ANALYSING LIFETIME OF COMPONENTS USING GAMMA DISTRIBUTION

K.Varshini, S.Sudendar, Arjun kumaran, S.Abitha shree, P.Barathi priya, Dr.M.Marimuthu

Department of computing

Coimbatore institute of technology

Coimbatore, Tamil Nadu, INDIA

Varshini99.vv@gmail.com, sudendarsude@gmail.com, arjunkumaran126@gmail.com, subhi.abitha@gmail.com, pbharathip17@gmail.com, marimuthu@cit.edu.in

ABSTRACT:

In today's world all the daily needs is connected with electronic gadgets. Electronic gadgets are becoming one of the essential needs. From fans to video gaming everything involves gadgets. Electronic gadgets have made the work of human easier. So, it is important to know the reliability and lifetime of the components that we use. This paper deals with determining the lifetimes of electronic gadgets produced by two different manufacturers using gamma distribution. Two parameters alpha and beta are calculated. A hypothesis is formulated to check if the two means are equal. The result establishes which one among the two manufacturer produces more efficient products.

KEYWORDS: Gamma distribution, alpha, beta, hypothesis.

1.INTRODUCTION

The lifetime of a component is statistically explained as how long a product is expected to perform its expected functions under specific conditions. Knowing about the lifetime of any component w buy is the most important aspect to be noted. Thus it is mandatory to know how long a component can perform its intended functions. However, lifetime specifications can only describe about specific set of populations. Any product can fail before its rate lifetime or afterwards. The rated lifetime of any component may or may not fail. The main reasons quoted for any component to fail before its rated lifetime are its designs, materials, component section, manufacturing process, and use environment. It is not necessarily being that all the products which are functionally same has similar

lifetime that is rated. The lifetime of components differs from product to product based on its manufacturing strategies and consumer usage.

This paper deals with the estimation of lifetime of electronic products that are produced by two different manufacturers using gamma distribution including two parameters alpha and beta. Also a hypothesis is formulated to identify the more efficient manufacturer.

Gamma distribution is a two parameter family of continuous probability distributions in probability theory and statistics. Among statiscal analysis, testing is considered to be one of the most important concept. Hypothesis gives a clear session in determining the efficiency of two different sectors.

2.LITERATURE REVIEW

The author uses multivariate gamma distribution for two reasons. The author resolves the issue of parameter estimation in the presence of truncation, which they considered to be the main theoretical contribution. They apply the model to assess the impact of dependence and found that the uncertainty is severely impacted. They generalize the underlying distribution and carefully refining the parameter estimation approach. [1]

The paper uses the estimation of reliability for two independent random variables X1 and X2, belonging to the same univariate family of distributions to compare the lifetimes of two components. They also use gamma distribution to relate the lifetimes of the two components. [2]

The main objective of the paper is to compare the lifetime reliability of LEDs. The lifetime of LEDs is compared. Also the mean time between failure (MTBF) of different LEDs and mean time to failure (MTTF) of different LEDs are studied and compared. The reliability of components estimates for the entire useful life phase of a product are commonly reported using MTBF and MTTF. [3]

The author studies two kinds of the lifetime prediction based on gamma processes. The study deduces a method for determining the relationships between the shape and scale parameters of the gamma distribution. When predicting the lifetimes, Bayesian inference methods were adopted to improve the prediction accuracy.

The paper has an attempt to have the comparative and detailed study of two parameter gamma distribution and Weibull distribution for modelling lifetime data from various fields. The goodness of fit of gamma distributions and Weibull distributions are compared with exponential distributions. [4]

The author defines a generalized gamma distribution in Bayesian analysis of exponential survival models. The author also compares the gamma distribution with the ordinary distribution and explains with many examples. [5]

The paper uses gamma distribution and k-gamma distribution. He assumes the k-

value and calculates their mean and variance which are equal to the parameter m and k times the parameter m respectively. [6]

3.PROPOSED WORK

As the demand for electronic gadgets is increasing, it is important to know the most efficient gadgets. In this paper we would like to compare the lifetimes of individual components of different companies using gamma distribution. The paper also deals with comparing the efficiencies by setting up the hypothesis and deriving the result using Z-Test.

The Data set contains different lifetimes of few individual components of two different companies. Using the data set the parameters of the gamma distribution, alpha and beta, are

estimated by two methods namely method of moments and method of maximum likelihood.

