Int j simul model 16 (2017) 1, 133-144
ISSN 1726-4529 Original scientific paper

OPTIMIZATION AND SIMULATION FOR AIRPORT EMERGENCY INVENTORY WITH REPLACEMENT

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Abstract
The paper assumes that the accident occurrence time is stochastic and emergency supplies is perishable, then two replacement stochastic models based on remaining lifetime and remaining quantity are first proposed. In order to identify the effectiveness of replacement strategy, two replacement-based stochastic models are compared with the general stochastic model that is non-replacement, measured by inventory level and total costs. A discrete-event simulation model is developed to demonstrate effects of occurrence time uncertainty, replacement ratios and distributed functions in occurrence time and demand. Sensitive analysis shows that the optimal decision is more sensitive to remaining quantity ratio as compared to remaining lifetime ratio. The paper shows that when decision-makers ignore occurrence time uncertainty and limited warehousing time, they may significantly miss better decisions. Further, simulation results demonstrate that different distributed functions in both occurrence time and demand lead to different inventory strategies.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: Occurrence Time Uncertainty, Emergency Supplies, Replacement strategy, Inventory Optimization

1. INTRODUCTION

Although civil aviation accident is event of small probability, the losses and fatalities are serious. For example, there were 92 accidents and 474 fatalities last year, which leads to big losses for companies and society. According to safety report from International Civil Aviation Organization (ICAO), about 70 % civil aviation accidents occurred around the airports, so the ICAO formulated a series of regulations for emergency supplies in the airport. The airports always reserve much more emergency supplies and replenish emergency supplies immediately after emergency response. Therefore, investments in airport emergency supplies are significant and a cause of financial concern and subsequent economic losses. Thus, minimizing the losses and the costs, while maintaining the constraint of service level, is the main purpose of the airport.

In this paper, we first propose replacement strategy and develop an integrated model of occurrence time uncertainty and limited warehousing time, capturing the effects of occurrence time uncertainty and replacement strategy on service level and total costs. Our designs of alternative inventory system are derived from two sources: (1) observations of emerging practices in returns processing and (2) previous researches on emergency supplies inventory management. We analyse a benchmark system where an airport emergency planner decides the inventory level with replacement strategy to minimize the total costs. We find that the inventory level in this benchmark system is not always higher or less than that in non-replacement setting. To understand how occurrence time uncertainty affects the inventory level, we setup the model with deterministic occurrence time and unlimited warehousing time, concluding that consideration of occurrence time uncertainty and limited warehousing time induces or reduces emergency inventory.