ABSTRACT

Reliability and survival analysis are widely used in systems engineering and clinical trial experiments. Innovations in reliability methods enhance the safety and reliability of complex technological systems, like engineering systems and offshore pipelines. Survival analysis is generally defined as a set of methods for analyzing data where the outcome variable is the time until an event of interest occurs. It can be a death, illness, failure, or completion of a mission. The time to event or survival time can be measured in days, weeks, years, etc.

The notion of ageing plays a significant role in reliability theory. Ageing has a direct impact on the failure rate function behavior. They can be used in maintenance planning, replacement planning, resource allocation, etc. The increasing failure rate (IFR), decreasing failure rate (DFR), and bathtub failure rate (BFR) distributions are widely used in reliability engineering.

Birnbaum and Saunders (1969) proposed a failure time distribution for fatigue failure caused by cyclic loading. It was also assumed that the failure was due to the development and growth of a dominant crack. Univariate Birnbaum-Saunders (BS) distribution has been used to analyze positively skewed lifetime data. It has received a lot of attention in the last few years. One of the most widely used approaches to reliability estimation is the well-known stress-strength (SS) model. Several physics and engineering applications use this model, including strength failure and the collapse of systems.

The step-stress model is a widely accepted accelerated life testing model. This accelerated testing reduces the time to failure. The data collected from such an accelerated test may then be extrapolated to estimate the underlying distribution of failure times under normal conditions. The step-stress experiment is a special case of accelerated testing that allows for different conditions at various intermediate stages of the experiment.

The thesis entitled *Some Contributions to Reliability Theory and Survival Analysis* has been arranged into 7 chapters. Chapter 1 introduces the basic concepts and definitions to the reader. Also, an extensive review of related literature has

been presented. The summaries of the investigation of study are stated below.

A New Generalization to the DUS Transformation and its Applications

Kumar et al. (2015) proposed a method called DUS transformation to obtain a new parsimonious class of distributions that does not require additional parameters but is found to be a better fit than the baseline distributions. Many of the engineering systems are parallel in nature. If a parallel system has n components and each of the components is well fitted as DUS transformation of any baseline lifetime distribution, then we have to use power generalization. A new transformation called the power generalized DUS transformation (PGDUS) is introduced and proposed new distributions with exponential, Weibull, and Lomax distributions as baseline distributions. Several mathematical properties are examined, including moments, moment generating functions, characteristic functions, quantile functions, order statistics, etc. The maximum likelihood approach to parameter estimation is discussed. Based on several real data sets, the proposed distributions are compared with some of the other failure rate lifetime distributions.

Exponential-Gamma $(3, \theta)$ Distribution: A Bathtub Shaped Failure Rate Model

Mixture distributions are useful when dealing with lifetime data analysis. A BFR distribution called the exponential-gamma $(3, \theta)$ distribution is examined in detail. An investigation is conducted on the shapes of the probability density function (pdf) and the failure rate. Various properties are discussed, including moments, moment generating functions, characteristic functions, quantile functions, and entropy. Distributions for the minimum and maximum are obtained. In order to estimate the parameters of the distribution, the maximum likelihood method is used. Through the use of a simulation study, biases and mean squared errors are analyzed for maximum likelihood estimators (MLEs). A comparison between the proposed lifetime distribution and other lifetime distributions is conducted using real-world data sets.

Generalized ν-Birnbaum Saunders Distribution

Birnbaum-Saunders (BS) distribution is widely used in reliability literature. In order to analyse data and incorporate flexibility in the form of the distribution, we need to consider the distribution with shape parameters. The generalization of the BS distribution, called the ν-Birnbaum Saunders distribution, is discussed. A number of intriguing and relevant characteristics are investigated in depth. The maximum likelihood principle is employed to estimate the parameters of the univariate ν-BS distribution. To obtain interval estimates, we use asymptotic confidence intervals. Both estimation methodologies have been thoroughly explored in an extensive simulation study. Based on these estimators, the probability coverage of confidence intervals has been evaluated. Real-life applications are provided with three different datasets and compared with the univariate BS distribution.

Inference for $\mathbf{R} = \mathbf{P}[\mathbf{Y} < \mathbf{X}]$ based on the Exponential-Gamma $(\mathbf{3}, \lambda)$ Distribution

When a manufacturer has knowledge of the mechanical reliability of the design through the stress-strength model before production, they can significantly reduce their production costs. A system's longevity is determined by its inherent strength and external stress. A discussion of the stress-strength reliability of the exponential-gamma $(3, \theta)$ distribution is presented. An assessment of the reliability estimation of the single-component model is provided. A simulation study is used to demonstrate how well the MLEs perform. A data application is presented using real data sets to demonstrate how the distribution performs in real-life situations.

A Simple Step-Stress Analysis of Type II Gumbel Distribution

Step-stress reliability analysis is useful in industrial engineering. A simple step-stress accelerated life-testing analysis is provided, incorporating Type-II censoring. Here, a flexible failure rate-based approach to Type II Gumbel distribution for SSALT analysis is considered. The baseline distribution of experimental units at each stress level follows the Type II Gumbel distribution. The MLEs for the model parameters are derived.

Lastly, Chapter 7 presents the concluding remarks of the thesis and proposals for future work.