) and Vlcek et al (2003).

A common practice in life testing is to terminate the life test by a predetermined time t_0 and note the number of failures. One of the objectives of these experiments is to set a lower confidence limit on the mean life. It is then to establish a specified mean life with a given probability of at least p which provides protection to consumers. The test may be terminated before the time is reached or when the number of failures exceeds the acceptance number in which case the decision is to reject the lot studies regarding truncated life tests. An ordinary time truncated acceptance sampling plan have been discussed by many authors, Goode and Kao(1961), Gupta and Groll(1961), Baklizi and EI Masri(2004), Rosaiah and Kantam (2005) and Tsai, Tzong and Shou(2006), Balakrishnan, Victor Leiva & Lopez (2007). Srinivasa Rao (2010), discussed Double acceptance sampling plans based on truncated life tests for Marshall – olkin extended exponential distribution. All these authors developed the sampling plans for life tests using single and double acceptance sampling. Srinivasa Rao (2010),discussed the Group acceptance sampling plans based on truncated life tests for Marshall – olkin extended Lomax distribution and Hybrid Group acceptance sampling plans for lifetime based on Log-Logistic distribution. Radahakrishnan and Alagirisamy was the first to attempt the attribute group acceptance sampling plan using weighted binomial distribution for Pareto distribution to determine the minimum number of groups. Sudamani ramaswamy A.R. and Priyah anburajan, (2012),discussed the Group Acceptance Sampling Plans Using Weighted Binomial On Truncated Life Tests For Inverse Rayleigh and Log – Logistic Distributions.

In this paper, an approach of designing group acceptance sampling plan using Weighted binomial for truncated life test is proposed, when the lifetime of the items follows different life time distributions. The distributions considered in this paper are Marshall – Olkin extended Lomax distribution, Marshall – Olkin extended exponential distribution, Weibull Distribution, Generalised Exponential distribution, Rayleigh Distribution, Inverse Rayleigh Distribution. The test termination time and mean ratio's are specified. The minimum number of testers is obtained such that it satisfies the consumer's risk. The probability of acceptance are also determined. The tables of the design parameter are provided for easy selection of the plan. The results are analysed with the help of tables and examples.

2. GLOSSARY OF SYMBOLS:

n	-	Size of the sample
d	-	Number of defectives
c	-	Acceptance number
$P_a(p)$	-	Probability of acceptance of a lot submitted for inspection
α	-	Producer's risk
β	-	Consumer's risk
σ	-	Scale parameter
T	-	Prefixed time
μ	-	Mean life
μ_0	-	Specified life
p	-	Failure probability
λ, γ	-	Shape parameter

a - Test termination time multiplier
r - Number of items in a group.

3. DISTRIBUTIONS :

The following are the distributions used in this paper :

(i) Generalized Exponential Distribution

The cumulative distribution function (cdf) of the generalized exponential distribution is given by

$$F(t,\sigma) = \left(1 - e^{-\frac{t}{\sigma}}\right)^{\lambda} \quad , t > 0, \sigma > 0 \tag{1}$$

where σ is a scale parameter and λ is the shape parameter and it is fixed as 2.

(ii) Marshall – Olkin extended Lomax distribution

The cumulative distribution function (cdf) of the Marshall – Olkin extended Lomax distribution is given by

$$F(t,\sigma) = \frac{(1+t/\sigma)^{\theta} - 1}{(1+t/\sigma)^{\theta} - \bar{\gamma}}, \bar{\gamma} = 1-\gamma \quad , t > 0, \sigma > 0 \tag{2}$$

where σ is a scale parameter and θ and γ are the shape parameters and they are fixed as 2.

(iii)Marshall – Olkin extended exponential distribution

The cumulative distribution function (cdf) of the Marshall – Olkin extended exponential distribution is given by

$$F(t,\sigma) = \frac{1 - e^{-t/\sigma}}{1 - \bar{\gamma} e^{-t/\sigma}}, \bar{\gamma} = 1-\gamma, \ t > 0, \sigma > 0 \tag{3}$$

where σ is a scale parameter and γ is the shape parameter and it is fixed as 2.

(iv) Rayleigh Distribution

The cumulative distribution function (cdf) of the Rayleigh distribution is given by

$$F(t,\sigma) = \left(1 - e^{-\frac{t^2}{2\sigma^2}}\right) \quad , t > 0, \sigma > 0 \tag{4}$$

where σ is a scale parameter.

(v) Weibull Distribution

The cumulative distribution function (cdf) of the Weibull distribution is given by

$$F(t,\sigma) = 1 - e^{-\left(\frac{t}{\sigma}\right)^m} \quad , t > 0, \sigma > 0 \qquad \textbf{(5)}$$

where σ is a scale parameter.

(vi) Inverse Rayleigh Distribution

The cumulative distribution function (cdf) of the Inverse Rayleigh distribution is given by

$$F(t,\sigma) = e^{-\frac{\sigma^2}{t^2}} \quad , t > 0 \ , \sigma > 0 \qquad \textbf{(6)}$$

where σ is a scale parameter.

If some other parameters are involved, then they are assumed to be known. The failure probability of an item by time t_0 is given by

$p = F(t_{0} : \sigma)$ **(7)**

The quality of an item is usually represented by its true mean lifetime. Let us assume that the true mean μ can be represented by the scale parameter. In addition, it is convenient to specify the test time as a multiple of the specified life so that $a\mu_0$ and the quality of an item as a ratio of the true mean to the specified life (μ/μ_0).

