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FOREWORD

SPECIAL ISSUE ON RELIABILITY, RISK AND MAINTENANCE

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Mathematical models in maintenance are an old topic: more than fifty years ago, researcher Efrain Turban published a paper in the prestigious journal "Management Science" (Turban, 1967) that analysed a national survey for identifying the gaps between the theory and practice. Specifically, their main question was why very few maintenance decision makers use the mathematical models to solve the main problems facing them.

Surprisingly, however, the gap mentioned by the author is still present today. Fair to say that the gap is becoming smaller, which may be a result of some factors.

Maintenance has earned a high level of reputation thanks to the recognition of its relationship with the good performance of systems. Failures in production processes and service delivery systems have very negative consequences, in financial, reliability and safety dimensions. As a result, the arsenal of models and approaches to handle maintenance problems has been increased substantially. A large spectrum of new techniques have been emerging from different areas and are being associated with classical operations research approaches applied in maintenance and reliability.

This special issue brings a blend of the important problems on maintenance and reliability being treated under the field of operational research.

Despite our objective here is not to identify the current impact of the models in practical life, we bring inside this special issue a review about maintenance effectiveness. The authors Lucas

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Costa and Cristiano Cavalcante, in the paper entitled "A Review on the Study of Maintenance Effectiveness" provide an excellent review of the existing literature on the Maintenance Effectiveness. First, the authors discuss the various conceptions and understandings of maintenance effectiveness. Afterwards, the authors define "maintenance effectiveness", as the level to which a maintenance policy fulfills its pre-defined objectives or optimizes general maintenance actions, hence improving the productive activities of an organization. The authors note that the increase in the number of papers is followed by a concern about the applicability of ideas and concepts to these papers. Thus, according to the authors, a tendency of the study of effectiveness on maintenance appears to be more explored in case-oriented mode, instead of proposing general and broad methods for evaluation. Lastly, another important finding is that the more catastrophic the failure a system is subject, the higher the level of the development of protective actions and evaluation processes of maintenance effectiveness for this system.

Beside the review paper, this special issue of Pesquisa Operacional presents other five papers, that we comment briefly as follows. The paper "A comparison of the performance of the geometric process and its extensions" by Yin and Wu compares the performance of some GP variants on real datasets based on the Akaike Information Criterion (AIC). The main motivation for the paper stems from the importance of the Geometric process (GP) in reliability and maintenance and the need for a better investigation of the performance of those extensions on fitting real datasets. This is because the GP is gaining popularity and many new extensions more recently, however the investigation of its performance is restricted to comparisons with that of the renewal process and that of the non-homogeneous Poisson process.

The paper "Age-based replacement with imperfect repair and risk as low as reasonably practicable" by Joyce Araújo, Rodrigo Lopes and Philip Scarf seeks to study how imperfect maintenance actions have consequences in terms of risk. To model the imperfect maintenance actions, it was considered that the maintenance actions can be perfectly or minimally repaired depending on the skills of the maintenance team. To consider the risk in maintenance actions, the maintenance policy considered the ALARP principle (as low as reasonably practicable) defining acceptable risk limits integrated into the maintenance policy. The article contributes to the literature combining the uncertainty of the quality of the maintenance action and the ALARP principle. Through the results maintenance managers can analyze the impact of the quality of maintenance actions on risk acceptance limits.

The authors Pauli Garcia, Luiz Gavião and Gilson Lima, in the paper entitled "Reliability allocation considering risk indicators and their uncertainties through probabilistic composition of preferences" introduce the use of probabilistic composition of preferences to solve the problem of reliability allocation. Despite the reliability allocation problem being a very well consolidated problem, some subjectivity associated with the opinions of specialists as a part of some solution models for this problem remains an important element that is not well discussed in the existing literature. In this paper, the authors consider that the specialists' opinions are modeled by a probability distribution and thus no longer consider the indices themselves. For the reliability al-

location problem the authors propose a seven steps method centered on probabilistic composition of preferences (PCP).

The paper, "A Diagnostics and Prognostics framework for Multi-Component Systems with Wear Interactions: Application to a Gearbox-platform" by Roy Assaf, Phuc Do and Phil Scarf brings a novel framework for diagnostics and prognostics for multi-component systems with wear interaction between components. The framework is illustrated and verified using an experimental platform that generates real data. The experimental results show the importance of modeling wear interactions in both diagnostics and prognostic processes of multi-component systems.

The authors Pauli Garcia, Tiago Neves, Carlos Jacinto, Vanessa Garcia and Gustavo Motta in the paper entitled "Proposal of an optimal redundancy and reliability allocation approach for designing complex systems" demonstrate the efficacy of a new approach that unifies the two more useful approaches in the solution of reliability allocation problem. In the first approach the redundancy allocation is the target and the reliability metrics of the components are known, while in the second approach the reliability metrics are not known and have to be determined through an optimization algorithm. Additionally, the authors treat the developing or improving technology and its impact on reliability of components to better address the expected development costs and failure costs on the problem of optimal combined allocation of redundancy and reliability problem.

Finally, we close this introductory paper of this special issue with thanks to the authors who submitted their papers, the anonymous reviewers, and the editor of Pesquisa Operacional for their generosity in assisting us during all the steps until we finish this special issue.

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