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Transmuted Survival of Lindley Distribution

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تحويل البقاء لتوزيع لندلي

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ABSTRACT

Background:

In this study, a new distribution was discovered as a survival model by utilising the survival function of the quadratic-transformed distribution, where the quadratic-transformed Lindley distribution was used to derive the transformed-as-survival (TSL) Lindley distribution, which is essential because it is more flexible and accurate in data applications. Since there are occasionally data points that do not meet the standard distribution, the new distribution provides more accurate results when applied to the data, and the probability density function and cumulative probability function are extracted. New deployment properties with reliable performance were derived from a statistical and mathematical perspective. We also estimated a dataset using traditional methods, and we utilized MATLAB to demonstrate that our new distribution is superior to the original.

Materials and Methods:

The researchers also estimated a datum set using the Maximum Likelihood Estimators method, and it manifested the excellence of our Transmuted Survival of Lindley Distribution compared to the Lindley Distribution

Results:

The results that the researchers obtained indicated that the new distribution(TSLD) is better than the original distribution . The distribution of the New GLD for this real data in table (1).

Conclusion:

In this research, the formula Transmuted Survival and Lindley distribution are used and the obtained result has more efficient distribution than the original distribution.

Key words:
Lindley Distribution(LD), Survival Function , Transmuted Survival Formula and Maximum Likelihood Estimation.

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INTRODUCTION

In this study, it is found that a new distribution of life distributions, by taking advantage of (TSF) and (LD), and it is found that this (TSLD) is characterised by high accuracy and flexibility when dealing with life data. [1] Researchers have found a new formulation (TS) called Transmuted Survival. [2] (LD) has been used in general in the study of survival through its application in various fields of life, including medical fields, engineering fields, investment, and other fields as well as the study of age data .Many researchers presented new studies based on LD , where these studies created new distributions and proved its properties as well. The main objective of these studies is to obtain more flexible distributions when dealing with life data. Deniz and Ojeda proposed a separate transformation of LD [3] that was implemented in enumerating the data associated with the deposit as well as Rama and Mishra [4],who studied the semi-Lindley distribution, In the papers [5, 6], the researchers focused on one-sided perimeter acquisition and a minus-zero transformation of Poisson-LD, and the advantages of the distribution and its various applications were discussed. The researchers discussed [7] the diverse characteristics of (LD) and presented tham severalsome many of directions. The authors[8] found a new concept which is the transmuted using the probability Cumulative function. The researchers found [9] the generalized Lindley distribution (generalized L D) and searched for its various properties and applications. Ibrahim E [10] found a new distribution with three Coefficients called (generalization of the Lindley distribution). Al-Ghitani, Al-Mutairi and other scientists discussed [15] the applications for (LD) to compete depending on the lifetime of those risks. Sankara [18] introduced the discrete Poisson-Lindley distribution (Poisson - LD) by merging the two distributions together In this study[19], the researchers optimized two parameters (weighted LD) and discussed its applications in survival data.

where the following formula is the formula transmuted for the calmative function:

$$F(t) = (1+\lambda)G(t) - \lambda G^2(t) \qquad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The (TS) formula depends initial , on Survival Function $S(t)$ which shall be in the following form : $S_2(t) = (1+\lambda)S^2(t) - \lambda S(t)$ ....(2)

MATERIALS AND METHODS

The Density Function ,the Cumulative Function , survival Function and the Hazard function of Lindley Distribution

$$f(t) = \frac{\theta^2(1+t)e^{-\theta t}}{1+\theta} \qquad \theta, t > 0 \quad \ldots\ldots\ldots\ldots(3)$$

$$F(t) = 1 - \frac{(1+\theta t+\theta)e^{-\theta t}}{1+\theta} \qquad \ldots\ldots\ldots\ldots(4)$$

$$S(t) = \frac{(1+\theta t+\theta)e^{-\theta t}}{1+\theta} \qquad \ldots\ldots\ldots\ldots(5)$$

$$h(t) = \frac{\theta^2(1+t)}{1+\theta(1+t)} \qquad \ldots\ldots\ldots\ldots(6)$$

Substituting the Survival Function of **(L D)** (5) into**(TS)** formal (2), The Survival Function of the new Distribution **(TSLD)** is obtained

$$S_2(t) = \frac{(1+\lambda)(1+\theta t+\theta)^2 e^{-2\theta t}}{(1+\theta)^2} - \frac{\lambda(1+\theta t+\theta)e^{-\theta t}}{1+\theta} \quad \ldots\ldots\ldots\ldots(7)$$

the Cumulative Function of (TSLD)

$$F_2(t) = 1 - \frac{(1+\lambda)(1+\theta t+\theta)^2 e^{-2\theta t}}{(1+\theta)^2} + \frac{\lambda(1+\theta t+\theta)e^{-\theta t}}{1+\theta} \ldots\ldots\ldots\ldots(8)$$

The Density Function of (TSLD)

The pdf of **(TSLD)** is derivative of the cumulative function **(TSLD)**

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$$f_2(t) = -\frac{(1+\lambda)\left[(1+\theta t+\theta)^2 e^{-2\theta t}(-2\theta) + (2\theta)(1+\theta t+\theta)\, e^{-2\theta t}\right]}{(1+\theta)^2} + \frac{\lambda\left[(1+\theta t+\theta)(-\theta)e^{-\theta t} + (\theta)e^{-\theta t}\right]}{1+\theta} \quad where\ \ \theta > 0$$

$$f_2(t) = \frac{(1+\lambda)}{(1+\theta)^2}(2\theta^2)(1+\theta t+\theta)\, e^{-2\theta t}[(1+t)] - \frac{\lambda}{1+\theta}(\theta^2)e^{-\theta t}[(1+t)]$$

$$f_2(t) = \frac{(\theta^2)(1+t)e^{-\theta t}}{(1+\theta)}\left[\frac{2(1+\lambda)\,(1+\theta t+\theta)\, e^{-\theta t}}{(1+\theta)} - \lambda\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

The function $f_2(t)$ should satisfy the conditions of the density function

The first condition $f_2(t) \geq 0\ \forall\ \ t > 0$ and at

$$\left[2(1+\lambda)\,(1+\theta t+\theta)\, e^{-\theta t} - \lambda(1+\theta)\right] \geq 0$$

$$\frac{2\,(1+\theta t+\theta)\, e^{-\theta t}}{(1+\theta) - 2(1+\theta t+\theta)\, e^{-\theta t}} \geq \lambda$$

