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Inventory management in a base-stock controlled serial production system with finite storage space

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ABSTRACT

We consider a serial production system controlled by the base-stock policy, in which customer demands must be satisfied immediately or it will be considered lost. Since the exact analysis is impossible for the general system, we present a phase-type approximation for a base-stock controlled serial production system. The numerical results indicate that this approximation provides good estimates for performance measures such as fill rate and mean queue-length distributions of each station. In addition, a cost model is constructed to determine the optimal base-stock level.

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1. Introduction

The purpose of supply chain management is to minimize operating costs while maintaining customer satisfaction. Three factors that cause uncertainty are widespread in the supply chain system. They are the difficulty in predicting customer demands, high inventory level, and an unstable manufacturing process (see [1]). Among them, difficulty in predicting customer demands is the main source of uncertainty. Therefore, businesses must maintain high inventory in order to satisfy unpredictable customer demands. Businesses use various production strategies or technological improvements, such as Total Quality Management (TQM), Enterprise Resource Planning (ERP), and 6 Sigma etc., to increase production efficiency. The main issue is to maintain Quality of Service (QoS) while reducing factors that cause uncertainty.

Due to the uncertainty and diversity of customer demands, manufacturers have switched from the traditional Build-to-Forecast (BTF) or Make-to-stock (MTS) strategies to Build-to-Order (BTO) or Make-to-Order (MTO) strategies. Taking the laptop computer assembly as an example, when a laptop computer company receives orders from Internet, it will pass these orders to the assemblers and ask them to have the product shipped immediately. A typical example of a detailed assembly process is shown in Table 1 with the maximum and minimum of operating time needed in each step. The laptop computers are stored in the warehouse after the testing step (the 6th step). In order to achieve 100% QoS, assemblers can prepare a lot of finished laptop computers in the warehouse, however, it is not cost-efficient and is unrealistic. As seen in Table 1, the total assembly time is between 31.88 h and 40.48 h. In stead of preparing a lot of finished computers, it is still possible to adopt a Build-to-order strategy if we start to assemble a new computer with plenty of time ahead. The assembler initially prepares some finished laptop computers in the warehouse, called base stock, and starts to assemble a new laptop computer when an order is received. This new one will used to fulfill the potential orders that arrive later. Another example can be seen in a fast-food restaurant. Customers coming to restaurant order their food and want to have it immediately. Fulfilling orders immediately can be done by preparing a lot of cooked food in the food rack, however, some of it may remain in the rack too long to sustain its original quality. Therefore, only a certain number of newly cooked food will be prepared in the rack and

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