14th International Symposium on Inventories – Budapest, Hungary – August 20-25, 2006

SYSTEM AVAILABILITYOOPTIMISED INTEGRATING MAINTENANCE INTERVAL, SPARES AND REPAIR CAPACITY

Karin de Smidt - Destombes
TNO Physics and Electronics Laboratory, The Netherlands

Research was done to determine the system availability of k-out-of-N systems as a function of the time between two succeeding maintenance instances, the number of spare parts and the repair capacity. We developed models for a single k-out-of-N system for which the components fail exponentially (no ageing) and for a single system of which the components do show signs of ageing.

We also developed a model for an installed base of multiple k-out-of-N systems with and without ageing components.

With these models to determine the system availability, we are still not capable of simultaneously finding the maintenance interval, number of spares and repair capacity such that the costs for obtaining a specified availability level are as small as possible. Due to dependencies between the parameters it is not easily done. For instance, when the maintenance interval is increased, the number of failed components in the system will also increase. In order to achieve a certain availability level (which implies that the maintenance period cannot be too long) we also have to increase the number of spares or we have to increase the repair capacity. At the same time, a decrease of the maintenance interval implies a more stable workload for the repair shop, which means that we can do with less spares or less repair capacity. Another trade-off possibility is found between the spares and repair capacity. If the amount of spares is increased, it is possible to decrease the repair capacity without increasing the maintenance duration. The same holds the other way around.

Each combination of parameters gives another value of the system availability and also implies different costs. Because of these dependencies we cannot determine the parameters sequentially in order to find the lowest costs for a specified availability level.

At first sight the METRIC methodology (marginal analysis) seemed applicable to solve this problem. However, we encountered some difficulties with applying this method. This was caused by non-convexity issues. For the model with the installed base we had an extra difficulty because the time between two maintenance instances is not a discrete parameter but a continuous one. We present an adjusted method, based on the marginal analysis, to find this parameter setting.
We show both methods and compare them to complete enumeration. The results we find have less than 0.2% higher cost than the optimal parameter setting in case of the single system. For the installed base the mean difference with the optimal parameter setting is less than 0.83%.