The second condition $\int_0^\infty f_2(t)dt = 1$

$$\int_0^\infty f_2(t)dt = \int_0^\infty \left[\frac{(1+\lambda)}{(1+\theta)^2}(2\theta^2)(1+\theta t+\theta)\, e^{-2\theta t}(1+t) - \frac{\lambda}{1+\theta}(\theta^2)e^{-\theta t}(1+t)\right]dt$$

$$\int_0^\infty f_2(t)dt = \int_0^\infty \frac{(1+\lambda)(2\theta^2)(1+\theta+\theta t)(1+t)e^{-2\theta t}}{(1+\theta)^2}\, dt - \int_0^\infty \frac{\lambda\,(\theta^2)e^{-\theta t}(1+t)}{1+\theta}\, dt$$

Let $L1 = \int_0^\infty \frac{(1+\lambda)(2\theta^2)(1+\theta t+\theta)(1+t)\, e^{-2\theta t}}{(1+\theta)^2} dt$

And C$L2 = \int_0^\infty \frac{\lambda\,(\theta^2)e^{-\theta t}(1+t)}{1+\theta}\, dt$

$$L1 = \frac{(1+\lambda)(2\theta^2)}{(1+\theta)^2}\int_0^\infty ((1+\theta) + (2\theta+1)t + \theta t^2)\ e^{-2\theta t}dt$$

$$L1 = \frac{(1+\lambda)(2\theta^2)}{(1+\theta)^2}\left((1+\theta)\int_0^\infty e^{-2\theta t}dt + (2\theta+1)\int_0^\infty te^{-2\theta t}\, dt + \theta\int_0^\infty t^2 e^{-2\theta t}\, dt\right)$$

$$L1 = \frac{(1+\lambda)(2\theta^2)}{(1+\theta)^2}\left(\frac{(1+\theta)}{2\theta} + \frac{(2\theta+1)}{4\theta^2} + \frac{1}{4\theta^2}\right)$$

$$L1 = \frac{(1+\lambda)(2\theta^2)}{(1+\theta)^2}\left(\frac{(2\theta+4\theta^2)}{4\theta^2} + \frac{(2\theta+2)}{4\theta^2} + \frac{1}{4\theta^2}\right)$$

$$L1 = \frac{(1+\lambda)(2\theta^2)}{(1+\theta)^2}\left(\frac{(\theta+1)^2}{2\theta^2}\right)$$

$$L1 = (1+\lambda)$$

$$L2 = \int_0^\infty \left[\frac{\lambda}{1+\theta}(\theta^2)e^{-\theta t}(1+t)\right]dt$$

$$L2 = \frac{\lambda}{1+\theta}(\theta^2)\int_0^\infty [(1+t)\, e^{-\theta t}]dt$$

$$L2 = \frac{\lambda}{1+\theta}(\theta^2)\int_0^\infty [(1+t)e^{-\theta t}]dt$$

$$L2 = \lambda$$

Then

$$\int_0^\infty f_2(t)dt = 1$$

$f_2(t)$is density function is obtained .

The following shows some shapes for The Density Function of the TSLD, The Cumulative Function of the TSLD, The Survival Function of the TSLD, The Hazard Function of the TSLD, for appointed values of the parameters θ, λ

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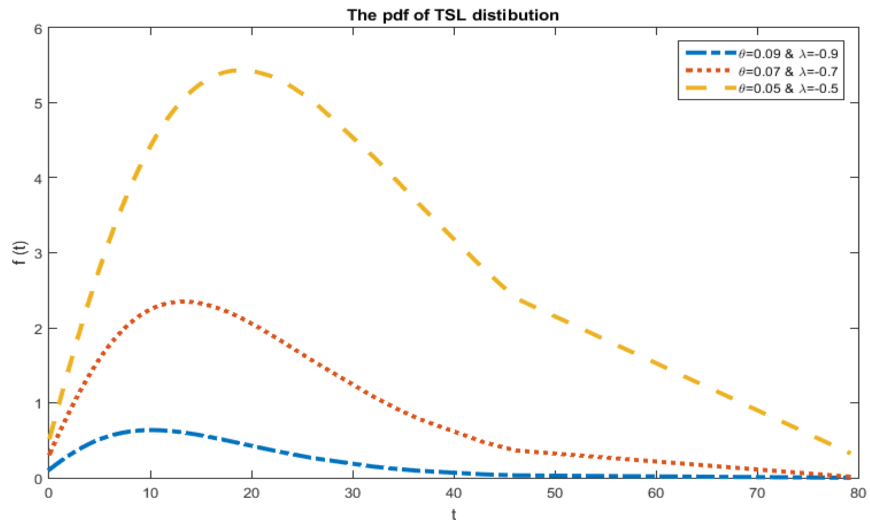
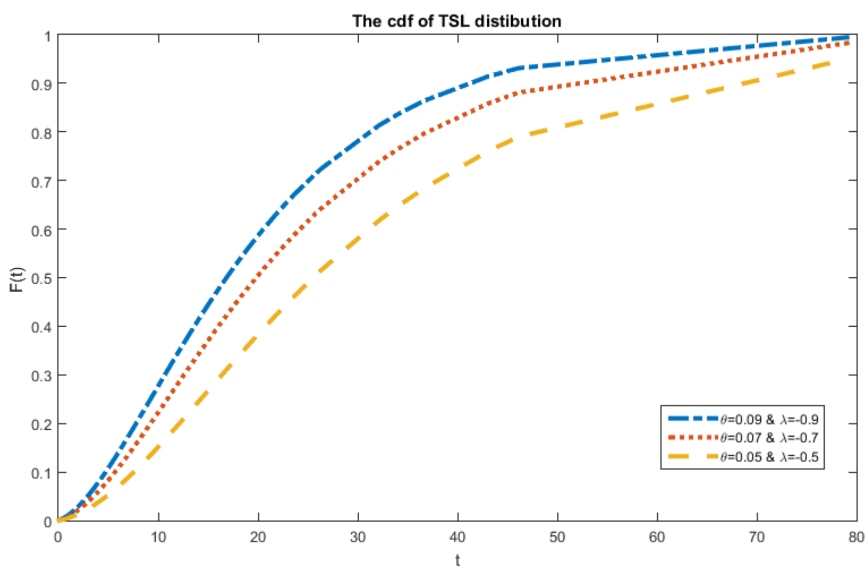


Figure(1): The density function of TSLD with altered values of θ and λ , it is observed that notice the function is increasing and then decreases with increasing time, it is twisted to the right and has one value.



