A METHODOLOGY FOR DESIGN OF ROBUST SERVICE NETWORKS

Rajesh Piplani and Ashish Saraswat, Center for Supply Chain Management, 50 Nanyang Ave., Nanyang Technological University, Singapore, mrpiplani@ntu.edu.sg
Rommert Dekker, Rotterdam School of Economics, Erasmus University Rotterdam, Netherlands

ABSTRACT

From time-to-time organizations need to re-look at their service networks and optimize them from the point of view of delivery lead-times, fill-rates and cost of serving the customers, as the demand grows in new regions and suppliers follow the manufacturing/assembly facilities relocated to cheaper locations. In this research we develop a methodology for design of service networks for repair and refurbishment of Electronics and IT products. The solution to the network design problem is the locations of facilities and flows of products and modules among those facilities that result in the least total overall cost, while satisfying the capacity and flow constraints.

This problem can be formulated as a mixed-integer linear program (MILP) and can be solved using commercial software (such as CPLEX). For this stage of our research, we worked with a company providing after-sales support to their computer manufacturing operations spread across Asia, including Australia and Japan. As the demand for their products was growing at a tremendous rate in China resulting in the need for more after-sales support there, the company wanted to re-engineer their existing network to handle this increased demand.

We developed the model of their service network and found an optimal network design. The network we modeled included retail and service centre locations in 16 countries in Asia, 126 different modules and 24 different OEM or repair vendor locations. The recommendation of the optimal network design was to merge the two existing China warehouses into one distribution centre, located in Shanghai.

This consolidation of warehouse operations may affect component flow in other parts of the network also, as flows from countries such as Thailand, Hong Kong and Taiwan may end up going to the China DC directly, rather than being routed through Singapore, as is the case in the existing network. Unlike the forward logistic network, in the reverse network, many parameters are hard to predict and lead to uncertainties in the network design. Some of the examples of these uncertainties include the amount of products coming back for repair, fraction of products under warranty, fraction of out-of-warranty products that are repaired, and so on. Sensitivity analysis is one approach to test if the optimal solution is robust to changes in these parameters (one parameter at a time) but is a reactive approach. Robust optimization is a proactive approach that results in a configuration which is near-optimal for all the scenarios. The approach entails first identifying all the parameters that are uncertain, and the range over which they may vary. Selection of the number of levels to be considered over each parameter range then leads to the definition of all the possible scenarios the network may encounter.

The uncertain parameters selected in this research are the supply (of faulty products), fraction of products under warranty, and repairable and refurbishment fractions. The next step is to develop the methodology for robust optimization (RO) of the service network.

Towards this end, we chose the min-max regret objective for the RO model; this ensures that the resultant robust network would not be too far from optimal for any of the scenarios. First the MILP problem corresponding to each scenario is solved, resulting in as many network designs (as the number of scenarios). Then the Robust Optimization problem is solved to minimize the maximum regret (distance) between the robust network and the network for each scenario.