Then we can rewrite (6) as a function of '*a*' (termination time) and the ratio μ/μ_0.

$p = F(a\,\mu_0 : \mu/\mu_0)$ **(8)**

Here when the underlying distribution is the inverse Rayleigh distribution

$$p = \exp\left(-\frac{1}{a^2\pi}\left(\frac{\mu}{\mu_0}\right)^2\right) \qquad \textbf{(9)}$$

When the underlying distribution is Rayleigh distribution

$$p = 1 - \sum_{j=0}^{k}\left(\frac{\left(\frac{am}{\mu/\mu_0}\right)^{2j} e^{-\left(\frac{am}{\mu/\mu_0}\right)^2}}{j!}\right) \qquad \textbf{(10)}$$

Where $m = \Gamma(k+1/2)/\Gamma(k+1)$

When the underlying distribution is the Marshall – Olkin extended exponential distribution

$$p = \frac{1 - e^{-\frac{1.5708a}{\mu/\mu_0}}}{1 - \bar{\gamma} e^{-\frac{1.5708a}{\mu/\mu_0}}}, \bar{\gamma} = 1 - \gamma \tag{11}$$

When the underlying distribution is the Marshall – Olkin extended Lomax distribution

$$p = \frac{\left[1 + 1.5708a / (\mu/\mu_0)\right]^{\theta} - 1}{\left[1 + 1.5708a / (\mu/\mu_0)\right]^{\theta} - \bar{\gamma}}, \bar{\gamma} = 1 - \gamma \tag{12}$$

When the underlying distribution is the Generalised exponential distribution

$$p = 1 - e^{-\frac{1.2279\, a}{\mu/\mu_0}} \tag{13}$$

When the underlying distribution is the Weibull distribution

$$p = 1 - e^{-\left(\frac{ba}{\mu/\mu_0}\right)^m} \tag{14}$$

4.1 CONDITIONS FOR THE APPLICATION OF GROUP SAMPLING PLAN USING WEIGHTED BINOMIAL

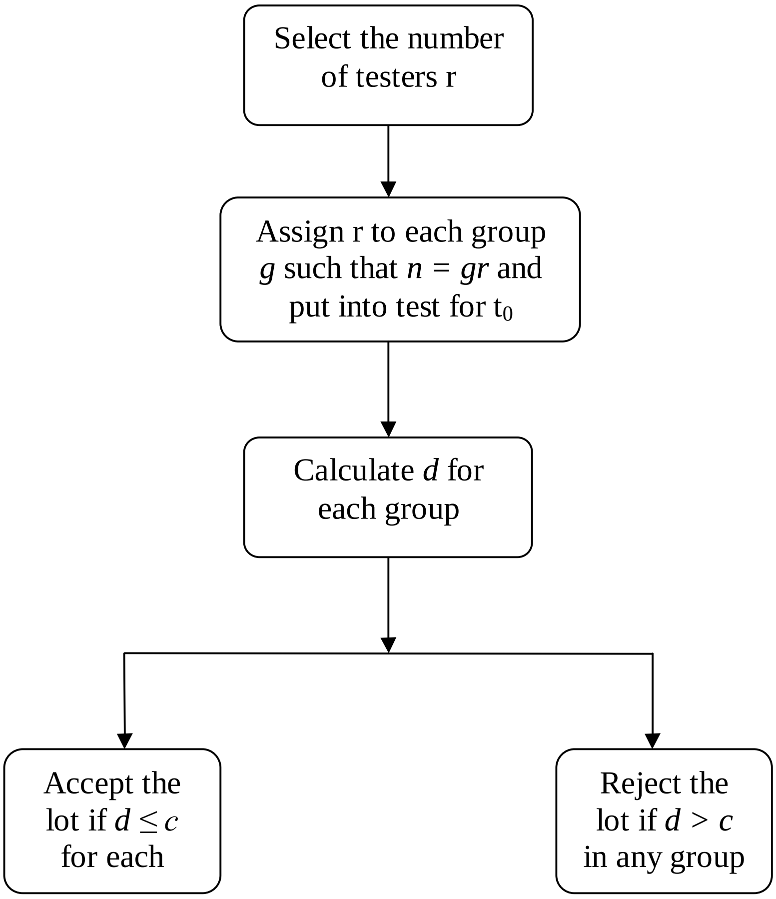
1.Production is continuous, so that results of past, present and future lots are broadly indicative of a continuing process. 2.Lots submitted may be sequential. 3.Inspection is by attributes, with the lot quality defined as the proportion defective. 4.Items are to be submitted for inspection in groups.

4.2 OPERATING PROCEDURE FOR A GROUP SAMPLING PLAN USING WEIGHTED BINOMIAL FOR LIFE TEST

The following is the operating procedure of the weighted group sampling plan for truncated life test given by Sudamani ramaswamy A.R. and Priyah anburajan, 1.Select the number of testers and allocate r items to each group so that the sample size for a lot will be $n= gr$. 2.Pre-fix the acceptance number c for a group and specify the experiment time t_0. 3.Perform the experiment for the g groups simultaneously and record the number of failures for each group. 4.Accept the lot if at most c failures occur in each of all groups before the experiment time t_0. 5.Terminate the experiment as soon as more than c failures occur in any group before time t_0 and reject the lot.

5.FLOW CHART

Operating procedure for Group sampling plan using weighted binomial for life test in the form of flow chart.



