TKI DINALOG
Dutch Institute for Advanced Logistics

AFTER-SALES SERVICE LOGISTICS

DYNAMIC SPARE PART CONTROL FOR PERFORMANCE-BASED SERVICE CONTRACTS

A discrete-event simulation study

Thales in the Netherlands is primarily involved in naval defence systems, among others radar systems. A quite new concept within Thales is the offering of after-sales services with performance-based service contracts. To meet the performance requirements stated in the contracts, Thales needs to maintain a supply chain network for the handling of spare parts that reduces the risk of system downtime at the customer, possibly followed by penalties for underperformance. The estimated failure rates of parts form an important indicator of the spare part stock levels, but the accuracy of those estimates is unknown. Therefore, operational failure data will be gathered in the coming years to improve failure rate estimates. This may also lead to stock level updates. Jasper van den Bussche, MSc student at the University of Twente, developed a tactical decision model that clarifies how to handle the incoming failure data, and to dynamically adapt stock levels accordingly.

SIMULATION MODEL FOR SCENARIO ANALYSES

Uncertainty in the actual failure rates of parts may yield an increased risk of backorders, downtime and penalties if the actual failure rates underlying initial spare part stock levels appear to be higher than originally estimated. As the supply chain performance will be measured on a yearly basis, the stock levels should be increased to mitigate the risk of penalties. But if the actual failure rates appear to be lower, inventories will be too high and eventually be redundant. Some aspects complicate the situation:

- The occurrence of failures is random, and we do not know whether several failures in a short time frame indicate a different failure rate or are just due to statistical fluctuations.
- Little failure data is expected to be gathered due to relatively low failure rates and a small installed base at Thales. The reliability of updated failure rate estimates can be low, leading to risks of underestimation and overestimation.
- Parts in the radar systems are rather expensive due to uniqueness and customer-specificity of the parts. That's why much costs are involved if stock levels would be increased. In addition, rather long lead times apply, so inventories cannot quickly be raised if necessary.

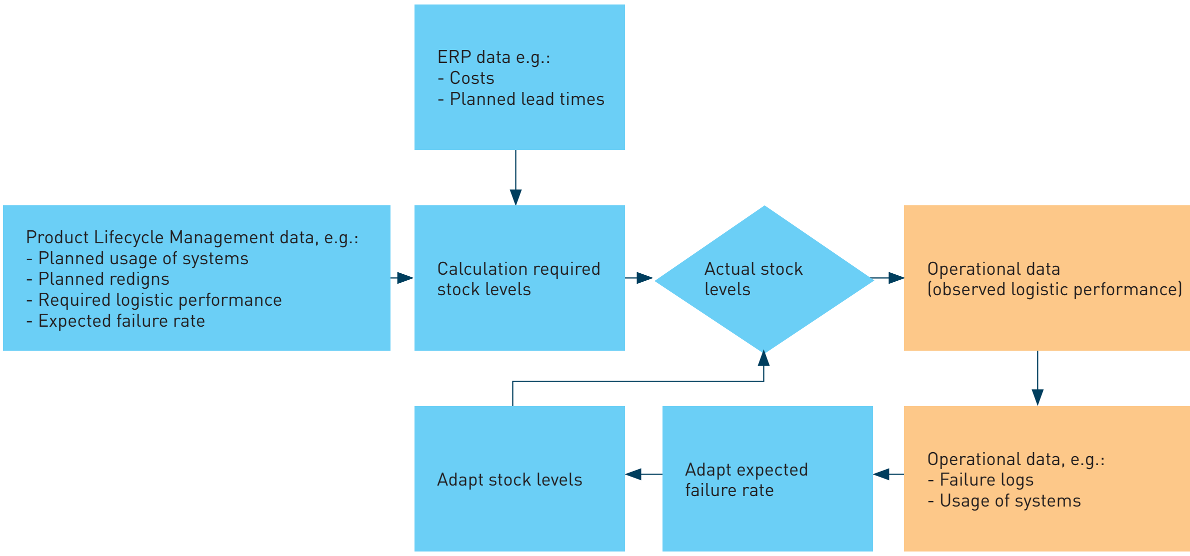

Figure 1 Schematic overview of the processes to calculate and adapt stock levels

This research addresses the trade-off between stock level intervention costs (i.e. holding cost, part cost, order cost) and potential penalty costs/savings by means of simulation-based scenario analyses to understand what might happen in practice. Besides increasing or decreasing stock levels, keeping or adapting the initial stock levels belong to the options as well.

A well-known failure rate updating model in the literature that can form the basis for stock level interventions and can deal with limited amounts of data is the Bayesian estimation. This model combines the initial estimate of the failure rate with failure data to arrive at an updated estimate. The sensitivity to the failure data can be tuned with a certain weight factor. Another setting of the model includes the waiting time before starting the updates.

To test different Bayesian settings while considering different part characteristics like demand and price, a simulation model has been developed to run possible scenarios and draw conclusions about the best practice.

RESULTS

According to the simulation runs, there are thresholds in place for the initially estimated failure rates before potential savings in penalty costs outweigh the costs for dynamic stock level interventions. The thresholds depend on the part price.

Part price	Estimated average number of failures per year
€1.000	0,020
€50.000	0,774
€100.000	2,406

Table 1 Thresholds for estimated average number of failures per year

It is more efficient, in terms of penalty costs and stock level intervention costs, to rely more heavily on the initial estimate in the Bayesian estimation if the part price is relatively high (€50.000 and €100.000) and/or if the estimated average failures per year is relatively low (⩽ 0,475). The most efficient starting times of the updates is at the end of the first year, and after 3 or 4 failures if the average failures per year is below 2,406 respectively equal or higher than 2,406.

Increasing initial stock levels is mainly interesting for relatively cheap parts (€1.000). For relatively expensive parts (€50.000 and €100.000), it is not cost-efficient to increase initial stock levels, provided there is no information about the actual failure rates before starting the service contracts and data collection.

For parts with relatively high failure rates (⩾ 2,406 failures per year), it might be interesting to shorten lead times instead of adding parts on stock but further research into corresponding costs is needed.

Topsector Logistiek

FACTS

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ProSeLoNext project – Powered by:

This activity was co-financed by the Netherlands Organization for Scientific Research (NWO), on behalf of the Ministry of Infrastructure and Water Management.