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BURR *X* DISTRIBUTION REPRESENT TO ACCELERATED LIFE TEST WITH SAMPLING PLAN

S.Gandhiya Vendhan and K.Chitraleka
Department of Statistics, Bharathiar University, Tamil Nadu, India-641046
Email: gandhiyavendhan@yahoo.com, chitraleka2011@gmail.com

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Abstract

This papers study on truncated life tests takes a look at while the lifetime follows the Burr *X* distribution represented in a recognition sampling plan. Accelerated lifestyles check is at the moment the focal manner of measuring invention reliability rapidly, and the layout of efficient take a look at tactics is important to ensure that *ALTs* can determine the product dependability and sensitivity analyses are executed to evaluate the make certain an impact on which the improbability inside the assumed *AF* brings at the threats. This examines the development of the idea and approach for the improvement of the most fulfilling *ALT* for the region and scale distribution, that's the furthermost purposeful and innovative shape of designing the most fulfilling *ALT* plan. A running function value represented within the sampling plans with associated threats is mentioned in the tables and related values.

2020 Mathematical Sciences Classification: 62C05, 60Exx.
Keywords and Phrases: Sampling Plan, Accelerate Life test, Producer risk, Consumer risk, Burr *X* Distribution.

1 Introduction

In the technique of manipulating the share of defective gadgets within the production, the technique is to be minimized and its miles carried out via the technique of manipulating charts. Product management way controlling the pleasant of the product using critical examination through sampling inspection plans. Reliability or life trying out includes estimating the expected durability over the years of an object. This will be an entire machine, a product, or a man or woman thing. We might also focus on a detail of an issue, which includes material assets.

An existence test is an electrical stress test that usually employs voltage and/or temperature to accelerate the appearance of damage-out reliability failures in a tool. To ensure reliability, life tests examine sampling, which usually involves accepting and rejecting a collection of things. General standards for processing the lots based on the sampled data must be precisely planned in terms of the existing test techniques for effective and efficient implementation of lifestyle examination sampling. Because a life test sample technique always includes a time-based life test, censorship and/or acceleration are frequently employed to cut down on testing time and effort.

In this work, hybrid censored *LSPs* with a specified form parameter are evolved for the Burr *X* distribution. The existence examination is presumptively conducted at a multiplied setting for which the *AF* is assumed. The development of *LSPs* has fulfilled producer and consumer risks. The outcomes of the sources of uncertainty in the acceleration factor and form parameters that were assumed were then assessed at the specific producer and client risks, and a technique for creating *LSPs* that can account for these uncertainties were also established.

2 Burr *X* distribution

Burr presented twelve distinct types of cumulative distribution features for modelling data [4]. The Burr-*X* and Burr-*XII* distribution capabilities garnered the most interest out of the one, twelve distribution capabilities. Rodriguez interprets the Burr- *XII* distribution in a radical manner [18]; also see Wingo [22]. In this work, we take into account the two-parameter Burr type *X* distribution. Two variables The cumulative distribution of the Burr- Type *X* distribution is as follows

Cumulative Distribution Function (CDF)

$$F(x, \alpha, \lambda) = \left(1 - e^{(\frac{x}{\lambda})^2}\right)^{\alpha} \quad x \geq 0,\ \alpha \geq 0,\ \lambda \geq 0. \tag{2.1}$$

Probability Density Function (PDF)

$$f(x, \alpha, \lambda) = \frac{2\alpha x}{\lambda^2} e^{(\frac{x}{\lambda})^2} (1 - e^{(-\frac{x}{\lambda})^2})^{(\alpha-1)} \quad x \geq 0,\ \alpha \geq 0,\ \lambda \geq 0. \tag{2.2}$$

The survival function of Burr-Type X distribution has

$$S(x, \alpha, \lambda) = 1 - \left(1 - e^{(-\frac{x}{\lambda})^2}\right)^{\alpha} \quad x \geq 0,\ \alpha \geq 0,\ \lambda \geq 0. \tag{2.3}$$

The hazard rate is given by

$$h(x, \alpha, \lambda) = \frac{\frac{2\alpha x}{\lambda^2} e^{-(\frac{x}{\lambda})^2} \left(1 - e^{-(\frac{x}{\lambda})^2}\right)^{(\alpha-1)}}{1 - \left(1 - e^{-\left(\frac{x}{\lambda}\right)^2}\right)^{\alpha}}; \quad x \geq 0,\ \alpha \geq 0,\ \lambda \geq 0. \tag{2.4}$$