Figure(2) : The Cumulative Function TSLD with altered values of θ and λ., the Distribution function is monotonously increasing with increasing time, and the $\lim_{t\to 0} F_2(t) = 0, \lim_{t\to\infty} F_2(t) = 1$

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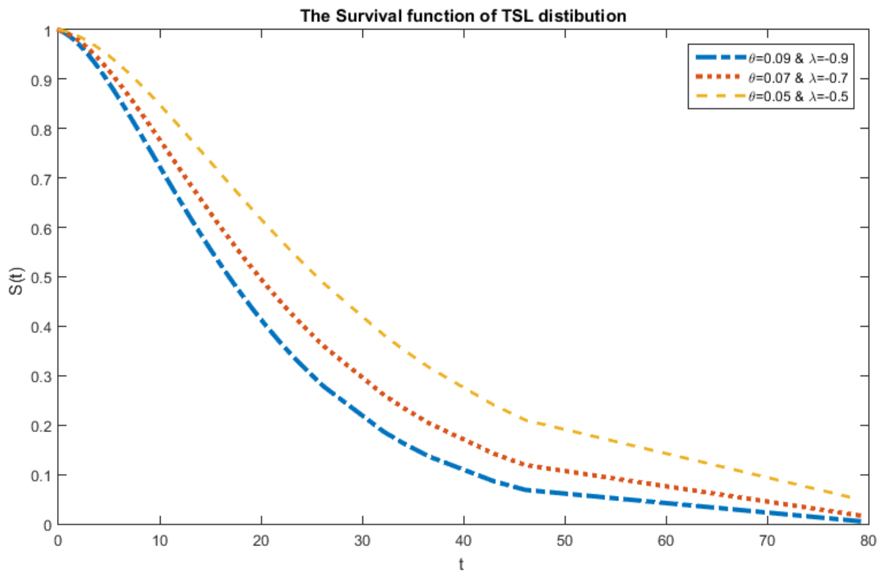

Figure(3): The Survival Function of TSLD with altered values of θ and λ. the Survival Function monotonously decrease with increasing time, it is twisted to the right .

3. Shape of TSLD:

3.2. The Limit of PDF of TSLD.

$$\lim_{t\to\infty} f_2(t) = \frac{(\theta^2)}{1+\theta}\lim_{t\to\infty}\left[\frac{(2)(1+\lambda)}{(1+\theta)}(1+\theta t+\theta)\,e^{-2\theta t}(1+t) - \lambda e^{-\theta t}(1+t)\right]$$

$$\lim_{t\to\infty} f_2(t) = \frac{(\theta^2)}{1+\theta}\lim_{t\to\infty}\left[\frac{(2)(1+\lambda)}{-2\,\theta(1+\theta)}(\theta)\,0 - \frac{\lambda 0(1)}{-\theta}\right]$$

$$\lim_{t\to\infty} f_2(t) = 0.$$

NOW,

$$\lim_{t\to 0} f_2(t) = \frac{(\theta^2)}{1+\theta}\lim_{t\to 0}\left[\frac{(2)(1+\lambda)}{(1+\theta)}(1+\theta t+\theta)\,e^{-2\theta t}(1+t) - \lambda e^{-\theta t}(1+t)\right]$$

$$\lim_{t\to 0} f_2(t) = \frac{(\theta^2)}{1+\theta}\lim_{t\to 0}\left[\frac{(2)(1+\lambda)}{(1+\theta)}(1+\theta 0+\theta)\,e^{-2\theta 0}(1+0) - \lambda e^{-\theta 0}(1+0)\right]$$

$$\lim_{t\to 0} f_2(t) = \frac{(\theta^2)}{1+\theta}\lim_{t\to 0}\left[\frac{(2)(1+\lambda)}{(1+\theta)}(1+\theta) - \lambda\right]$$

$$\lim_{t\to 0} f_2(t) = \frac{(\theta^2)}{1+\theta}\lim_{t\to 0}[(2+2\lambda) - \lambda]$$

$$\lim_{t\to 0} f_2(t) = \frac{(\theta^2)(2+\lambda)}{(1+\theta)}.$$

3.2. The Limit of CDF and Survival Function of TSLD.

$$\lim_{t\to\infty} F_2(t) =$$

$$\lim_{t\to\infty}\left(1-(1+\lambda)\frac{1}{(1+\theta)^2}(1+\theta t+\theta)^2 e^{-2\theta t} + \lambda\frac{1}{1+\theta}(1+\theta t+\theta)e^{-\theta t}\right)$$

$$\lim_{t\to\infty} F_2(t) = \left(1-\frac{(1+\lambda)}{(1+\theta)^2}\lim_{t\to\infty}(1+\theta t+\theta)^2 e^{-2\theta t} + \frac{\lambda}{1+\theta}\lim_{t\to\infty}(1+\theta t+\theta)e^{-\theta t}\right)$$

$\lim_{t\to\infty} F_2(t) = \left(1 - \frac{(1+\lambda)}{(1+\theta)^2} 0 + \frac{\lambda}{1+\theta} 0\right)$

$\lim_{t\to\infty} F_2(t) = 1$

This mean If t convergent to infinity then the limit of the cdf is equal to one is obtained.