6. CONSTRUCTION OF TABLES

The probability of acceptance can be regarded as a function of the deviation of specified average from the true average. This function is called operating characteristic (oc) function of the sampling plan. Once the minimum number of testers is obtained one may be interested to find the probability of acceptance of a lot when the quality of the product is good enough. The probability of acceptance of the group acceptance sampling plan using weighted binomial distribution is given by

$$L(p) = \left(\sum_{i=1}^{c} \binom{r-1}{i-1} p^{i-1} (1-p)^{r-1} \right)^{g} \qquad \textbf{(15)}$$

where p is the probability that an item in a group fails before the termination time $t_0 = a\mu_0$. The minimum number of testers required can be determined by considering the consumer's risk when the true mean life equals the specified mean life ($\mu = \mu_0$)

(worst case) by means of the following inequality: $L(p_0) \le \beta$ **(16)**

where p_0 is the failure probability at $\mu = \mu_0$. Here minimum number of testers *r* is obtained using (15) and (16).The failure probabilities are obtained by fixing the time multiplier '*a*' as 0.7, 0.8, 1.0, 1.2, 1.5 and 2.0 and the mean ratios μ/μ_0 as 2, 4, 6, 8, 10 and 12. The minimum number of testers is determined by fixing the number of groups and the consumer's risk β as 0.25, 0.10, 0.05, and 0.01 in the equations (15) and (16). These choices are consistent with Gupta and Groll (1961), Gupta (1962), Kantam et al (2001), Baklizi and EI Masri (2004), Balakrishnan et Al (2007). The minimum numbers of testers is determined for the above cited distributions and are presented in the Table 1 to Table 6 respectively. The minimum sample size for the above distributions can be obtained by using $n = rg$ in the tables, Table 1 to Table 6. The tables indicates that, as the test termination time multiplier '*a*' increases, the number of testers '*r*' decreases, i.e., a smaller number of testers is needed, if the test termination time multiplier increases for a fixed number of groups. The probability of acceptance are also calculated and are presented in the Table 7 to Table 12 when the life time of the item follows different distributions.

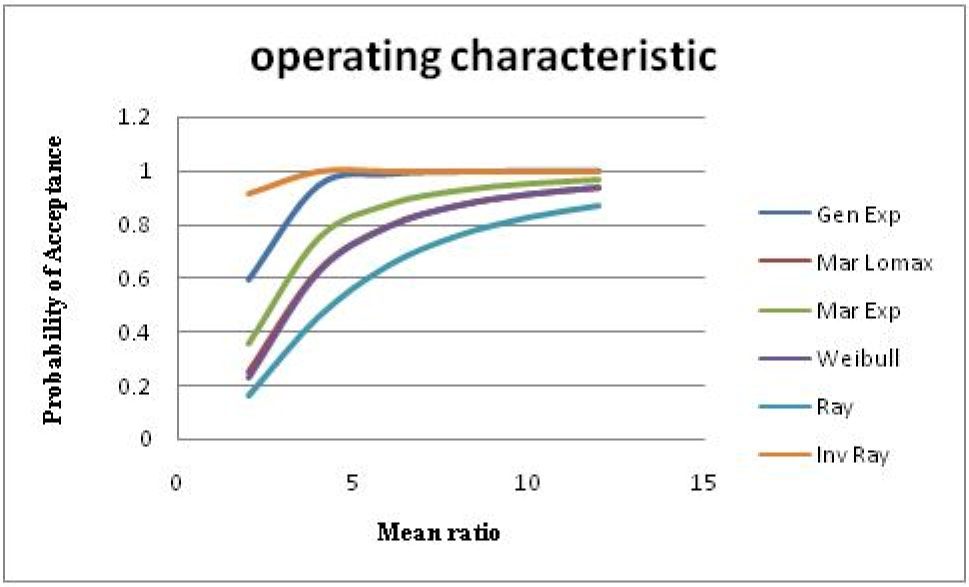


FIGURE 1: OC curve for Probability of acceptance against μ/μ_0 Group Sampling Plan using weighted binomial distribution when the life time of the item follows different distributions.

Table1 : Minimum number of testers for Group Sampling Plan using weighted binomial distribution when the life time of the item follows Generalized Exponential Distribution

β	g	c	a					
			0.7	0.8	1.0	1.2	1.5	2.0
0.25	2	1	3	3	3	2	2	2
	3	2	5	5	4	4	3	3
	4	3	7	6	5	5	4	4
	5	4	9	8	7	6	5	5
0.10	2	1	4	4	3	3	2	2
	3	2	6	6	5	4	4	3
	4	3	9	7	6	5	5	4
	5	4	11	9	8	7	6	5
0.05	2	1	5	5	4	3	3	2
	3	2	7	6	5	4	4	3
	4	3	9	8	7	6	5	4
	5	4	12	10	8	7	6	5
0.01	2	1	7	6	5	4	3	3
	3	2	9	8	6	5	4	4
	4	3	11	10	8	8	6	5
	5	4	13	12	9	8	7	6

Table 2: Minimum number of testers for Group Sampling Plan using weighted binomial distribution when the life time of the item follows Marshall – Olkin Extended Lomax Distribution

β	g	c	a					
			0.7	0.8	1.0	1.2	1.5	2.0
0.25	2	1	2	2	2	2	2	2
	3	2	3	3	3	3	3	3
	4	3	5	4	4	4	4	4
	5	4	6	6	5	5	5	5
0.10	2	1	2	2	2	2	2	2
	3	2	4	4	3	3	3	3
	4	3	5	5	5	4	4	4
	5	4	6	6	6	5	5	5
0.05	2	1	3	3	3	2	2	2
	3	2	4	4	4	4	3	3
	4	3	5	5	5	5	4	4
	5	4	7	6	6	6	5	5
0.01	2	1	4	4	3	3	3	3
	3	2	5	5	4	4	4	3
	4	3	6	6	5	5	5	4
	5	4	7	7	6	6	6	5

