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Fuzzy Availability Analysis of a Battery Production System

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Abstract : In today's competitive market, there are many alternative products that can be used in similar manner and purpose. Therefore, the utility of the product is an important issue for the preferability of the brand. This utility could be measured in terms of its functionality, durability, reliability. These all are affected by the system capabilities. Reliability is an important system design criteria for the manufacturers to be able to have high availability. Availability is the probability that a system (or a component) is operating properly to its function at a specific point in time or a specific period of times. System availability provides valuable input to estimate the production rate for the company to realize the production plan. When considering only the corrective maintenance downtime of the system, mean time between failure (MTBF) and mean time to repair (MTTR) are used to obtain system availability. Also, the MTBF and MTTR values are important measures to improve system performance by adopting suitable maintenance strategies for reliability engineers and practitioners working in a system. Failure and repair time probability distributions of each component in the system should be known for the conventional availability analysis. However, generally, companies do not have statistics or quality control departments to store such a large amount of data. Real events or situations are defined deterministically instead of using stochastic data for the complete description of real systems. A fuzzy set is an alternative theory which is used to analyze the uncertainty and vagueness in real systems. The aim of this study is to present a novel approach to compute system availability using representation of MTBF and MTTR in fuzzy numbers. Based on the experience in the system, it is decided to choose 3 different spread of MTBF and MTTR such as 15%, 20% and 25% to obtain lower and upper limits of the fuzzy numbers. To the best of our knowledge, the proposed method is the first application that is used fuzzy MTBF and fuzzy MTTR for fuzzy system availability estimation. This method is easy to apply in any repairable production system by practitioners working in industry. It is provided that the reliability engineers/managers/practitioners could analyze the system performance in a more consistent and logical manner based on fuzzy availability. This paper presents a real case study of a repairable multi-stage production line in lead-acid battery production factory in Turkey. The following is focusing on the considered wet-charging battery process which has a higher production level than the other types of battery. In this system, system components could exist only in two states, working or failed, and it is assumed that when a component in the system fails, it becomes as good as new after repair. Instead of classical methods, using fuzzy set theory and obtaining intervals for these measures would be very useful for system managers, practitioners to analyze system qualifications to find better results for their working conditions. Thus, much more detailed information about system characteristics is obtained.

Keywords : availability analysis, battery production system, fuzzy sets, triangular fuzzy numbers (TFNs)
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