Now

$\lim_{t\to 0} F_2(t) = \lim_{t\to 0}\left(1 - (1+\lambda)\frac{1}{(1+\theta)^2}(1+ \theta(1+t) + \theta(1+t) + \theta^2(1+t)^2)\, e^{-2\,\theta t} + \lambda\frac{1}{1+\theta}(1+ \theta t + \theta)e^{-\theta t}\right)$

$\lim_{t\to 0} F_2(t) = \lim_{t\to 0}\left(1 - (1+\lambda)\frac{1}{(1+\theta)^2}(1+ \theta(1+0) + \theta(1+0) + \theta^2(1+0)^2)\, e^{-2\,\theta 0} + \lambda\frac{1}{1+\theta}(1+ \theta 0 + \theta)e^{-\theta 0}\right)$

$\lim_{t\to 0} F_2(t) = \lim_{t\to 0}\left(1 - (1+\lambda)\frac{1}{(1+\theta)^2}(1 + 2\,\theta + \theta^2) + \lambda\frac{1}{1+\theta}(1+ \theta)\right)$

$$\lim_{t\to 0} F_2(t) = 0$$

If t convergent to zero than the limit of the cdf is equal to zero is obtained

It is concluded that the range of the Cdf function is closed interval and its domain is the positive real numbers and that it is a positive which satisfies the conditions of cumulative Distribution function.

and vice versa with the survival function

$$\lim_{t\to 0} S_2(t) = 1$$

$$\lim_{t\to\infty} S_2(t) = 0$$

4. The Statistical Characteristics :

These characteristics present formulas of The Hazard Function , Moments, Moment Generating Function, Order Statistics of TSLD and Maximum Likelihood Estimators Of TSLD.

4.1. The Hazard Function: [8], [12] ,[13]

The Hazard Function is defined by

$$h_2(t) = \frac{f_2(t)}{S_2(t)}$$

$$h_2(t) = \frac{f(t)(2(1+\lambda)S\,(t) - \lambda)}{S(t)((1+\lambda)S\,(t) - \lambda)}$$

$$h_2(t) = h(t)\frac{(2(1+\lambda)S\,(t) - \lambda)}{((1+\lambda)S\,(t) - \lambda)}$$

$h_2(t) = h(t)\left[\frac{\lambda}{((1+\lambda)S\,(t)-\lambda)} + 2\right]$ ....(10)

Then the Hazard Function of TSLD .

$h_2(t) = \frac{\theta(1+t)}{1+\theta(1+t)}\left[\frac{\lambda}{\left((1+\lambda)\frac{1}{1+\theta}(1+\theta t+\theta)e^{-\theta t}-\lambda\right)} + 2\right]$ ....(11)

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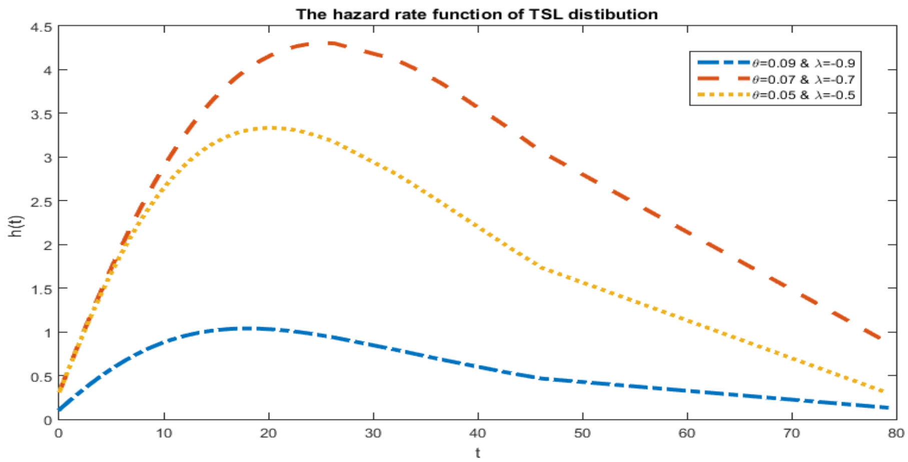

Figure (4): The Hazard Function of TSLD with Altered Values of θ and λ,

Now it is find the limit:

$$\lim_{t\to 0} h_2(t,\theta,\lambda) = \lim_{t\to 0} \frac{\theta(1+t)}{1+\theta(1+t)}\left[\frac{\lambda}{\left((1+\lambda)\frac{1}{1+\theta}(1+\theta t+\theta)e^{-\theta t}-\lambda\right)}+2\right]$$

$$\lim_{t\to 0} h_2(t,\theta,\lambda) = \frac{\theta(\lambda+2)}{1+\theta}$$

And

$$\lim_{t\to \infty} h_2(t,\theta,\lambda) = \lim_{t\to \infty} \frac{\theta(1+t)}{1+\theta(1+t)}\left[\frac{\lambda}{\left((1+\lambda)\frac{1}{1+\theta}(1+\theta t+\theta)e^{-\theta t}-\lambda\right)}+2\right]$$

$$\lim_{t\to \infty} h_2(t,\theta,\lambda) = \infty$$

4.2. Cumulative Hazard Function of TSLD: [12]

$$H_2(t) = \log S(t) + \log\big((1+\lambda)S(t) - \lambda\big) \quad \ldots\ldots\ldots\ldots(12)$$

$$H_2(t) = \log\left(\frac{1}{1+\theta}(1+\theta t+\theta)e^{-\theta t}\right) + log\left[\left(\frac{(1+\lambda)}{1+\theta}(1+\theta t+\theta)e^{-\theta t}-\lambda\right)\right]$$

$$H_2(t) =$$

$$(log(1+\theta t+\theta) - 2\log(1+\theta) - \theta t) + \log\big((1+\lambda)(1+\theta t+\theta)e^{-\theta t} - \lambda(1+\theta)\big)$$

….(13)

4.3.Moment of TSLD:[3][15]

This section presents the rth moment and moment generating function of TSLD.