Table 3: Minimum number of testers for Group Sampling Plan using weighted binomial distribution when the life time of the item follows Marshall – Olkin Extended Exponential Distribution

β	g	c	a					
			0.7	**0.8**	**1.0**	**1.2**	**1.5**	**2.0**
0.25	**2**	**1**	2	2	2	2	2	2
	3	**2**	4	4	3	3	3	3
	4	**3**	5	5	5	4	4	4
	5	**4**	7	6	6	5	5	5
0.10	**2**	**1**	3	3	3	2	2	2
	3	**2**	5	4	4	3	3	3
	4	**3**	6	6	5	5	4	4
	5	**4**	8	7	6	6	5	5
0.05	**2**	**1**	4	3	3	3	2	2
	3	**2**	5	5	4	4	3	3
	4	**3**	7	6	5	5	4	4
	5	**4**	8	7	7	6	5	5
0.01	**2**	**1**	5	4	4	3	3	2
	3	**2**	6	6	5	5	4	3
	4	**3**	8	7	6	5	5	4
	5	**4**	9	8	7	6	6	5

Table 4: Minimum number of testers for Group Sampling Plan using weighted binomial distribution when the life time of the item follows Weibull Distribution

β	g	c	a					
			0.7	**0.8**	**1.0**	**1.2**	**1.5**	**2.0**
0.25	**2**	**1**	2	2	2	2	2	2
	3	**2**	3	3	3	3	3	3
	4	**3**	4	4	4	4	4	4
	5	**4**	6	5	5	5	5	5
0.10	**2**	**1**	3	2	2	2	2	2
	3	**2**	4	4	3	3	3	3
	4	**3**	5	5	4	4	4	4
	5	**4**	6	6	5	5	5	5
0.05	**2**	**1**	3	3	2	2	2	2
	3	**2**	4	4	4	3	3	3
	4	**3**	5	5	5	4	4	4
	5	**4**	6	6	6	5	5	5
0.01	**2**	**1**	4	3	3	3	2	2
	3	**2**	5	4	4	4	3	3
	4	**3**	6	6	5	5	4	4
	5	**4**	7	7	6	6	5	5

Table 5: Minimum number of testers for Group Sampling Plan using weighted binomial distribution when the life time of the item follows Rayleigh Distribution.

β	g	c	a					
			0.7	0.8	1.0	1.2	1.5	2.0
0.25	2	1	3	2	2	2	2	2
	3	2	4	4	4	3	3	3
	4	3	5	5	5	5	4	4
	5	4	7	7	6	6	5	5
0.10	2	1	3	3	3	3	2	2
	3	2	5	5	4	4	4	3
	4	3	6	6	6	5	5	4
	5	4	8	7	7	6	6	5
0.05	2	1	4	4	3	3	3	2
	3	2	5	5	5	4	4	3
	4	3	7	7	6	6	5	4
	5	4	8	8	7	7	6	5
0.01	2	1	5	5	4	4	3	3
	3	2	6	6	6	5	4	4
	4	3	8	8	7	6	5	5
	5	4	9	9	8	7	7	6

Table 6: Minimum number of testers for Group Sampling Plan using weighted binomial distribution when the life time of the item follows Inverse Rayleigh Distribution.

β	g	c	a					
			0.7	0.8	1.0	1.2	1.5	2.0
0.25	2	1	2	2	2	2	2	2
	3	2	4	4	3	3	3	3
	4	3	5	5	4	4	4	4
	5	4	7	6	5	5	5	5
0.10	2	1	3	3	2	2	2	2
	3	2	5	4	4	3	3	3
	4	3	6	5	5	4	4	4
	5	4	7	7	6	5	5	5
0.05	2	1	4	3	3	2	2	2
	3	2	5	4	4	3	3	3
	4	3	6	6	5	5	4	4
	5	4	8	7	6	6	5	5
0.01	2	1	5	4	3	3	3	2
	3	2	6	5	4	4	4	3
	4	3	7	6	5	5	5	4
	5	4	9	8	7	6	6	5

Table 7: Probability of acceptance for Group Sampling Plan using weighted binomial distribution for c = 2 & g = 3, when the life time of the item follows Generalized Exponential Distribution.

