

Identifying the Best Parameter Distribution for University Hostel Building Maintenance

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Abstract: In Malaysia University hostel building maintenance, failure of the component to function became a major contribution to the university losses and high maintenance cost. Therefore, there is a need to have an optimal maintenance strategy such as replacement, repair and inspection. Before any optimal maintenance strategy can be implemented failure distribution and the parameters of the hostel building component need to be identified. Therefore, the main objective in this paper is to propose a best parameter failure distribution for Hostel building maintenance management for Malaysia University and approach in applying the, Goodness of a Distribution Fit and Maximum Likelihood Estimator (MLE) techniques in identifying the failure distribution and the parameters of hostel building component. The approach proposed can assist maintenance engineers to make more precise identification in failure data analysis as well as in maintenance optimisation analysis. The paper starts by introducing the application of MLE techniques to identify the best failure fit distribution and its parameters. It follows by numerical examples to determine whether the best fit failure distribution and its parameters are applicable to be applied in maintenance optimisation analysis. This is carried out by comparing the proposed approach with a case study from the literature.

Key words: Maximum Likelihood Estimator • Goodness of a Distribution Fit and Best fit Failure Distribution

INTRODUCTION

In reliability and maintainability study, the characteristic of the component will go through decreasing, constant and increasing failure rate. Respectively these characteristics can be presented via the failure distribution of the University hostel building component. There are many types of failure distribution used in reliability analysis such as exponential, weibull, normal and gamma distributions. In the application of maintenance optimisation, the failure distribution of the equipment must be specified before any maintenance strategy is carrying out. Wrong identification of failure distribution will affects the cost of maintenance University hostel building. For example, preventive replacement (PR) strategy to be worthwhile only if the failure rate of the component is increase [1]. If the PR

strategy is carried out at decreasing or constant failure rate, the replacement and downtime cost will significantly increase by time. The increasing failure rate can be presented by weibull, normal and gamma distributions, whereas exponential distribution shows the constant failure rate. [4] study on the consequences of mis-specifying the form of the failure distribution of inspection strategy. From the analysis, they indicated that if the failure distribution incorrectly specified the long run expected cost per unit time will significantly increase [2-4].

In the process of failure distribution identification, Maximum Likelihood Estimator (MLE) techniques are widely used [3,4]. The MLE technique is used for specifying the best fit failure distribution and technique is used to determine the parameters of distribution. The Goodness of fit is used to specify the best fit failure distribution with testing of each failure distribution

models (exponential, weibull, normal and gamma) Then MLE technique is applied to determine the parameters of distribution[5-7]. The basic idea in a new approach is determines only the shape parameter, p of weibull distribution using Goodness of Fit technique. The value of shape parameter, p can be used to specify the best fit failure distribution before its parameters can be estimated using MLE technique [7].

Maximum Likelihood Estimation (MLE): Many computer-based methods present a probability plotting alternative to rank regression; an example is the Maximum Likelihood Estimator (MLE). The idea behind maximum likelihood parameter estimation is to determine the parameters that maximize the probability (likelihood) of the sample data fitting that distribution [6,7]. Maximum likelihood estimation endeavours to find the most ‘likely’ values of distribution parameters for a set of data by maximizing the value of what is called the likelihood function. From a statistical point of view, the method of maximum likelihood is considered to be more robust (with some exceptions) and yields estimators with good statistical properties. In other words, MLE methods are versatile and apply to most models and to different types of data (both censored and uncensored) [8].

Goodness of a Distribution Fit: Statistical goodness-of-fit tests should be applied to test the fit to the assumed underlying distributions. There are many statistical tools that can help in deciding whether or not a distribution model is a good choice from a statistical point of view, which are often based on the type of number of data points and other criteria [5-7]. The highest likelihood value in case of MLE. Goodness-of-fit tests including χ^2 (chi-square). It is also important to ensure that the time axis chosen is relevant to the problem; otherwise misleading results can be generated [7]. The methods of exploratory data analysis can be applied when appropriate. Statistical software can be used to rank different distributions based on the best mathematical fit depending on which statistical method is chosen. Note that for the MLE data analysis the ranking of the distributions will be different, since a quantitative measure of goodness of fit (combination of weight factors) will depend on the chosen data analysis method [8].