Theorem4.3.1

If $t\sim$ TSLD(t,λ,θ), the rth central moment about the origin ,and the rth central moment and about the mean μ as follows :

$$E_2(T^r) = \frac{(1+\lambda)r!}{(2\theta)^r}\left(1+\frac{r^2+5r+4\theta r}{4(1+\theta)^2}\right) - \frac{\lambda r!}{1+\theta}\left(\frac{(\theta+r+1)}{(\theta)^r}\right) \ldots\ldots\ldots\ldots(14)$$

$$E_2(T-\mu)^r = \sum_{k=0}^{r} C_k^r\left[\frac{k!}{(2\theta)^k}\left[(1+\lambda)\left(1+\frac{k(k+5+4\theta)}{4(1+\theta)^2}\right) - \frac{\lambda k!}{1+\theta}\left(\frac{(\theta+k+1)}{(\theta)^r}\right)\right]\right]\left(-\left(\frac{1}{(2\theta)}\left[(1+\lambda)\left(1+\frac{(3+2\theta)}{2(1+\theta)^2}\right) - \frac{2\lambda(\theta+2)}{1+\theta}\right]\right)\right)^{r-k} \ldots\ldots\ldots\ldots(15)$$

Depending on the first part of the proof , it is find the expected value and variance

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The Expected Value of TSLD .

$$E_2(T) = \frac{(1+\lambda)}{2\,\theta}\left(1+\frac{3\ +2\ \theta}{2(1+\ \theta)^2}\right) - \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right) \dots\dots\dots\dots (16)$$

$$E_2(T^2) = \frac{2(1+\lambda)}{(4)\theta^2}\left(1+\frac{7+4\ \theta}{2(1+\ \theta)^2}\right) - \frac{2\lambda}{\theta^2}\left(\frac{3\ +\theta}{1+\ \theta}\right).$$

The Variance of TSLD

$$V_2(t) = \frac{2(1+\lambda)}{(4)\theta^2}\left(1+\frac{7+4\ \theta}{2(1+\theta)^2}\right) - \frac{2\lambda}{\theta^2}\left(\frac{3\ +\theta}{1+\ \theta}\right) - \left(\frac{(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\ \theta)^2}\right) - \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right)\right)^2 .(17)$$

Now +

will prove second part from theorem based on the first part

$$E_2(T-\mu)^r = \sum_{k=0}^{r} C_k^r \left[\frac{(1+\lambda)r!}{(2\ \theta)^r}\left(1+\frac{k^2+5k+4k\ \theta}{4(1+\theta)^2}\right) - \frac{\lambda\ k!}{(\ \theta)^k}\left(\frac{(\ \theta\ +k+1\ )}{1+\ \theta}\right)\right] \left(-\frac{(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\theta)^2}\right) + \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right)\ \right)^{r-k}$$

Compete prove of second part .

Note based on part two from theorem (4.1.1), the researchers get the SK and KU is obtained

Let

$$SK = E(T-\mu)^3 =$$

$$SK = \sum_{k=0}^{3} C_k^3 \left[\frac{3(1+\lambda)}{4(\ \theta)^3}\left(1+\frac{k^2+5k+4k\ \theta}{4(1+\ \theta)^2}\right) - \frac{\lambda\ k!}{(\ \theta)^k}\left(\frac{(\ \theta\ +k+1\ )}{1+\ \theta}\right)\right] \left(-\frac{(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\ \theta)^2}\right) + \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right)\ \right)^{3-k} \dots\dots\dots\dots\dots\dots(18)$$

And

$$KU = E(T-\mu)^4 =$$

$$KU = \sum_{k=0}^{4} C_k^4 \left[\frac{3(1+\lambda)}{2(\ \theta)^4}\left(1+\frac{k^2+5k+4k\ \theta}{4(1+\ \theta)^2}\right) - \frac{\lambda\ k!(\ \theta\ +k+1\ )}{(\ \theta)^k\,(1+\ \theta)}\right]\left(\frac{-(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\ \theta)^2}\right) + \frac{\lambda(2+\theta)}{\theta(1+\ \theta)}\ \right)^{4-k} \dots\dots\dots\dots\dots\dots(19)$$

The Coefficient of Variation **of TSLD**

$$CV = \left(\frac{2(1+\lambda)}{(4)\theta^2}\left(1+\frac{7+4\ \theta}{2(1+\theta)^2}\right) - \frac{2\lambda}{\theta^2}\left(\frac{3\ +\theta}{1+\ \theta}\right) - \left(\frac{(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\ \theta)^2}\right) - \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right)\right)^2\ \right)^{1/2} \left(\frac{(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\ \theta)^2}\right) - \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right)\right)^{-1} \dots(20)$$

Standard deviation **of TSLD .**

$$\sigma = \left(V_2(t)\right)^{1/2}$$

$$\sigma = \left(\frac{2(1+\lambda)}{(4)\theta^2}\left(1+\frac{7+4\ \theta}{2(1+\theta)^2}\right) - \frac{2\lambda}{\theta^2}\left(\frac{3\ +\theta}{1+\ \theta}\right) - \left(\frac{(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\ \theta)^2}\right) - \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right)\right)^2\ \right)^{1/2} .(21)$$

Coefficient of Skewness **of TSLD .**

$$\gamma = SK\left(V_2(t)\right)^{-3/2}$$

$$\gamma = \sum_{k=0}^{3} C_k^3 \left[\frac{3(1+\lambda)}{4(\ \theta)^3}\left(1+\frac{k^2+5k+4k\ \theta}{4(1+\theta)^2}\right) - \frac{\lambda\ k!}{(\ \theta)^k}\left(\frac{(\ \theta\ +k+1\ )}{1+\ \theta}\right)\right] \left(-\frac{(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\theta)^2}\right) + \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right)\ \right)^{3-k} \left(\frac{2(1+\lambda)}{(4)\theta^2}\left(1+\frac{7+4\ \theta}{2(1+\theta)^2}\right) - \frac{2\lambda}{\theta^2}\left(\frac{3\ +\theta}{1+\ \theta}\right) - \left(\frac{(1+\lambda)}{2\ \theta}\left(1+\frac{3\ +2\ \theta}{2(1+\ \theta)^2}\right) - \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\ \theta}\right)\right)^2\ \right)^{-3/2} ..(22)$$

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Coefficient of kurtosis **of TSLD .**

$\psi = KU\left(V_2(t)\right)^{-2}$

$$\psi = \left[\sum_{k=0}^{4} C_k^4 \left[\frac{3(1+\lambda)}{2(\theta)^4}\left(1+\frac{k^2+5k+4k\,\theta}{4(1+\theta)^2}\right) - \frac{\lambda\, k!(\theta+k+1)}{(\theta)^k(1+\theta)}\right]\left(\frac{-(1+\lambda)}{2\,\theta}\left(1+\frac{3+2\,\theta}{2(1+\theta)^2}\right) + \frac{\lambda(2+\theta)}{\theta(1+\theta)}\right)^{4-k}\right]\left(\frac{2(1+\lambda)}{(4)\theta^2}\left(1+\frac{7+4\,\theta}{2(1+\theta)^2}\right) - \frac{2\lambda}{\theta^2}\left(\frac{3+\theta}{1+\theta}\right) - \left(\frac{(1+\lambda)}{2\,\theta}\left(1+\frac{3+2\,\theta}{2(1+\theta)^2}\right) - \frac{\lambda}{\theta}\left(\frac{2+\theta}{1+\theta}\right)\right)^2\right)^{-2} \quad ....(23)$$