β	r	a	μ/μ_0					
			2	4	6	8	10	12
0.25	**5**	**0.7**	0.790212	0.976264	0.994433	0.998089	0.999179	0.999592
	5	**0.8**	0.704228	0.962524	0.990947	0.996851	0.998637	0.999319
	4	**1.0**	0.694882	0.958691	0.989719	0.996365	0.998411	0.999200
	4	**1.2**	0.548454	0.925907	0.980534	0.992946	0.996872	0.998411
	3	**1.5**	0.655769	0.945401	0.985426	0.994644	0.997600	0.998771
	3	**2.0**	0.421908	0.872885	0.962300	0.985426	0.993271	0.996485
0.10	**6**	**0.7**	0.691278	0.961612	0.990843	0.996839	0.998639	0.999322
	6	**0.8**	0.580275	0.939969	0.985169	0.994802	0.997743	0.998870
	5	**1.0**	0.517556	0.922206	0.979972	0.992837	0.996851	0.998410
	4	**1.2**	0.548454	0.925907	0.980534	0.992946	0.996872	0.998411
	4	**1.5**	0.345114	0.855819	0.958691	0.984438	0.992946	0.996365
	3	**2.0**	0.421908	0.872885	0.962300	0.985426	0.993271	0.996485
0.05	**7**	**0.7**	0.592612	0.944177	0.986447	0.995294	0.997968	0.998986
	6	**0.8**	0.580275	0.939969	0.985169	0.994802	0.997743	0.998870
	5	**1.0**	0.517556	0.922206	0.979972	0.992837	0.996851	0.998410
	4	**1.2**	0.548454	0.925907	0.980534	0.992946	0.996872	0.998411
	4	**1.5**	0.345114	0.855819	0.958691	0.984438	0.992946	0.996365
	3	**2.0**	0.421908	0.872885	0.962300	0.985426	0.993271	0.996485
0.01	**9**	**0.7**	0.414487	0.902315	0.975387	0.991347	0.996243	0.998120
	8	**0.8**	0.365344	0.884016	0.969943	0.989297	0.995319	0.997646
	6	**1.0**	0.366551	0.878260	0.967516	0.988240	0.994802	0.997368
	5	**1.2**	0.344530	0.864194	0.962524	0.986189	0.993828	0.996851
	4	**1.5**	0.345114	0.855819	0.958691	0.984438	0.992946	0.996365
	4	**2.0**	0.125022	0.694881	0.897760	0.958691	0.980534	0.989719

Table 8: Probability of acceptance for Group Sampling Plan using weighted binomial distribution for c = 2 & g = 3, when the life time of the item follows Marshall – Olkin Extended Lomax Distribution.

β	r	a	μ/μ_0					
			2	4	6	8	10	12
0.25	**3**	**0.7**	0.572182	0.839264	0.918926	0.951592	0.967936	0.977234
	3	**0.8**	0.503319	0.801573	0.897778	0.938348	0.958929	0.970730
	3	**1.0**	0.384387	0.723743	0.851477	0.908549	0.938348	0.955727
	3	**1.2**	0.290701	0.646267	0.801573	0.875203	0.914825	0.938348
	3	**1.5**	0.190242	0.537021	0.723743	0.820589	0.875203	0.908549

	3	**2.0**	0.095196	0.384387	0.596365	0.723743	0.801573	0.851477
0.10	**4**	**0.7**	0.250669	0.629022	0.793755	0.870958	0.912202	0.936578
	4	**0.8**	0.186541	0.560849	0.747008	0.838873	0.889235	0.919453
	3	**1.0**	0.384387	0.723743	0.851477	0.908549	0.938348	0.955727
	3	**1.2**	0.290701	0.646267	0.801573	0.875203	0.914825	0.938348
	3	**1.5**	0.190242	0.537021	0.723743	0.820589	0.875203	0.908549
	3	**2.0**	0.095196	0.384387	0.596365	0.723743	0.801573	0.851477
0.05	**4**	**0.7**	0.250669	0.629022	0.793755	0.870958	0.912202	0.936578
	4	**0.8**	0.186541	0.560849	0.747008	0.838873	0.889235	0.919453
	4	**1.0**	0.101465	0.436914	0.652372	0.770520	0.838873	0.881213
	4	**1.2**	0.054685	0.333393	0.560849	0.699611	0.784502	0.838873
	3	**1.5**	0.190242	0.537021	0.723743	0.820589	0.875203	0.908549
	3	**2.0**	0.095196	0.384387	0.596365	0.723743	0.801573	0.851477
0.01	**5**	**0.7**	0.093848	0.435583	0.653984	0.772553	0.840720	0.882778
	5	**0.8**	0.058087	0.357889	0.587422	0.721913	0.802317	0.853086
	4	**1.0**	0.101465	0.436914	0.652372	0.770520	0.838873	0.881213
	4	**1.2**	0.054685	0.333393	0.560849	0.699611	0.784502	0.838873
	4	**1.5**	0.021781	0.216468	0.436914	0.594530	0.699611	0.770520
	3	**2.0**	0.095196	0.384387	0.596365	0.723743	0.801573	0.851477

Table 9: Probability of acceptance for Group Sampling Plan using weighted binomial distribution for c = 2 & g = 3, when the life time of the item follows Marshall – Olkin Extended Exponential Distribution.

β	**r**	**a**	**μ/μ_0**					
			2	**4**	**6**	**8**	**10**	**12**
0.25	**4**	**0.7**	0.557089	0.855019	0.931081	0.960109	0.974073	0.981822
	4	**0.8**	0.472121	0.816724	0.911578	0.948510	0.966428	0.976418
	3	**1.0**	0.636853	0.891434	0.950033	0.971544	0.981683	0.987240
	3	**1.2**	0.525759	0.847867	0.928932	0.959309	0.973742	0.981683
	3	**1.5**	0.373147	0.773711	0.891434	0.937232	0.959309	0.971544
	3	**2.0**	0.185127	0.636853	0.816024	0.891434	0.928932	0.950033
0.10	**5**	**0.7**	0.353812	0.747146	0.873170	0.924779	0.950439	0.964952
	4	**0.8**	0.472121	0.816724	0.911578	0.948510	0.966428	0.976418
	4	**1.0**	0.322040	0.733435	0.867124	0.921577	0.948510	0.963680
	3	**1.2**	0.525759	0.847867	0.928932	0.959309	0.973742	0.981683
	3	**1.5**	0.373146	0.773711	0.891434	0.937232	0.959309	0.971544
	3	**2.0**	0.185127	0.636853	0.816024	0.891434	0.928932	0.950033
0.05	**5**	**0.7**	0.353812	0.747146	0.873170	0.924779	0.950439	0.964952
	5	**0.8**	0.267407	0.688101	0.839661	0.903892	0.936317	0.954809
	4	**1.0**	0.322040	0.733435	0.867124	0.921577	0.948510	0.963680
	4	**1.2**	0.206163	0.645402	0.816724	0.890194	0.927340	0.948510