Estimation Based on the Subjective Survey Method: The same questionnaire used for collection snapshot data is also used for collecting failure data. They are devoted for collecting failure data. Table 1 Template of the failure

data included in the Survey Form for the Subjective Survey Method

Name	Designation Department	Hostel & Room No.	Street & Quarters	Available Time (09.30)
Nature of complaint				
Contact Number (Optional)				

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Date: Signature: At the time which part of the snapshot analysis is presented to the University, the concept of failure data has been explained to the engineers. Following that explanation, the data collection is started. The data collection took about approximately one year from 1

Data Collection: It is recognised the importance of the accurate data for maintenance modelling using failure data concept. In this context data were collected at Kolej Universiti Islam Melaka (KUIM) using a methods, subjective survey (SS).For the SS method, a survey form was designed and delivered to the maintenance engineers at Hostel Building. After collecting a sample for the period of approximately one year dated from 1 July 2012 to 31 December 2012, the completed forms were collected back from the maintenance engineers[4]. The application of the objective method requires data, maintenance records of faults detected at inspection which should be sufficient in quantity and quality.The Subjective Probability (SP) estimation method has an advantage over the SS method, which is the speed, often reducing to an afternoon that which may otherwise require a survey spanning months and years. However, when a data collection survey is necessary to define maintenance problem and identify engineering solutions, which is typical to this case study, recommended estimating the failure distribution parameter using the SS method in addition to the SP method [4-7]. This research does not discuss the result and finding using the SP method since the main purpose of this study is to enhance the SS method. In this research the SS method is used in the first stage to estimate the failure rate distribution. Table 1.2 shows the questions related to the failure data.

July 2012 to 31 December 2012. Over the period, about 480 faults were collected. The classification of the high faults obtained is 135 as breakdown with 28.1% and 2 as detected min faults with 0,4 %. This detected fault includes the inspection and corrective actions.

Table 5: Result show Failure Distribution model

Delay Time Distribution	Parameter		Goodness of fit		Degree of Freedom
	$\hat{\alpha}$	$\hat{\beta}$	χ^2	$\chi^2_{0.05}$	
Exponential	-	5.309	3.20645	3.841	4
Gamma	13.7277	0.3868	742.543	3.84	3
Weibull	2.8535	0.4885	54.3362	5.991	3
Normal	5.7135	8.6064	44.5165	5.991	3

$\chi^2 = 44.5165$ and $\chi^2_n = 5.99$ and of gamma distribution shows higher value of $\chi^2 = 742,543$ and $\chi^2_n = 3.842$. Therefore, traditional approach concludes that the best fit failure distribution follows the exponential distribution. In the new approach result, the shape p, for exponential test is determined and the value of $\chi^2 = 3.206$ and $\chi^2_n = 3.841$ This result indicates that the best fit of the failure time (Table 1.5) also follows the exponential distribution (refer to estimation of shape parameters. This result proved that the approach proposed for failure distribution is exponent can be used as a practical technique in determining the best fit failure distribution in Hostel building maintenance in Malaysia University.

Summary: In this paper, a new approach to determine the best fit distribution is proposed. The basic idea in the approach is determine the shape parameters, exponential distribution test. From the shape parameters, p, the best fit distribution of failure time can be predicted [9-12]. Numerical example showed a similar result for both of traditional approach and the new approach. Simpler calculation steps to determine the best fit distribution is the main advantages by using a MLE and Goodness of a Distribution Fit approach compared to approach that used require more calculation steps. This new approach can assist engineers to reduce the time analysis and the result is valid for maintenance strategies purposes [11-12].

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