4.4. Moments Generating Function **of TSLD .**

$M_T(z) = E_2(e^{zT}) = \int_0^\infty e^{zT} f_2(t)dt$ where $-h < z > h$ and $h > 0$, $h \in IR$

$M_T(z) = E_2(e^{zT}) == \sum_{r=1}^{\infty} \frac{Z^r}{r!} E_2(t^r)$

$$M_T(z) = \sum_{r=1}^{\infty} \frac{(z)^r}{r!}\frac{r!}{(2\,\theta)^r}\left[(1+\lambda)\left(1+\frac{r(r+5+4\,\theta)}{4(1+\theta)^2}\right) - (2)^r\lambda\left(\frac{(\theta+r+1)}{1+\theta}\right)\right] \ldots(24)$$

4.5. Characteristic Function **of TSLD .**

$$M_t(ix) = \sum_{r=1}^{\infty} \frac{(ix)^r}{r!}\frac{r!}{(2\,\theta)^r}\left[(1+\lambda)\left(1+\frac{r(r+5+4\,\theta)}{4(1+\theta)^2}\right) - (2)^r\lambda\left(\frac{(\theta+r+1)}{1+\theta}\right)\right] .(25)$$

4.6. Quantile function **of TSLD .**

The function is inverse of cdf . such that $t = Q(p) = F^{-1}(p)\, where\ 0 < p < 1$

$$p = 1 - \frac{(1+\lambda)(1+\theta t+\theta)^2 e^{-2\,\theta t}}{(1+\theta)^2} + \frac{\lambda(1+\theta t+\theta)e^{-\theta t}}{1+\theta}$$

$$1 - p = \frac{(1+\theta t+\theta)e^{-\theta t}}{1+\theta}\left(\frac{(1+\lambda)(1+\theta t+\theta)\, e^{-\theta t}}{(1+\theta)} + \lambda\right)$$

$$\ln(1-p) = ln\left[\frac{(1+\theta t+\theta)e^{-\theta t}}{1+\theta}\left(\frac{(1+\lambda)(1+\theta t+\theta)\, e^{-\theta t}}{(1+\theta)} + \lambda\right)\right] \ldots\ldots.(26)$$

The equation that the researchers got(26) can only be solved for t using numerical methods .

4.7 Mode **of TSLD .**

$$\frac{\partial f_2(t)}{\partial t} = 0$$

$$\frac{\partial f_2(t)}{\partial t} = \frac{\left(\frac{(1+\lambda)(2\,\theta^2)\left((1+\theta)+(1+2\,\theta)t+t^2\,\theta\right)e^{-2\,\theta t}}{(1+\theta)^2} - \frac{\lambda(\theta^2)e^{-\theta t}[(1+t)])}{1+\theta}\right.}{\partial t}$$

$$\frac{\partial f_2(t)}{\partial t} = 0$$

$$\frac{(1+\lambda)(2\,\theta^2)e^{-2\,\theta t}}{(1+\theta)^2}\left((-2\,\theta^2)(1+t)^2+1\right) - \frac{\lambda(\theta^2)e^{-\theta t}}{1+\theta}\left((-\theta)(1+t)+1\right) = 0$$

$$(1+\lambda)(2)e^{-\theta t}\left((-2\,\theta^2)(1+t)^2+1\right) - \lambda\left((-\theta)(1+t)+1\right)(1+\theta) = 0$$

$$(1+\lambda)(2)e^{-\theta t}\left((-2\,\theta^2)(1+t)^2+1\right) = \lambda\left((-\theta t - \theta^2 t) + 1 - \theta^2\right)$$

$$(1+\lambda)(2)e^{-\theta t}\left((-2\,\theta^2)(1+t)^2+1\right) + \lambda(\theta t + \theta^2 t) = \lambda(1-\theta^2) ..(26)$$

the researchers can solve equation (27) numerically

5. Order statistic **of TSLD .**:[10]

$Y_1 = Min(T_1, T_2, \ldots.., T_n)$

$Y_2 =$ the 2nd smallest of $T_1, T_2, \ldots.., T_n$.

$Y_n = Max(T_1, T_2, \ldots.., T_n)$

Then min cdf order statistic

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$$F_{Y_1}(t) = 1 - \left((1+\lambda)\frac{1}{(1+\theta)^2}(1+\ \theta t+\ \theta)^2 e^{-2\,\theta t} - \lambda\frac{1}{1+\theta}(1+\ \theta t+\ \theta)e^{-\,\theta t}\right)^n \;..(28)$$

Then the min pdf order statistic

$$f_{Y_1}(t) = \frac{n\left(1-(1+\lambda)\frac{1}{(1+\theta)^2}(1+\theta t+\theta)^2e^{-2\,\theta t}+\lambda\frac{1}{1+\theta}(1+\theta t+\theta)e^{-\,\theta t}\right)^{n-1}(\theta^2)e^{-\,\theta t}(1+t)\left[\frac{(2)(1+\lambda)}{(1+\theta)}(1+\theta t+\theta)\,e^{-\,\theta t}-\lambda\right]}{1+\theta} \;\ldots(27)$$

Then the max cdf order statistic

$$F_{Y_n}(t) = \left(1-(1+\lambda)\frac{1}{(1+\theta)^2}(1+\ \theta t+\ \theta)^2e^{-2\,\theta t}+\lambda\frac{1}{1+\theta}(1+\ \theta t+\ \theta)e^{-\,\theta t}\right)^n \ldots(29)$$

Then the max pdf order statistic

$$f_{Y_n}(t) = \frac{n\left(1-(1+\lambda)\frac{1}{(1+\theta)^2}(1+\theta t+\theta)^2e^{-2\,\theta t}-\lambda\frac{1}{1+\theta}(1+\theta t+\theta)e^{-\,\theta t}\right)^{n-1}(\theta^2)e^{-\,\theta t}(1+t)\left[\frac{(2)(1+\lambda)}{(1+\theta)}(1+\theta t+\theta)\,e^{-\,\theta t}\_\lambda\right]}{1+\theta}\ldots$$

