On Optimisation Of Integrated Production-Inventory Systems

by

UPENDRA KUMAR
Mechanical Engineering Department

Submitted
in fulfilment of the requirements of
the degree of Doctor of Philosophy

to the

Indian Institute of Technology, Delhi

March 1980

CERTIFICATE

The thesis entitled "On Optimisation of Integrated Production-Inventory Systems" submitted by Mr. Upendra Kumar to Indian Institute of Technology, New Delhi, for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out by him under my guidance and supervision. The results presented in this thesis have not been submitted elsewhere for the award of any degree.

(PREM VRAT)

Associate Professor of Industrial Engg.
Deptt. of Mechanical Engg.
Indian Institute of Technology
New Delhi

ACKNOWLEDGMENTS

It is with a sense of deep gratitude that I wish to thank Prof. Prem Vrat for his fraternal guidance in steering this work to its completion. I feel highly indebted for the encouragement received from him from time to time, specially during the pessimistic phases of the work.

I should like to acknowledge the help rendered by my friends, in particular Mr. P. Jagdiswaran of BHEL, Delhi and Mr. A. Subash Babu of IIT Delhi.

I am grateful to the management of Bharat Heavy Electricals Limited, New Delhi for permitting me to carry out the research work at IIT Delhi on part-time basis.

28.3.'80

(UPENDRA KUMAR)

ABSTRACT

In this thesis an attempt has been made to investigate production-inventory systems with a view to analyse the inter-relationships among the associated parameters and arrive at an overall optimal solution for the system. The importance of an integrated approach towards deciding the optimal inventory and production policy is highlighted. Previous work done in this area has been critically reviewed and classified on the basis of the techniques employed. Further sub-classification is based on the environmental aspects of the problem.

Mathematical models have been developed for single-item multi-stage production-inventory systems to minimise total system cost. These are based on the consideration that the value of the product increases as it advances along various stages of production. Two deterministic models have been developed to determine the Economic Batch Quantity. One of these models considers the effect of batch-splitting and establishes an optimal batch-splitting policy. Quantitative decision criteria have been evolved to indicate whether to resort to pure batch production, split-batch production or flow-line production with unit-by-unit shipment between various production stages. Classical models are shown as special cases of these models.

Another model for single-item multi-stage case is developed for a stochastic environment. Demand is assumed to occur at random intervals at the same rate whereas processing and setup times vary, each following exponential distribution with different means, 'One-for-one' ordering policy is assumed and optimal inventory policy is determined for each of the intermediate sture attached with every production stage. Implications of aggregating production stages into an equivalent single stage are discussed at length.

Examples have been included to demonstrate applications of these models. Sensitivity of the system to various parameters is also examined. The sensitivity analysis reveals that cost-curves are rather flat in the optimal zone.

An algorithm to study the effect of rejection allowance on single-item single-stage stochastic production-inventory systems is developed. Analysis of the results obtained using the algorithm shows that as the probability of manufacturing a defective item increase, the total system cost increases and the difference between maximum level and reorder level reduces, an observation which appears sound even intuitively.

A generalised computer simulation model has been constructed for multi-product multi-stage stochastic production-inventory systems. This is based on the assumption that interarrival times and sizes of demand, setup and processing times follow Erlang distributions. Also incorporated are effects of binomial rejections and machine break-downs, which are assumed to follow normal distribution. Simulation results are analysed from the point of view of the priority dispatching strategies and effect of environmental variability on system of performance. Results presented in the thesis provide useful insight into and predict the behaviour of the system in a plausible manner.

Substantial part of the work reported in this thesis has been published/presented by the author in various journals/conferences.

CONTENTS

CHAPTER Page