	3	**1.5**	0.373146	0.773711	0.891434	0.937232	0.959309	0.971544
	3	**2.0**	0.185127	0.636853	0.816024	0.891434	0.928932	0.950033
0.01	**6**	**0.7**	0.210147	0.634669	0.806292	0.882125	0.921207	0.943768
	6	**0.8**	0.140251	0.560349	0.758859	0.85101	0.899576	0.927963
	5	**1.0**	0.141511	0.568795	0.766395	0.856731	0.903892	0.931286
	5	**1.2**	0.068294	0.455328	0.688101	0.803898	0.866674	0.903892
	4	**1.5**	0.094964	0.513997	0.733435	0.836220	0.890194	0.921577
	3	**2.0**	0.185127	0.636853	0.816024	0.891434	0.928932	0.950033

Table 10: Probability of acceptance for Group Sampling Plan using weighted binomial distribution for c = 2 & g = 3,,when the life time of the item follows Weibull distribution.

β	**r**	**a**	**μ/μ_0**					
			2	**4**	**6**	**8**	**10**	**12**
0.25	**3**	**0.7**	0.553939	0.836658	0.918293	0.951384	0.967855	0.977199
	3	**0.8**	0.479176	0.797578	0.896751	0.937995	0.958785	0.970665
	3	**1.0**	0.349203	0.715988	0.849259	0.907734	0.937995	0.955556
	3	**1.2**	0.247335	0.633636	0.797578	0.873651	0.914123	0.937995
	3	**1.5**	0.141586	0.515837	0.715988	0.817331	0.873651	0.907734
	3	**2.0**	0.051815	0.349203	0.580048	0.715988	0.797578	0.849259
0.10	**4**	**0.7**	0.232536	0.624122	0.792322	0.870445	0.911993	0.936486
	4	**0.8**	0.166748	0.553953	0.744797	0.838034	0.888873	0.919284
	3	**1.0**	0.349203	0.715988	0.849259	0.907734	0.937995	0.955556
	3	**1.2**	0.247335	0.633636	0.797578	0.873651	0.914123	0.937995
	3	**1.5**	0.141586	0.515837	0.715988	0.817331	0.873651	0.907734
	3	**2.0**	0.051815	0.349203	0.580048	0.715988	0.797578	0.849259
0.05	**4**	**0.7**	0.232536	0.624122	0.792322	0.870445	0.911993	0.936486
	4	**0.8**	0.166748	0.553953	0.744797	0.838034	0.888873	0.919284
	4	**1.0**	0.081944	0.425706	0.648084	0.768721	0.838034	0.880788
	3	**1.2**	0.247335	0.633636	0.797578	0.873651	0.914123	0.937995
	3	**1.5**	0.141586	0.515837	0.715988	0.817331	0.873651	0.907734
	3	**2.0**	0.051815	0.349203	0.580048	0.715988	0.797578	0.849259
0.01	**5**	**0.7**	0.083040	0.429758	0.651887	0.771728	0.840365	0.882617
	4	**0.8**	0.166748	0.553953	0.744797	0.838034	0.888873	0.919284
	4	**1.0**	0.081944	0.425706	0.648084	0.768721	0.838034	0.880788
	4	**1.2**	0.038424	0.318218	0.553953	0.696441	0.782928	0.838034
	3	**1.5**	0.141587	0.515837	0.715988	0.817331	0.873651	0.907734
	3	**2.0**	0.051815	0.349203	0.580048	0.715988	0.797578	0.849259

Table 11:Probability of acceptance for Group Sampling Plan using weighted binomial distribution for c = 2 & g = 3, when the life time of the item follows Rayleigh Distribution.

β	r	a	μ/μ_0					
			2	4	6	8	10	12
0.25	**4**	**0.7**	0.351721	0.646963	0.789485	0.862245	0.903391	0.928687
	4	**0.8**	0.301163	0.591553	0.747535	0.831411	0.880248	0.910831
	4	**1.0**	0.227771	0.494340	0.666351	0.768461	0.831411	0.872304
	3	**1.2**	0.492753	0.708547	0.818940	0.878467	0.913293	0.935201
	3	**1.5**	0.421431	0.639344	0.761488	0.833767	0.878467	0.907616
	3	**2.0**	0.309309	0.549000	0.676255	0.761488	0.818940	0.858632
0.10	**5**	**0.7**	0.163682	0.457232	0.647746	0.758602	0.825852	0.869010
	5	**0.8**	0.126735	0.391992	0.588152	0.710420	0.787596	0.838394
	4	**1.0**	0.227771	0.494340	0.666351	0.768461	0.831411	0.872304
	4	**1.2**	0.177712	0.415135	0.591553	0.706312	0.781069	0.831411
	4	**1.5**	0.124704	0.325019	0.494340	0.618720	0.706312	0.768461
	3	**2.0**	0.309309	0.549000	0.676255	0.761488	0.81894	0.858632
0.05	**5**	**0.7**	0.163682	0.457232	0.647746	0.758602	0.825852	0.869010
	5	**0.8**	0.126735	0.391992	0.588152	0.710420	0.787596	0.838394
	5	**1.0**	0.080291	0.288946	0.481196	0.617498	0.71042	0.774722
	4	**1.2**	0.177712	0.415135	0.591553	0.706312	0.781069	0.831411
	4	**1.5**	0.124704	0.325019	0.494340	0.618720	0.706312	0.768461
	3	**2.0**	0.309309	0.549000	0.676255	0.761488	0.818940	0.858632
0.01	**6**	**0.7**	0.069548	0.305454	0.511702	0.649527	0.739701	0.800328
	6	**0.8**	0.048394	0.243908	0.443024	0.588000	0.68778	0.757092
	6	**1.0**	0.025438	0.156798	0.329251	0.476374	0.588000	0.670680
	5	**1.2**	0.053712	0.215574	0.391992	0.532493	0.635546	0.710420
	4	**1.5**	0.124704	0.325019	0.494340	0.618720	0.706312	0.768461
	4	**2.0**	0.001399	0.081944	0.258753	0.425706	0.553953	0.648084