8. Maximum Likelihood Estimators Of TSLD:[14]

The Likelihood function of the pdf is :

$$L(\lambda,\theta;t1,t2,\ldots,tn) = \prod_{I=1}^{n} f_2(\lambda,\theta;t_i)$$

$$= \prod_{I=1}^{n}\frac{(\theta^2)e^{-\,\theta t}(1+t)\left[(2)(1+\lambda)(1+\ \theta t+\ \theta)\,e^{-\,\theta t}-\lambda(1+\ \theta)\right]}{(1+\ \theta)^2}$$

$$L(\lambda,\theta;t1,t2,\ldots,tn) = L$$

$$= \frac{(\theta^2)^n\,e^{-\sum_{I=1}^{n}\theta t_I}\prod_{I=1}^{n}((1+t_I)\prod_{I=1}^{n}\left[(2)(1+\lambda)(1+\ \theta t+\ \theta)\,e^{-\,\theta t}-\lambda(1+\ \theta)\right]}{(1+\ \theta)^{2n}}$$

$$lnL = 2nln(\theta) - \theta\sum_{I=1}^{n}t_I + \sum_{I=1}^{n} ln(1+t_I) - 2nln(1+\ \theta) + \sum_{I=1}^{n}\ln\left((2)(1+\lambda)(1+\ \theta t+\ \theta)\,e^{-\,\theta t}-\lambda(1+\ \theta)\right)$$

$$\frac{dlnL}{d\ \theta} = \frac{2n}{\theta} - \sum_{I=1}^{n}t_I - \frac{2n}{1+\theta} + \sum_{I=1}^{n}\frac{(2)(1+\lambda)((1+t)\,e^{-\,\theta t}-\theta(1+\theta t+\theta)\,e^{-\,\theta t})-\lambda}{(2)(1+\lambda)(1+\theta t+\theta)\,e^{-\,\theta t}-\lambda(1+\theta)\,]} = 0\ldots(30)$$

$$\frac{\partial L}{\partial\,\lambda} = \sum_{I=1}^{n}\frac{(2)(1+\theta t+\theta)\,e^{-\,\theta t}-(1+\theta)}{(2)(1+\lambda)(1+\theta t+\theta)\,e^{-\,\theta t}-\lambda(1+\theta)\,]} = 0\ \ldots.(31)$$

$$\frac{2n+\theta 2n-\theta 2n}{\theta(1+\theta)} + \sum_{I=1}^{n}\frac{(2)(1+\lambda)((1+t)\,e^{-\,\theta t}-\theta(1+\theta t+\theta)\,e^{-\,\theta t})-\lambda}{(2)(1+\lambda)(1+\theta t+\theta)\,e^{-\,\theta t}-\lambda(1+\theta)\,]} = \sum_{I=1}^{n}t_I$$

$$\frac{2n}{\theta(1+\theta)} + \sum_{I=1}^{n}\frac{(2)(1+\lambda)((1+t)\,e^{-\,\theta t}-\theta(1+\theta t+\theta)\,e^{-\,\theta t})-\lambda}{(2)(1+\lambda)(1+\theta t+\theta)\,e^{-\,\theta t}-\lambda(1+\theta)\,]} = \sum_{I=1}^{n}t_I$$

$$\frac{\partial\,L}{\partial\,\lambda} = \sum_{I=1}^{n}\frac{(2)(1+\theta t+\theta)\,e^{-\,\theta t}-(1+\theta)}{(2)(1+\lambda)(1+\theta t+\theta)\,e^{-\,\theta t}-\lambda(1+\theta)\,]} = 0$$

$$\sum_{I=1}^{n}\frac{(2)(1+\theta t+\theta)\,e^{-\,\theta t}-(1+\theta)}{(2)(1+\lambda)(1+\theta t+\theta)\,e^{-\,\theta t}-\lambda(1+\theta)\,]} = 0$$

The numerical method is used to solve the above equations (30) and (31)

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RESULTS AND DISCUSSION

9. Applications: bladder cancer Datum [10]

In this section, the researchers apply a verifiable datum set to display that the TSLD can be a better model than the Lindley Distribution (LD) and a New Generalized Lindley Distribution (New GLD) [11]. The date set fixed in Table (1) exemplifies an uncensored datum set identical to the remission times (in months) of a random sample of 128 bladder cancer patients reported by Lee and Wang [10] [11]. Based on [11], the second table describes the maximum likelihood estimates, standard error, and log-likelihood. Whereas this research used this table to clarify distributions, we estimated their parameters using the maximal likelihood method. We discovered that the standard error of the TSL distribution is smaller than that of the other two distributions, as is the value of the negative log-likelihood. As a result, the TSL distribution maximizes the maximum likelihood function and is therefore regarded as the superior of the two.

The Third Table discusses the A IC, A ICC, B IC, and KS of the Survival Models founded data criteria that explain how the TSL_ Model is perfect at elucidating the relevance between variables. When the researchers want to know how perfect the TSL_ Model is, the Third Table reveals that the TSL_ Model has the best fit to the set data by applying the Statistics Tests: A IC, B IC, and C AIC. These statistics provide the lowest values compared to other survival models in Table 3. For the purpose of comparing the three distribution survival models, the researchers examine the data set using statistical standards such as -2 log-likelihood, AIC (Akaike information criterion), AIC C (corrected Akaike information criterion), BI C (Bayesian information criterion), and K S (Kolmogorov Smirnov test). The greater the distribution, the smaller the l2, AIC, and AICC values:

Table 1: Remission times (in months) for patients with bladder cancer

0.08	2.09	3.48	4.87	6.94	8.66	13.11	23.63	0.20	2.23
0.52	4.98	6.97	9.02	13.29	0.40	2.26	3.57	5.06	7.09
0.22	13.80	25.74	0.50	2.46	3.64	5.09	7.26	9.47	14.24
0.82	0.51	2.54	3.70	5.17	7.28	9.74	14.76	26.31	0.81
0.62	3.82	5.32	7.32	10.06	14.77	32.15	2.64	3.88	5.32
0.39	10.34	14.83	34.26	0.90	2.69	4.18	5.34	7.59	10.66
0.96	36.66	1.05	2.69	4.23	5.41	7.62	10.75	16.62	43.01
0.19	2.75	4.26	5.41	7.63	17.12	46.12	1.26	2.83	4.33
0.66	11.25	17.14	79.05	1.35	2.87	5.62	7.87	11.64	17.36
0.40	3.02	4.34	5.71	7.93	11.79	18.10	1.46	4.40	5.85
0.26	11.98	19.13	1.76	3.25	4.50	6.25	8.37	12.02	2.02
0.31	4.51	6.54	8.53	12.03	20.28	2.02	3.36	6.76	12.07
0.73	2.07	3.36	6.93	8.65	12.63	22.69	5.49		

