RELIABILITY PREDICTION MODEL FOR THE FIRST TIME FAILURE OF POWER DISTRIBUTION TRANSFORMERS

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ABSTRACT

This study considered a prediction model for the first time failure of power distribution transformers, studied the properties of certain models particularly for the reliability prediction model and fitted the distribution to the data on power holding company of Nigeria in Osun, Ondo, Oyo and Ekiti State. This was with a view to predicting the first time failure of power distribution transformers.

Several statistical and mathematical properties of Half exponential power distribution were derived while the parameter using maximum likelihood method was estimated. The shape, scale and location parameters were estimated using optimization method through R language. This method gave the maximum likelihood estimate of the parameters which gave the best fit to the Half exponential power distribution model.

The behavior of first time failure of power distribution transformers was predicted with the given parameters especially when a simulation of 50,000 samples were estimated using the rejection sample technique. Under the same condition, this also fitted about the shape and scale parameters.

The study concluded that the first time of failure for transformers was predictable under the condition set in Nigeria.

Chapter 1

INTRODUCTION

Reliability theory is a body of ideas, mathematical models, and methods directed to predict, estimate, understand, and optimaize the life span distribution of systems and their components (adapted from Barlow *et al.*, 1965). Reliability of the system (or component) refers to its ability to operate properly according to a specified standard (Crowder *et al.*, 1991). Reliability is described by the reliability function $S(x)$, which is the probability that a system (or component) will carry out its mission through time x (Rigdon and Basu, 2000). The reliability function (also called the survival function) evaluated at time x is the probability P, that the failure time, say X, is beyond time x that is $\Pr\{X > x\}$.

Reliability theory is a general theory about systems failure. It allows researchers to predict the age-related failure kinetics for a system of given architecture (reliability structure) and given reliability of its components. Reliability theory predicts that even those systems that are entirely composed of non-aging elements (with a constant failure rate) will nevertheless deteriorate (fail more often) with age, if these systems are redundant in irreplaceable elements. Aging, therefore, is a direct consequence of systems redundancy. Reliability theory also predicts the late-life mortality deceleration with subsequent leveling off, as well as the late-life mortality plateaus, as an inevitable consequence of redundancy exhaustion at extreme old ages.

Reliability theory in general is essentially the application of probability theory to the modeling of failures and the prediction of success probability. Modern probability theory base many of its results on the concept of a random variable, its pdf's, and the cdf's. In the case of reliability, the random variable of interest is the time to failure, T. We develop the basic relationships needed by focusing on the probability that the time to failure T is in some interval $(t, t+\delta t)$

$$P(t \le T \le t+\delta t) \equiv \Pr\{t \le T \le t+\delta t\} \qquad (1.1)$$

The above probability in (1.1) can be related to the density and distribution functions, and the results are

$$\Pr\{t \le T \le t+\delta t\} = f(t) = \frac{F(t+\delta t) - F(t)}{\delta t} \qquad (1.2)$$

where $F(t)$ and $f(t)$ are the cdf and pdf (or the failure density function), respectively. dividing by δt in (1.2) and let $\delta t \to 0$, we obtain from the fundamental definition of the derivative the fact that the density function is the derivative of the distribution function: $f(t) = \frac{dF(t)}{dt}$ (1.3)

Clearly, the distribution function is then the integral of the density function

$$F(t) = \int_0^t f(x)dx \qquad (1.4)$$

We note that the function F(t) is equivalent to the probability of failure by time t. Since the random variable T is defined only for the interval [0, +∞) (no negative time), from (1.2) we can derive

$$F(t) = \Pr\{T < t\} = \int_0^t f(x)dx \qquad (1.5)$$

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