3 Review of Burr X distribution

In their [7] work, Khaleel *et al.* introduced the Beta Burr type X distribution, an unique non-stop distribution that extends the Burr type X distribution and has increased, reduced, and tub forms for the risk characteristic. In this study, Ahmad *et al.* [1] developed an estimation of R where y and x are independent but no longer identically distributed Burr type X random variables. To investigate the three estimating techniques, Monto Carlo simulation is accomplished. While the information is provided in businesses, Aludatat *et al.* [2] got Bayesian and non-Bayesian estimators for the parameter of the Burr type X distribution. The generated information's utility suggests that the estimators are effective. Umar Rizam Abu Bakar and Yusuf Madaki study due to Yousof and Afify [23] expands the Kum-G family and Burr X distribution by introducing a beta Kumaraswamy Burr type X distribution with six parameters. Beta Kum-BX distribution compared to a number of its sub-styles and also distinctive in-law style. Its characteristics make it a great model for symmetric right- and left-skew data sets.

We recommend medical practitioners, docs, engineers, and statisticians undertake this appropriate Beta Kum-BX in modeling their massive group of records as it consists of 3 strong fashions assets. In their study, Khaleel and Ibrahim [7], they introduced the new extension distribution for Burr X with the Beta Burr X parameter. Beta Burr X distribution derived *CDF*, *PDF*, and chance characteristic for *BBX1*. This distribution carried out rainfall facts and used statistical criteria to illustrate the goodness-of-match of the rainfall statistics. Refacy [17] this model parameters and the acceleration element have envisioned the usage of the most probability estimation approach and sample predictions are considered for future order facts. In addition, the asymptotic confidence intervals for the model parameters are mentioned. Nesor Ahmad *et al.* [3] this article discussed the gold standard increased lifestyles test plans for Burr kind X distribution with a log-linear version underneath periodic inspection and type I censoring. *ALT* plans for minimizing as var($\hat{Y}$a) below the assumptions of Burr type X distribution, periodic inspection, and type I censoring with a log-linear version.

The findings that the biased estimates have at the insurance of the decrease-z sure, the unfairness of and the anticipated asymptotic variance were explored by Surles and Padgett [20]. The work due to Raqab and Kundu [16] is intended to help readers to remember the unique components of a parameter. The relationship between the Burr-type X distribution and other well-studied distributions, such as the gamma distribution and the Weibull distribution. Homes by Irving Burr [4] will be discussed, along with the concept of the cumulative feature and the challenges of becoming the characteristic. Examples are shown and a discussion of a new cumulative feature with good-sized practicability is possible.

A thorough mathematical analysis of the beta burr type X distribution is provided in this publication by Faton Merovci, Mundher Abdullah Khaleel, *et al.* [9]. Additionally, the Fisher records matrix is used to determine the asymptotic self-belief durations for the parameters. By adding a further form parameter, Yousof and Afify [23] presented a new Burr *X-G (BX-G)* family of distributions. Through taking integer parameter values, several distributions develop into unique cases of the suggested family. A few numerical homes belonging to the new family. Plans for reputation sampling for the Burr type X distribution by Hu and Gui [5]. Tables with the minimum sample sizes are essential to guarantee the median's existence.

Sartawi and Abu-Salih have explored several facets of the single parameter ($\lambda = 1$) Burr type X distribution. where and represent the scale and shape parameters, respectively [19]. Ahmad *et al.* [3], Jaheem [6]. Nowadays, the generalized Rayleigh (GR) distribution, as effectively observed by Surles and Padgett, can be thought of as the Burr-type X distribution along the same lines as the GE distribution [20]. For the sake of clarity, In this study, The GR distribution will be used to refer to the Burr-type X distribution. It was shown that the two-parameter GR distribution and the two-parameter gamma, Weibull, and GE distributions have a lot in common.

Stress is believed to be a temporal characteristic that increases linearly. The most probabilistic strategy, as well as the McMc approach, are used to produce traditional and Bayesian estimates for version parameters. In this study, Mustafa Korkmaz and Emrah Altun *et al.* [16] explore the distribution using a few different models to demonstrate the distribution's adaptability in representing facts with heavy tails. Utilizing data from data collecting examples, a novel version of the VaR (Value of Risk) estimation with the Burr X Pareto distribution is shown. This version offers an alternative to the generalized Pareto version for financial institutions. In their [3] study, Nesar Ahmad and Sabiha Khan *et al.* take into account planning ALT for objects whose lifetimes adhere to the Burr type X failure version.

