SOME STUDIES IN THE DESIGN OF A TWO-ECHELON REPAIR-INVENTORY SYSTEM IN THE PRESENCE OF FORBIDDEN REGIONS

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Some Studies in the Design of a Two-Echelon Repair-Inventory System in the Presence of Forbidden Regions

by

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CERTIFICATE

The thesis entitled **Some Studies in the Design of a Two-Echelon Repair-Inventory System in the Presence of Forbidden Region** being submitted by Major K.R. Seshasayee, to the Indian Institute of Technology, Delhi, for the award of the Degree of **Doctor of Philosophy,** is a record of bona fide research work carried out by him. He has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which has attained the standard required for a Ph.D.degree of this Institute. This work has not been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

The management and control of recoverable items inventory of sub-system is of vital importance for the efficient performance of the system since the bulk of the spare parts inventory investment is in recoverable items in any large industrial activity, military organizations etc. Also, since the operating systems are geographically widespread in these organizations the failed recoverable item is replaced from their stock pool in the second echelon locations called bases while the first echelon location called the depot stocks the items for issue to bases and also has repair facility to repair failed recoverable items. So far in all the models available, the decision variable that has been considered is allocation of serviceable items to each of the locations such that the total expected backorders are minimized subject to a budgetary constraints. However, there is a need to consider the location of the depot also as a decision variable when designing a repair-inventory system for a new equipment or to redesign the existing system. Also, the average repair cycle time of the recoverable item at the depot and the failure rate of the recoverable items at the bases are two other controllable decision variables to have an integrated design for a two-echelon repair inventory system. This study is devoted to developing models of this nature and solution methodologies to solve the models.

The locational decisions of the problem considered get further complicated when the optimal (near optimal) locations obtained may be an existing structure, a reserved forest, airport, lake etc. Hence, forbidden regions which neither permit a location in their interior nor allow passage through them are to be incorporated as constraints in the models. In order to facilitate the computations of shortest constrained distances in the presence of forbidden regions, algorithms were developed to compute the shortest constrained distances between any two points in the plane in the presence of forbidden region(s) with shape of a single convex polygon/ a single circle/two convex polygons/two circles. Where available test problems for a single facility location problems in the presence of forbidden regions were solved.

The location-allocation models for a two-echelon repair-inventory system in the presence of each of the forbidden region(s) mentioned above were developed and solved for a number of problems. The locational aspect of the model was solved using direct search technique due to Hooke and Jeaves since the objective function is non-covex and the alloctional aspect using iterative algorithms. The effectiveness of direct search technique was established by solving test problems for unconstrained location-allocation problems available.

In order to have an integrated design of a two-echelon repair-inventory system, the average repair cycle of a recoverable item at the depot and the expected failure rate of recoverable items at the bases are considered as decision parameters in addition to the location-allocation decisions and an integrated model was developed . An iterative algorithm was presented to solve the integrated model.

Some times, it may so happen that the optimal (near optimal) location for the depot obtained may still not be suitable to the management due to some internal organizational reasons and it may be desirable to have feasible alternative decisions at slightly higher costs. In order to facilitate this, iso-cost curves around the optimal (near optimal) location at steps of increasing total cost levels are drawn. An algorithm was developed to determine the iso-cost points for a desired objective function value. A number of curves were drawn for each problem. Throughout this work the performance criterion considered is the total expected system cost per period and the constraints are in the form of forbidden regions. An attempt has been made in this work to develop realistic models and solve them for an integrated design of a two-echelon repair-inventory system.

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