

## SOME PROPERTIES OF BI-WEIBULL DISTRIBUTIONS

(Beberapa Sifat Taburan Dwi-Weibull)

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### ABSTRACT

In reliability, a Bi-Weibull distribution can be represented by a combination of two decreasing, constant or increasing failure rate functions. Several versions of Bi-Weibull distributions can be found but these versions differ in the way in which the two Weibull distributions were combined and in the number of parameters specified. In this paper we determine the Bi-Weibull distribution from a combination of two Weibull distributions each having 2 or 3-parameters. We also determine the probability density, cumulative distribution, survival and hazard functions of the 4, 5, and 6-parameter Bi-Weibull distributions. The result is that by increasing the number of parameters would give the distribution more flexibility. An application of the 4-parameter Bi-Weibull distribution is also included using real data.

*Keywords:* Bi-Weibull distribution; Weibull distribution; survival function; hazard function

### ABSTRAK

Dalam bidang kebolehpercayaan, taburan Dwi-Weibull boleh dibina melalui gabungan dua fungsi kadar kegagalan yang menurun, malar atau menokok. Beberapa versi taburan Dwi-Weibull boleh diperolehi tetapi versi yang diketengahkan ini berbeza daripada cara bagaimana dua taburan Weibull itu digabungkan dan mengenai bilangan parameter yang ditentukan. Dalam makalah ini dibincangkan cara untuk menentukan taburan Dwi-Weibull daripada campuran dua taburan Weibull yang mempunyai 2 atau 3 parameter. Seterusnya ditentukan ketumpatan kebarangkalian, taburan kumulatif, fungsi kemandirian dan fungsi bahaya bagi taburan Dwi-Weibull yang mempunyai 4, 5, dan 6 parameter. Hasil yang diperolehi menunjukkan bahawa apabila bilangan parameter ditingkatkan, ia akan memberi kelonggaran kepada taburan berkenaan. Satu penggunaan taburan Dwi-Weibull 4-parameter dengan menggunakan data sebenar juga diberikan.

*Kata kunci:* Taburan Dwi-Weibull; taburan Weibull; fungsi kemandirian; fungsi bahaya

### References

- Al-Fawzan M. A. 2000. Methods for Estimating the Parameters of the Weibull Distribution. King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia.
- Almeida F. & Louzada-Neto F. 2000. Modelling Survival Data with Bathtub-Shaped Hazard Via Bi-Weibull Hazard Model. International Biometric Society, 4<sup>th</sup> RBRAS meeting, 20-21 July- Brazil.
- Berger J.O. & Sun D. 1993. Bayesian Analysis for the Poly Weibull Distribution. Journal of the American Statistical Association, **88**(424): 1412-1418.
- Castillo E., Hadi A.S., Balakrishnan N. & Sarabia J.M. (2005). *Extreme Value and Related Models with Applications in Engineering and Science*. Hoboken: John Wiley and Sons. Inc.
- Davison A.C. & Louzada-Neto F. 2000. Inference for the Poly Weibull Model. *Journal of the Royal Statistical Society, Series D: The Statistician*, **49**: 189-196.
- Endo E. & Tamura Y. 1997. Technological Progress Model of Crystalline Silicon Solar Cells by Using By Logistic Curve. Electro-technical Laboratory, Umezono, Tsukuba Ibaraki, 305 Japan.
- Hanagal D.D. 2005. *A Multivariate Weibull Distribution*. Department of Statistics, University of Pune, India.
- Heckert A. 2003. <http://www.mathwave.com>, alan.heckert@mist.gov (10 April 2008).

- Kies J.A. 1958. The Strength of Glass. Naval Research Lab. Report No. 5093, Washington D.C.
- Merran E.S., Hastings N. & Peacock B. 2000. *Statistical Distributions*. Third Edition, Wiley Series in Probability and Statistics.
- Murthy D.N.P, Xie M. & Jiang R. 2004. *Weibull Models*. Hoboken: John Wiley & Sons, Inc.
- Phani K.K. 1987. A New Modified Weibull Distribuion Function. *Communications of the American Ceramic Society* **70**: 182-184.
- Smith F. & Hoepfner D.W. (1990). Use of the Four Parameter Weibull Function for fitting fatigue and compliance calibration data, *Engineering Fracture Mechanics* **36**: 173-178.

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