4 Accelerated Life Test

Accelerated life testing (ALT) is a technique of taking a look at and analyzing to decide how disasters could probably occur inside the destiny. ALT is a famous technique of testing because of its ability to accelerate time. ALT is regularly used while we can't manage to pay to watch for screw-ups to occur at their ordinary charge however we want to recognize how disasters are possible to occur in the future.

Consider an electronics manufacturer who wants to understand how many screw-ups will occur in 10 years (possibly for assurance functions). If the factor being examined has a mean life of 30 years, the producer cannot fairly spend several years performing a reliability check as they are ready to release their product on the market soon. By increasing the pressure on the component, failure could be induced more rapidly. If carried out efficaciously, that is equal to speed up the passage of time. The electronics manufacturer can accumulate failure facts at a ramification of stresses, to shape the correct life-pressure version, and then enter the use pressure into the life-pressure version to decide the failure distribution that is expected to arise at the use pressure.

A selection of techniques, which serve one-of-a-kind purposes, had been termed expanded existence trying out which involves the acceleration of disasters with the single motive of the quantification of the life traits of the product underneath ordinary use conditions.

4.1 Assumptions of *LSPs*

1. At time 0, under a challenging scenario for which AF is known, n devices are randomly selected from a large pool and put to the test.
2. Failed devices are not replaced by fresh ones.
3. The lifestyle examination of the prolonged state is halted either at the censoring time A or at the c failure, whichever occurs first.
4. The lot is rejected if the cth failure occurs first. The lot is approved under all other circumstances.

4.2 Constructions, of the *LSPs*

The modern world examines sampling issues, which are best described as the following hypothesis testing issue.

$$\begin{cases} H_0 : \eta U = \eta U_0 \\ H_1 : \eta U = \eta U_1 \qquad \eta U_1 < \eta U_0. \end{cases} \tag{4.1}$$

In which ηU_0 *and* ηU_1 are pre-precise constants that can be decided upon by a small number of producers and buyers. The project time tUM in the usage situation is provided and lets in *RU (tUM)* = (1-*FU (tUM)*) to be the reliability at the project time. The validity of the subsequent courtship is then established.

The mutual settlement on *RU (tUM)* can be expressed in phrases of ηU. n the upgraded scenario, the device lives trails a Burr X distribution with the size parameter being determined by the formula $\eta A = \eta U/AF$. and the shape parameter is constant. This is, the CDF of the lifetime at the improved specification is given through.

$$F_A(t_A) = (1 - e^{(-\frac{tA}{\eta A})^2})^{\theta}. \tag{4.2}$$

The expanded circumstance, hypotheses (4.1) may be re-expressed as follows,

$$\begin{cases} H_0 : \eta A = \eta A_0. \\ H_1 : \eta A = \eta A_1 \quad \eta A_1 < \eta A_0. \end{cases} \tag{4.3}$$

The pattern length (n) and rejection quantity (c) are taken into account together with the *LSP* to ensure that the requirements for the next manufacturer and customer opportunity are met.

$$L(\eta A0) = Pr\left(\frac{Acceptalot}{\eta A = \eta A0}\right) = \sum_{k=0}^{c-1} \binom{n}{k} (1 - q_0)^k q_0^{n-k} = 1 - \alpha, \tag{4.4}$$

$$L(\eta A1) = Pr\left(\frac{Acceptalot}{\eta A = \eta A1}\right) = \sum_{k=0}^{c-1} \binom{n}{k} (1 - q_1)^k q_1^{n-k} = \beta. \tag{4.5}$$

Items lives at the accelerated condition follow a Burr X distribution with scale parameter defined but shape parameter left untouched byηA . In other words, the lifetime *CDF* undert the accelerated condition is given by

$$F_A(t_A) = (1 - e^{(-\frac{tA}{\eta A})^2})^\theta. \tag{4.6}$$

The sample size (n) and the number of rejections (c) of the *LSP* must satisfy the following producer and consumer risk standards

$$\sum_{k=0}^{c-1} \binom{n}{k} (1 - q_0)^k q_0^{n-k} \geq 1 - \alpha, \tag{4.7}$$

$$\sum_{k=0}^{c-1} \binom{n}{k} (1 - q_1)^k q_1^{n-k} \leq \beta, \tag{4.8}$$

$$q_i = 1 - \left(1 - e^{-(\frac{\tau A}{\eta U})^2}\right)^\theta, i = 0, 1 \tag{4.9}$$

and α and β necessarily satisfy both the producer and consumer risks.

