Failure Distribution of the University Hostel Building

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Abstract—**In University hostel maintenance, failure of the component and equipment of University Hostel building became have a major impact on the high cost of university. Therefore, there is a need to have an optimal maintenance strategy such as replacement, repair and inspection. Before that, if any optimal maintenance strategy can be implemented failure distribution and the parameters of the hostel building component need to be identified. The main objective in this paper is to propose a parameter failure distribution for University Hostel building maintenance management. The method proposesapproachGoodness of a Distribution Fit and Maximum Likelihood Estimator (MLE) techniques in identifying the failure distribution and the parameters for hostel building component. The approach proposed can improve maintenance engineers to use failure data 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 failure distribution parameters are applicable to be applied in maintenance optimisation analysis. This is carried out by approach with a case study.**

Index Terms—**Maximum likelihood estimator, goodness of a distribution fit and failure distribution.**

I. 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. [2], [3] study on the consequences of mis-specifying the form of the failure

distribution of inspection 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.

II. 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 [5]-[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].

III. 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 χ2 (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].

IV. Estimation Based on the Subjective Survey Method

The samequestionnaire used for collection snapshot data is also used for collecting failure data. They are devoted for collecting failure data. Table I shows template of the failure

data included in the Survey Form for the Subjective Survey Method.

TABLE I: 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)					

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 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.
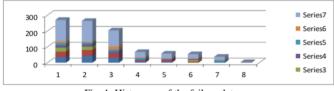

Fig. 1. Histogram of the failure data.

V. 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 method, 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.

TABLE II: FAILURE DATA

		CAUSES OF FAULTS OF CIVIL							
		July	Augus	Sept	Oct	Nov	Dec	TOTAL	PERCEN
TOTAL FAULT									
COMPONENT NAME/ AREA OF FAULT	Lamp	35	35	25	15	14	11	135	**28.1**
	Door	43	37	21	16	10	5	132	**27.5**
	Sink	30	27		15	12	18	102	**21.3**
	Shower	7	6		7	10	4	34	**7.1**
	Window	7	11		3	4	4	29	**6**
	Pipe		7	10	7		3	27	**5.6**
	Toilet	6				9	4	19	**4**
	Bed		1		1			2	**0.4**
PERCENT		128	124	56	64	59	40	480	

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. Fig. 1 shows the sample histogram of failure data.

Table II shows a sample of failure data based on component/area of fault versus causes of faults.

VI. IDENTIFICATION THE BEST FIT FAILURE DISTRIBUTION AND ITS PARAMETERS

Table III shows mean time to failure data collection from university hostel building based on daily basis.

TABLE III: MEAN TIME TO FAILURE DATA COLLECTION FROM UNIVERSITY HOSTEL BUILDING

0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	15.75
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	0.1067	2.16	7.3044	12.296	18.03
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	18.03
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	18.03
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	18.03
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	18.03
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	2.16	7.3044	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	2.16	12.296	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	2.16	12.296	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	2.16	12.296	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	7.3	12.296	15.75	34.31
0.1067	0.1067	0.1067	0.1067	2.16	7.3	12.296	15.75	34.31

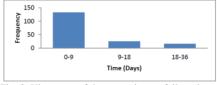Table IV shows the simulation calculation for goodness of fit data distribution.

Fig. 2. Histogram of the mean time to failure data.

Fig. 2 shows the Histogram of mean time to failure data.

TABLE IV: SIMULATION CALCULATION GOODNESS DISTRIBUTION

j	interval	upperbound	nj-number observed	probability	Expected value	(nj-npj)^2/npj
1	0-9	9	133	0.82	142	0.577960643
2	9-18	18	34	0.15	26	2.407801825
3	18-36	inf	7	0.03	6	0.220683623
k= 3	n=		174	1.00	chisq calculate	3.206446091

Hipotesis   Ho - distribution follow exponent
H1- distribution not follow exponent

compare with chisq statistic

dof = 3-1-1	2.00
alfa	0.05
chisqfrm table	3.84

lambda (MLE)	mttf
0.18835939	5.309

result   accept Ho because chisq calculate less than chisq from table

VII. DISCUSSION

Table V shows the result of potential distribution which can represent failure distribution for hostel facilities maintenance.

TABLE V: RESULT SHOW FAILURE DISTRIBUTION MODEL

Delay Time Distribution	Parameters		Goodness of Fit		Degree of Freedom
	$\hat{\alpha}$	$\hat{\beta}$	χ^2	χ_n^2 -0.05	
Exponential	-	5.309	3.2064	3.841	4
Gamma	13.7277	0.387	742.54	3.84	3
Weibull	2.8535	0.489	54.336	5.991	3
Normal	5.7135	8.606	44.517	5.991	3

The purpose of parameter and Goodness of fit are to suggest which distribution has to be chosen when the test is accepted and possibly a tied among them. The selection of distribution is according to the lowest value of χ^2 and χ_n^2. These results prove that the distribution parameter for hostel building management in Malaysia. Distributions. The index of fit chisq from table 1.6 less 3.84 than the chisq calculated is 3.206446091, mean that selecting pattern best fit failure distribution follows the exponential distribution failure rate data hostel building component to compare other distribution of weibull, normal and gamma distribution test present the values of parameter 2.8535,04885 ,5.7135, 8.6064 and 13.7277 , 03868, respectively. The goodness of fit , of weibull distribution shows higher value of χ^2 = 54.332 and χ_n^2 = 5.991, of normal distribution shows higher value of χ^2 = 44.5165 and χ_n^2 = 5.99, and of gamma distribution shows higher value of χ^2 = 742,543 and χ_n^2 = 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 χ^2 = 3. 206 and χ_n^2 = 3.841

This result indicates that the best fit of the failure time (Table V) 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

VIII. CONCLUSION

In this research, the parameter fit distribution is proposed. The basic facts in this approach can be determinedby the shape parameters, for example exponential distribution test. From the shape parameters, the fit distribution of failure time can be predicted [9]-[11]. Simpler calculation steps to determine the best fit distribution is the main advantages by using a MLE and Goodness of a Distribution Fit. This approach can assist engineers to reduce the time analysis and the result is valid for maintenance strategies purposes [12]-[15]. As a part of the future research, the indicator pattern of parameter for University hostel building component maintenance can be proposed to improve the accuracy by applying Artificial Intelligence (AI) techniques.

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