Table 12:Probability of acceptance for Group Sampling Plan using weighted binomial distribution for c = 2 & g = 3, when the life time of the item follows inverse Rayleigh Distribution.

β	r	a	μ/μ_0					
			2	4	6	8	10	12
0.25	**4**	**0.7**	0.953527	1.000000	1.000000	1.000000	1.000000	1.000000
	4	**0.8**	0.854926	0.999999	1.000000	1.000000	1.000000	1.000000
	3	**1.0**	0.783125	0.999887	1.000000	1.000000	1.000000	1.000000
	3	**1.2**	0.570848	0.997470	1.000000	1.000000	1.000000	1.000000
	3	**1.5**	0.311283	0.967985	0.999887	1.000000	1.000000	1.000000

	3	**2.0**	0.104549	0.783125	0.990314	0.999887	1.000000	1.000000
0.10	**5**	**0.7**	0.912882	1.000000	1.000000	1.000000	1.000000	1.000000
	4	**0.8**	0.854926	0.999999	1.000000	1.000000	1.000000	1.000000
	4	**1.0**	0.529505	0.999664	1.000000	1.000000	1.000000	1.000000
	3	**1.2**	0.570848	0.997470	1.000000	1.000000	1.000000	1.000000
	3	**1.5**	0.311283	0.967985	0.999887	1.000000	1.000000	1.000000
	3	**2.0**	0.104549	0.783125	0.990314	0.999887	1.000000	1.000000
0.05	**5**	**0.7**	0.912886	1.000000	1.000000	1.000000	1.000000	1.000000
	4	**0.8**	0.854926	0.999999	1.000000	1.000000	1.000000	1.000000
	4	**1.0**	0.529505	0.999664	1.000000	1.000000	1.000000	1.000000
	3	**1.2**	0.570848	0.997470	1.000000	1.000000	1.000000	1.000000
	3	**1.5**	0.311283	0.967985	0.999887	1.000000	1.000000	1.000000
	3	**2.0**	0.104549	0.783125	0.990314	0.999887	1.000000	1.000000
0.01	**6**	**0.7**	0.864328	1.000000	1.000000	1.000000	1.000000	1.000000
	5	**0.8**	0.746999	0.999998	1.000000	1.000000	1.000000	1.000000
	4	**1.0**	0.529505	0.999664	1.000000	1.000000	1.000000	1.000000
	4	**1.2**	0.249314	0.992568	0.999999	1.000000	1.000000	1.000000
	4	**1.5**	0.063559	0.912330	0.999664	1.000000	1.000000	1.000000
	3	**2.0**	0.104549	0.783125	0.990314	0.999887	1.000000	1.000000

7.EXAMPLES

Suppose that the experimenter is interested in establishing that the true unknown average life is at least 1000 hours. It is desired to test if the mean is greater than 1,000 hrs based on the testing time of 700 hrs, when the mean ratio μ/μ_0 =2 with β = 0.05 using 3 groups and acceptance numbers c = 2. This leads to the termination multiplier a = 0.7. Following are the results obtained when the lifetime of the test items follows the Generalized Exponential distribution, Marshall – Olkin extended Lomax distribution, Marshall – Olkin extended exponential distribution, Weibull Distribution,Inverse Rayleigh Distribution respectively.

7.1 Generalized Exponential Distribution: Let the distribution followed be Generalized Exponential**,** it is assumed that g = 3, c = 2 and β = 0.05.This leads to the termination multiplier a = 0.7.From Table 7 the minimum number of testers required is r = 7.Thus we will draw a sample of size 21 items and allocate 7 items to each of 3 groups to put on tester for 700 hours. This indicates that a total of 21 items are needed and that 7 items are allocated to each of 3 groups. The lot will be accepted if not more than 2 failure occurs before 700 hrs in each of 3 groups. The experiment is truncated as soon as the 3^{rd} failure occurs before the 700^{th} hrs. From Table 7, the probability of acceptance is 0.944177 when the true mean is 4,000 hrs. This shows that, if the true mean life is 4 times of 1000 hrs, the producer's risk 0.055823.