$$q_i = 1 - \left(1 - e^{-(\frac{\tau_A * AF}{\eta U})^2}\right)^\theta, \tag{4.10}$$

since $\eta_A = \frac{\eta_U}{AF}$ For i=0,1. In eq(4.10), $(\tau^* AF)$ A is the same "censoring time" as the form and q_i could be interpreted as the possibility that a unit is an correspondent "censoring time" at the usage condition under testing hypotheses. The resulting *LSPs* are displayed in Tables 4.1 and 4.2 for the following combinations of parameter values.
(α,β)= (0.05,0.05),(0.01,0.01),
q_0=0.99,0.97,0.95,0.90,0.85,0.80,0.75,0.70,0.60,0.50,
q_1=0.97,0.95,0.90,0.85,0.80,0.75,0.70,0.60,0.50,0.40.

4.3 Properties of *LSPs*

The following characteristics apply to the *LSPs* in Tables 4.1 and 4.2.

1. As q_0 rises for a given, α,β and q_1, n falls.
2. For given α,β and q_0, n decreases as q_1 increases.
3. As and/or rises for a given α,β and q_1, n decreases.
4. c acts the same way as in (4.1) through 4.7 over.

Following are some explanations for property (4.1). for a given q_1 and the current q_0 consider the sample plan (n,c) that satisfies the inequality (4.7) and (4.8). According to John *et al.* the following link exists withν_1=2c and ν_2=2(n-c+1) as its parameters, of the F distribution. The summing term in (4.7) increases, as q increases because $\frac{\nu_2(1-q)}{\nu_1 q}$ decreases as q grows. In other words, as q_0 rises, the left side of inequality (4.7) gets bigger. Assume that q_0 is raised to $q_0^{'}$ and that n' is the smallest sample size needed for the given values of q_1 and $q_0^{'}$.

Example 4.1. In positive-type digital electronics, voltage is used as a stress variable to hasten breakdowns, and inverse strength dating has been successfully applied (Nelson *et al.* [12]). Given by is the AFAF for the inverse power connection (Nelson *et al.* [12]). $AF = (VA/VU)^{\nu} AF = (V_A V_U)^{\nu}$ Where V^U isthe voltage used in the circumstance (measured in V), V^A is the extended voltage, (measured in V) and ν is the tool's feature parameter. Assume that τ_A is the censoring time under the accelerated condition is 900h, η *U0* =100,0000 η *U1*=250084, α=0.05, β=0.05, then, (15) or (16) can be used to calculate q_0 and q_1. $q_0 = 1-(1-e^{(-\frac{900*5.287}{1000000})^2})^{0.2}$., $q_1 = 1-(1-e^{(-\frac{900*5.287}{250084})^2})^{0.2}$. Then the corresponding *LSP* is approximately determined using Table 2 with q_0 = 95, and q_1=90, this results in (n, c) = (234, 17). Then, using Table 4.2 and q_0 = 95, and q_1=90, the appropriate *LSP* is roughly computed, yielding (n,c) = (234, 17).

Example 4.2. If τ_A is 500h the time spent censoring under accelerated conditions and ηU0=100,0000 η U1=180655,α=0.01, β =0.01, respectively, then equations (4.9) or (4.10) can be used to get q_0 and q_1 Using (4.10), we obtain q_0=1-(1-e$^{(-\frac{500*18.28}{1000000})^2}$)$^{0.05}$., q_1=1-(1-e$^{(-\frac{500*18.28}{180655})^2}$)$^{0.05}$. Then, using Table 4.1 and q_0 = 95 and q_1 = 90, the appropriate LSP is roughly computed, yielding (n,c) = (299,7).

Table 4.1: *Hybrid Censored For LSPs* α*=0.01,* β = 0.01

q_1	q_0			α=1						
	99	95	90	85	80	75	70	60	50	40
95	7,299	(b,a)		-	-	-	-	-	-	-
90	6,200	66,850	-	-	-	-	-	-	-	-
85	6,175	48,600	68,530	-	-	-	-	-	-	-
80	5,155	45,580	59,425	38,175	-	-	-	-	-	-
75	4,100	41,555	53,375	35,165	62,245	-	-	-	-	-
70	4,90	40,535	45,300	29,134	57,228	40,115	-	-	-	-
60	3,55	26,325	35,240	28,100	44,165	30,86	40,105	-	-	-
50	3,40	24,300	29,190	28,75	29,99	30,80	35,82	35,63	-	-
40	2,25	20,225	18,100	24,60	24,75	25,60	27,60	25,45	33,51	-
30	1,8	15,100	11,50	15,30	20,55	15,30	23,43	15,24	23,33	18,23