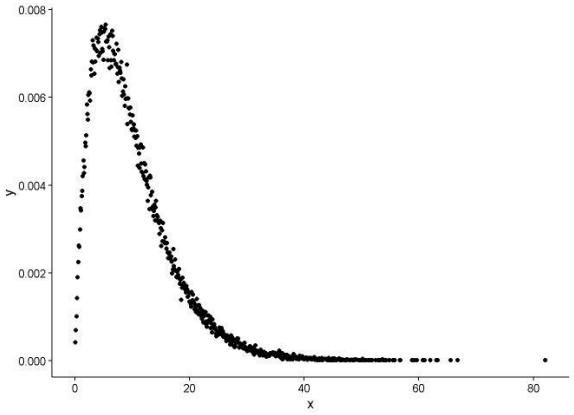

Figure 3.1 Exponential Curve

The Figure 3.1 shows the exponential curve of the probability density of a component using gamma distribution.

In probability theory and statistics, the gamma distribution is a two parameter family of continuous probability distributions. The lifetime of components is compared using the probability density function given by

$$\mathbf{f(x)=} \frac{x^{\alpha-1}}{\beta^{\alpha}\Gamma(\alpha)} e^{\frac{-x}{\beta}}$$

x≥ 0 , α>0,β>0re

x is the lifetime of individual components.

Two parameters are α and β.

The two parameters α and β are estimated by the following methods.

METHOD OF MOMENTS

$$S=\sqrt{\frac{1}{(N-1)}\sum(x_i-\bar{x})^2}$$

Where $\alpha=\frac{x^{-2}}{s^2}$ and $\beta=\frac{s^2}{\bar{x}}$

MAXIMUM LIKELIHOOD ESTIMATE

$$\beta=\frac{(1+\sqrt{1+\frac{4y}{3}})}{4y}$$

where $y=\ln(\bar{x})-\overline{\ln(x)}$ and $\alpha=\frac{\bar{x}}{\beta}$.

The general graph for a gamma distribution with different values of α and β is shown below in Figure 3.2

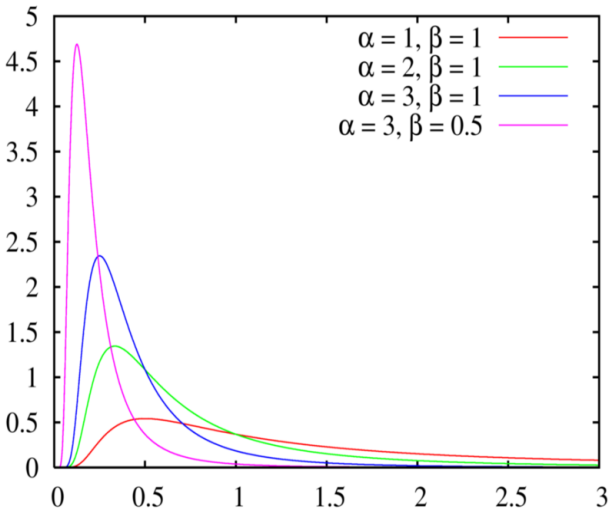

Figure 3.2 Gamma Distribution Graph

A Z-test is a type of hypothesis test. Hypothesis testing is just a way to figure out if results from a test are valid or repeatable. A Z test, is used when your data is approximately normally distributed.

Running a Z test requires five steps:

1. Stating the null hypothesis and alternate hypothesis.
2. Choosing an alpha level.
3. Finding the critical value of z in a z table.
4. Calculating the z test statistic using the formula given below.

$$Z = \frac{(\hat{p}_1 - \hat{p}_2) - 0}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$\hat{\boldsymbol{p}} = \frac{\widehat{p_1}}{\widehat{p_2}}$

$n_1$is the population of dataset A

$n_2$is the population of dataset B

5. Comparing the test statistic to the critical z value and decide if you should support or reject the null hypothesis.

4.RESULT

The lifetimes of few individual components of two companies are compared using gamma distribution fit by estimating the parameters α and β. The most efficient company is found out by setting up the hypothesis and by deriving the result using Z-test.

5.CONCLUSION

Knowing the reliability and lifetime of the components that we use is the most important task for us these days, since all our daily needs are connected to electronic gadgets. It is also very important for us to know about the most efficient company and to compare the components of each company.

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