ABSTRACT

Software reliability has become an important area of research since software is an essential part of much industrial and commercial system. Even though there are no complete, scientific and quantitative measures to assess software engineering, software reliability measure is a tool to evaluate software reliability engineering. An important phase of software life cycle is the testing phase because a great deal of efforts is put down to this phase and majority of the cost is associated with this phase. One of the most challenging problems faced in the software industry is to develop reliable software and software reliability is the most significant component of continuous application availability. One of the important ways of measuring the quality of the software is counting the number of remaining faults after the release and many models are proposed for the estimation of this quantity. Software reliability is the probability that the software will be functioning without failure during a specified period of time under the given environmental conditions. Even for the two identical copies of the same software, the reliability may be different under different environments. The reliability may also vary from one machine to another, from one time point to another and from one software to another. The following are the differences identified when considering software and hardware systems. (1) Software has no ageing property (2) Once a fault is removed from the software, there is no chance of occurrence of the same failure again (3) Execution of two copies from a software program give exactly the same result. Software reliability models play an important role in developing software systems and enhancing the performance of computer software. In general, software reliability models can be classified into two types, depending on the operating domain. The most popular category of models depends on failure time, which uses the concepts such as mean time between failures and failure intensity function. The second category of software model measures reliability as the ratio of successful runs to the total number of runs. The intensity (or failure rate) function plays a pivotal role for modelling software failure time data. The models described above are based on distribution function of failure time and reliability measures derived from it. An alternative and equivalent approach for modelling statistical data is to use quantile function. Even though both the functions convey the same information about the distribution, the methodologies and concepts based on distribution function are more popular
in practice. One of the reasons for the popularity of the distribution function approach is the inferential procedure due to maximum likelihood estimation. But for the inference purposes, quantile based estimates are more robust under censoring which is very common in reliability theory. There are many simple quantile functions for empirical model building where distribution functions are not effective. In such situations conventional methods of analysis using distribution functions are not appropriate. Random numbers from any distribution can be generated using appropriate quantile functions. The characteristics derived from quantile function are more applicable in modelling and data analysis. One reason for this is that quantile based studies were carried out mostly when the traditional approach fails to give results of desired quality. In most of the cases of modelling and analysis, there have been no systematic and parallel developments for replacing distribution functions by quantile functions. For the quantile function of order statistics, there are explicit general distribution forms.

The study of the reliability properties associated along with probability distribution function \( F(x) \), density function \( f(x) \) and survival function \( \bar{F}(x) = 1 - F(x) \) along with various other characteristics such as failure rate, mean, percentiles, higher moments of residual life, etc., are used for understanding how the failure time data arises in practice. A systematic study on the application of quantile function in reliability studies have been carried out by [Nair and Sankaran, 2009b]. They have discussed commonly used reliability measures in terms of quantile functions and various relationships connecting them were derived. They have also analysed quantile function model discussed in [Hankin and Lee, 2006] in the context of reliability analysis. Our present work extends these ideas to develop necessary theoretical framework for modelling and analysis of software reliability data based on quantile functions. This new approach provides us an alternative methodology and new models that have desirable properties. In this study we consider quantile based reliability analysis such as identifying quantile functions that are useful in software reliability, defining new families of quantile functions using various properties of reliability functions and related measures.