Table(2) The Maximum Likelihood estimates, Standard Error and Negative Log likelihood

Survival Model	MLE	SE	Negative Log likelihood
LD	$\hat{\theta} = 196 \times 10^{-3}$	12×10^{-3}	419529×10^{-3}
New GLD	$\hat{\theta} = 0.18$	0.035	412750×10^{-3}
	$\hat{\alpha} = 4.679$	1.308	
	$\hat{\beta} = 1.324$	0.171	
TSL	$\hat{\theta} = 0.2188$	0.2812	4093114×10^{-4}
	$\hat{\lambda} = -0.7217$	0.0783	

Table (3) . The negative log-likelihood and A IC values for three survival Models , AICC, BIC and K-S .

Survival Model	-2×log-likelihood	A IC	A ICC	B IC	KSL
LD	83904×10^{-2}	84106×10^{-2}	841091×10^{-3}	843892×10^{-3}	74×10^{-3}
New GLD	825501×10^{-3}	831501×10^{-3}	831694×10^{-3}	840057×10^{-3}	116×10^{-3}
TSL	818.6229	822.6229	808.7246	828.1642	0.0825

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Conflict of interests.

There are non-conflicts of interest.

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الخلاصة

في هذه الدراسة، تم اكتشاف توزيع جديد كنموذج بقاء من خلال استخدام وظيفة البقاء للتوزيع المحول من الدرجة الثانية، حيث تم استخدام توزيع ليندلي المحول من الدرجة الثانية لاشتقاق توزيع ليندلي المحول على قيد الحياة (TSL) ، وهو ضروري لأنه أكثر مرونة ودقة في تطبيقات البيانات. نظرًا لوجود نقاط بيانات في بعض الأحيان لا تفي بالتوزيع القياسي، فإن التوزيع الجديد يوفر نتائج أكثر دقة عند تطبيقه على البيانات، ويتم استخراج دالة كثافة الاحتمال ودالة الاحتمال التراكمي. تم اشتقاق خصائص النشر الجديدة ذات الأداء الموثوق من منظور إحصائي ورياضي. لقد قدرنا أيضًا مجموعة عن سرطان المثانه بيانات باستخدام الطرق التقليدية، واستخدمنا برنامج ما تلاب لإثبات أن توزيعنا الجديد أفضل من التوزيع الأصلي.

مقدمة:

وجدنا في هذه الدراسة توزيعًا جديدًا من توزيعات الحياة ، وذلك بالاستفادة من (TSF) و (LD) ، ووجدنا أن هذا (TSLD) يتميز بالدقة والمرونة العالية عند التعامل مع بيانات الحياة. [1]وجد الباحثين صيغة جديده (TS) سميت بصيغة تحويل البقاء. [3]تم الاستفادة من (LD) عموما في دراسة البقاء وذلك من خلال تطبيقه في مجالات الحياة المختلفة ومنها المجالات الطبية ومجالات هندسة و الاستثمار و مجالات أخرى وكذلك دراسة بيانات العمر, . حيث قدم العديد من الباحثين دراسات جديده ترتكز على توزيع لندلي حيث هذه الدراسات اوجدت توزيعات جديده واثبتت خصائصها أيضًا. ان الهدف الاساسي من هذه الدراسات الحصول على توزيعات اكثر مرونة عند التعامل مع بيانات الحياه . قدم كل من دنيز وأوجيدا مقترح تحويلًا منفصلاً لـ توزيع لندلي [2] حيث نفذ في تعداد البيانات التي تربط بالإيداع. المؤلفون في هذه الدراسة [3] وجدوا مفهوم جديد وهو التحويل باستخدام دالة الكثافة الاحتمالية ,وكذلك راما وميشرا [4] درسوا شبة توزيع لندلي , وركز الباحثين في البحثين [5، 6]على اكتساب محيط أحادي الجانب وتحويل ناقص صفري لـ Poisson–LD وتمت مناقشة مزايا التوزيع وتطبيقاته المختلفة. وناقشا الباحثون في [7] الخصائص المتنوعة لـ (LD) وعرضوا ذلك في عدد من الاتجاهات. وجد الباحثين في [9] توزيع لندلي المعمم (L D معمم) وبحثوا عن خصائصه وتطبيقاته المختلفة. إبراهيم إي [10]وجد توزيع جديد بثلاث معاملات تسمى (تعميم توزيع لندلي]. ناقش الغيطاني والمطيري وعلماء اخرون في [15] التطبيقات لل (L D) من اجل التنافس بالاعتماد على العمر الافتراضي لتلك المخاطر .قدم سانكارا [18] توزيع بواسون لندلي المنفصل (Poisson –L D) وذلك بدمج التوزيعان معا . في هذه الدراسة[19] حيث قاموا الباحثون بتحسين معلمتين (LD الموزون) وناقشوا تطبيقاته في بيانات البقاء.

حيث ان الصيغة التاليه صيغه التحويل لدالة الكثافة

$$F\,(t)\;=\;(1\;+\;\lambda)\,F\,(t)\;-\;F\,^\wedge\,2\,(t)\ldots(1))$$

ما الصيغة التالية فهي صيغة التحويل لدالة البقاء

طرق العمل:

استخدمنا توزيع لندلي و صيغة تحويل البقاء للحصول على توزيع اكثر مرونة

الاستنتاجات:

استخدمنا طريقة الامكان الاعظم وبيانات حقيقيه عن سرطان المثانة ووجدنا ان التوزيع الجديد افضل في الحصول على النتائج.

الكلمات المفتاحية:

داله البقاء , صيغة تحويل البقاء ,داله البقاء و طريقة الامكان الاعظم.