7.2 Marshall – Lomax extended exponential distribution: Let the distribution followed be Marshall – Olkin Extended Lomax**,** it is assumed that g = 3, c = 2 and β =

0.05.This leads to the termination multiplier a = 0.7. From Table 8 the minimum number of testers required is r = 4.Thus we will draw a sample of size 12 items and allocate 4 items to each of 3 groups to put on tester for 700 hours. This indicates that a total of 12 items are needed and that 4 items are allocated to each of 3 groups. The lot will be accepted if not more than 2 failure occurs before 700 hrs in each of 3 groups. The experiment is truncated as soon as the 3rd failure occurs before the 700th hrs. From Table 8, the probability of acceptance is 0.629022 when the true mean is 4,000 hrs. This shows that, if the true mean life is 4 times of 1000 hrs, the producer's risk 0.370978. ***7.3 Marshall – Olkin Extended Exponential Distribution :*** Let the distribution followed be Marshall – Olkin Extended Exponential, it is assumed that g = 3, c = 2 and β = 0.05.This leads to the termination multiplier a = 0.7. From Table 9 the minimum number of testers required is r = 5.Thus we will draw a sample of size 15 items and allocate 5 items to each of 3 groups to put on tester for 700 hours. This indicates that a total of 15 items are needed and that 5 items are allocated to each of 3 groups. The lot will be accepted if not more than 2 failure occurs before 700 hrs in each of 3 groups. The experiment is truncated as soon as the 3rd failure occurs before the 700th hrs. From Table 9, the probability of acceptance is 0.747146 when the true mean is 4,000 hrs. This shows that, if the true mean life is 4 times of 1000 hrs, the producer's risk 0.252854. ***7.4 Weibull Distribution :*** Let the distribution followed be Weibull, it is assumed that g = 3, c = 2 and β = 0.05.This leads to the termination multiplier a = 0.7. From Table 10, the minimum number of testers required is r = 4.Thus we will draw a sample of size 12 items and allocate 4 items to each of 3 groups to put on tester for 700 hours. This indicates that a total of 12 items are needed and that 4 items are allocated to each of 3 groups. The lot will be accepted if not more than 2 failure occurs before 700 hrs in each of 3 groups. The experiment is truncated as soon as the 3rd failure occurs before the 700th hrs. From Table 10, the probability of acceptance is 0.747146when the true mean is 4,000 hrs. This shows that, if the true mean life is 4 times of 1000 hrs, the producer's risk 0.252854. ***7.5 Rayleigh Distribution:*** Let the distribution followed be Rayleigh**,** it is assumed that g = 3, c = 2 and β = 0.05.This leads to the termination multiplier a = 0.7. From Table 11 the minimum number of testers required is r = 5.Thus we will draw a sample of size 15 items and allocate 5 items to each of 3 groups to put on tester for 700 hours. This indicates that a total of 15 items are needed and that 5 items are allocated to each of 3 groups. The lot will be accepted if not more than 2 failure occurs before 700 hrs in each of 3 groups. The experiment is truncated as soon as the 3rd failure occurs before the 700th hrs. From Table 11, the probability of acceptance is 0.457232when the true mean is 4,000 hrs. This shows that, if the true mean life is 4 times of 1000 hrs, the producer's risk is 0.542768. ***7.6 Inverse-Rayleigh Distribution:*** Let the distribution followed be Inverse-Rayleigh**,** it is assumed that g = 3, c = 2 and β = 0.05.This leads to the termination multiplier a = 0.7. From Table 12 the minimum number of testers required is r = 5.Thus we will draw a sample of size 15 items and allocate 5 items to each of 3 groups to put on tester for 700 hours. This indicates that a total of 15 items are needed and that 5 items are allocated to each of 3 groups. The lot will be accepted if not more than 2 failure occurs before 700 hrs in each of 3 groups. The experiment is truncated as soon as the 3rd failure occurs before the 700th hrs. From Table 12, the probability of acceptance is 1 when the true mean is 4,000 hrs. (i.e.) If the true mean life is 4 times of 1000 hrs, the producer's risk vanishes and it remains zero for most of the values in the table (Table 12). This shows that using inverse Rayleigh distribution will be more profitable for the producer.

8. COMPARISON OF THE PROBABILITY OF ACCEPTANCE FOR MINIMUM NUMBER OF TESTERS (c=2,g = 3,a = 0.7,β = 0.05):

Lifetime distribution	***r***	**μ/μ_0**					
		2	**4**	**6**	**8**	**10**	**12**
Generalized Exponential	7	0.5926119	0.944177	0.986447	0.995294	0.997968	0.998986
Marshall – Lomax Extended Exponential Distribution	4	0.2506692	0.629022	0.793755	0.870958	0.912202	0.936578
Marshall – Olkin Extended Exponential Distribution	5	0.3538121	0.747146	0.87317	0.924779	0.950439	0.964952
Weibull Distribution	4	0.2325357	0.624122	0.792322	0.870445	0.911993	0.936486
Rayleigh Distribution	5	0.1636819	0.457232	0.647746	0.758602	0.825852	0.86901
Inverse Rayleigh Distribution	5	0.9128817	1	1	1	1	1

9.CONCLUSIONS:

In this paper, designing a Group Sampling Plan using weighted binomial distribution for the truncated life test is presented. The minimum number of testers and the probability of acceptance are calculated, when the consumer's risk β and other plan parameters are specified, assuming that the lifetime of an item follows different distributions. When all the above tables (Table 7 to Table 12) are compared, the Lomax and weibull distribution gives the minimum number of testers but the probability of acceptance is less, Considering both the factors.i.e. minimum number of testers and the probability of acceptance, the Inverse Rayleigh distribution is comparatively the best. It can also be observed that the minimum number of testers required decreases as the test termination time multiplier increases in all the above cited distributions and thus it is concluded that the tables provided can be used conveniently in practical situations when a multiple number of items at a time are adopted for a life test to save the cost and time of the experiment.

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