Table 4.2: *Hybrid Censored For LSPs* α*=0.05,* β*=0.05*

q_1	q_0									
	99	95	90	85	80	75	70	60	50	40
95	10,950	-	-	-	-	-	-	-	-	-
90	8,140	17,234	-	-	-	-	-	-	-	-
85	7,140	17,215	17,16	-	-	-	-	-	-	-
80	6,96	13,210	16,11	19 90	-	-	-	-	-	-
75	6,72	7 100	15,10	17, 79	23,85,	-	-	-	-	-
70	5,55	6,80	12,80	15,70	18,65	23,70	-	-	-	-
60	4,40	5,65	10,62	15, 70	18, 65	22,67	27,70	-	-	-
50	3,20	4,49	9,55	13, 60	16, 55	20 60	26, 67	45, 93	-	-
40	2,11	3,34	6,34	11, 48	14,48	18, 52	25, 64	45,94,	55, 95	-
30	1,5	1,9	3,14	11, 47	12,40	15,43	22,55	42,87	43,73	56,86

−not applicable since $q_0 \leq q_1$
[a]Sample size (n)
[b]Rejection number (c)
[c]n > 1,000

5 Applications

Application 5.1

The data collection is made up of 63 measurements of the strengths of 1.5 cm glass fibers that were originally collected by staff members at the UK National Physical Laboratory. Sadly, the document does not provide the measurement units. The numbers are 0.55, 0.74, 0.77, 0.81, 0.84, 0.93, 1.04, 1.11, 1.13, 1.24, 1.25, 1.27, 1.28, 1.29, 1.30, 1.36, 1.39, 1.42, 1.48, 1.48, 1.49, 1.49, 1.51, 1.52, 1.53, 1.54, 1.55, 1.55, 1.58, 1.59, 1.60, 1.61, 1.61, 1.62, 1.63, 1.64, 1.66, 1.66, 1.67, Smith and Naylor have also examined these data.

Application 5.2

Microcircuit failure can happen as a result of electro migration, which is the movement of atoms within the conductors of the circuit. The information below comes from a 59 conductor accelerated life test (Nelson and Doganaksoy [13]). There are no suppressed observations, and failure times are measured in hours. 6.545 9.289 7.543 6.956 6.492 5.459 8.120 4.706 8.687 2.997 8.591 6.129 11.038 5.381 6.958 4.288 6.522 4.137 7.459 7.495 6.573 6.538 5.589 6.087 5.807 6.725 8.532 6.663 6.369 7.024 8.336 9.218 7.398 6.033 10.092 7.496 4.531 7.974 8.799 7.683 7.224 7.365 6.923 5.640 5.434 7.937 6.515 6.476 6.071 10.491 5.923 In this instance, when n=59, the mean x =6.929, and the standard deviation s=1.574843.

Application 5.3

Online Data Entry software evaluation Table 1 displays the test data from a modest online data entry software product that has been around in Japan since 1980 (Ohba [14]). The software is a little over 40,000 *LOC* in size. The number of shifts dedicated to running test cases and evaluating the outcomes served as the basis for calculating the testing time. Table 5.1 displays the couples of observation time and total number of faults discovered.

***Table* 5.1**

Testing time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Failures	2	1	1	1	2	2	2	1	7	3	1	2	2	4	1	6	1	3	1	3	1
Cumulative failures	2	3	4	5	7	9	11	12	19	21	22	24	26	30	31	37	38	41	42	45	46

6 Conclusion

For the Burr X distribution, Accelerated life test created fully hybrid censored life test sampling problem are developed under the assumption that the AF between the extended and usage scenarios as well as the form parameter are known. Sensitivity analysis of the uncertainty in AF and m show that if AF are overestimated, the real manufacturer risk will grow, whereas the real customer risk will increase asAF are underestimated.

Among the most common lifespan distributions utilised in reliability engineering is the Burr X distribution. In order to save down on testing time and effort, advanced, hybrid censored life checking out procedures are frequently used in practise. Therefore, it is highly anticipated that reliability engineers would be able to successfully and effectively employ the findings from this effort to guarantee the dependability of their products. The shape parameter is regarded as being acknowledged in this article. Future research may be successful by extending the current examination to the scenario where the form parameter is unknown. Comparisons of the current *LSPs* with the plans subject to type-I or type-II censorship with ongoing test device monitoring is another study field for the future.

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