Editorial

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Biographical notes: Bharatendra Rai is an assistant professor at the Charlton College of Business, University of Massachusetts-Dartmouth. He completed his PhD in industrial engineering from Wayne State University, Detroit, and later worked at Ford as a quality/reliability engineer. His research interests include quality/reliability engineering, robust design, and applications in forecasting, data mining, and pattern recognition. He has a Master's in quality, reliability, and OR from Indian Statistical Institute and another Master's in statistics from Meerut University. He also worked at Indian Statistical Institute as an SQC specialist providing consulting to Indian industries during 1993–2000. He is an author of over 40 journal/conference papers and serves on the editorial board of several international journals.

Om Prakash Yadav is an assistant professor in the Industrial and Manufacturing Engineering Department at North Dakota State University, USA. He completed his PhD in industrial engineering at Wayne State University, Detroit, USA. He has over 20 years' experience teaching, research, industry, and consulting in India and USA. He has spent more than three years of his working experience in the auto industry in North America. He received his BSc in mechanical engineering from Malaviya National Institute of Technology (MNIT), Jaipur (India) and MSc in industrial engineering from the National Institute of Industrial Engineering (NITIE), Bombay (India). He has published over 30 research papers in the area of quality, reliability, product development and operations management. His research interests are focused around product development, reliability and quality engineering, concurrent engineering and manufacturing systems engineering.

This special issue aims to provide research articles that capture and address interesting issues related to the modelling and analysis of automobile warranty data. Over recent years it has been seen that the yearly warranty cost of major automobile companies and their suppliers has run into billions of dollars. In addition, market-driven needs for wider warranty coverage, in terms of time and

mileage, expose these companies to the risk of higher warranty spending. Warranty cost reduction programmes have thus become a major objective and challenge in these companies. At the same time, warranty data that capture vehicle failures in true field conditions provide a rich source of information to design, manufacturing, and service engineers seeking reliability and robustness improvements leading to warranty cost reduction. Therefore, developing sound modelling and analysis methods for warranty data has become an important field of research with practical implications.

This special issue consists of seven papers by leading researchers and practitioners working in the area of modelling and analysis of warranty data. The paper 'A constrained quadratic spline as a model for the cumulative hazard function', by Krivtsov, Kolmanovsky and Davis, argues that very often traditional probability distributions do not lend enough flexibility in modelling of real-world lifetime data. They, therefore, propose a constrained quadratic spline, with a single free knot as a model of the cumulative hazard function for increasing failure rate distributions. They illustrate the proposed approach with fleet battery and an axle seal component data. The results obtained indicate a better approximation to actual data, compared with traditional probability distributions.

Component or sub-system suppliers often encounter situations where, at the time of developing warranty claims forecasting models, they do not have sales date data. In their paper, 'Modelling automotive warranty claims with build-to-sale data uncertainty', Kleyner and Sanborn propose a Monte Carlo simulation procedure to generate the missing time from build to sale data. They discuss different simulation algorithms and analyse their accuracy by comparing simulated data with actual data, based on various vehicle platforms.

The paper 'Reliability assessment based on two-dimensional warranty data and accelerated failure time model', by Baik and Murthy uses an accelerated failure time (AFT) model to capture the effect of usage rate on the time to failure. The authors classify the use rate among customers into light users, normal users, heavy users and very heavy users, and propose a methodology for reliability assessment that consists of three steps. The proposed approach is illustrated in detail, using simulated data.

The next paper, entitled 'Product warranty: modelling with 2D-renewal process', by Corbu, Chukova and O'Sullivan, deals, as the name suggests, with the two-dimensional renewal process. It suggests an approach to test whether the available data can be considered as coming from a two-dimensional renewal process, and proposes a numerical procedure for the evaluation of the two-dimensional renewal function. They further illustrate its use for warranty cost analysis.

The paper 'Price-warranty length decision with Glickman–Berger model', by Manna studies the problem of joint optimal determination of product price and warranty length for the maximisation of manufacturer's profit. In the literature problems dealing with one-dimensional warranty are mostly reported. This paper re-emphasises the important role of the Glickman–Berger model, and also points out certain inaccuracies in the literature involving computation of warranty cost and methodology for model optimisation. The paper also proposes a procedure to extend the Glickman–Berger model for two-dimensional warranty.

Vehicles that are produced in any month get sold in that or future months. At the time of analysing warranty data, often the sale date of only those vehicles for which

warranty claims exist are known and the sale date of those vehicles that did not have reported failures is not available. The paper 'Modelling sales lag and reliability of an automobile component from warranty database', by Karim suggests lognormal distribution to be a good candidate to model sales lag and subsequent estimation of reliability from warranty data.

Failures can be broadly classified into hard and soft failures. For hard failures the gap between failure reporting and failure occurrence is expected to be small compared to soft failures. Thus, warranty claim data are more accurate for hard failures compared to the soft failures. In the paper titled 'Non-parametric hazard rate estimation of hard failures with known mileage accumulation rates in vehicle population', Rai and Singh provide a stepwise methodology with examples to develop non-parametric component/sub-system level hazard rate estimates when dealing with hard failures.

The Guest Editors would like to thank all the authors for submitting and revising papers for the special issue. We also wish to extend our sincere thanks to those individuals who acted as reviewers for the papers submitted to this issue. Lastly, the Guest Editors would like to express their sincere appreciations to Dr Zissimos P. Mourelatos, the Editor-in-Chief, for his advice, help and support to make this special issue come into being.