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Agent-based Simulation Model of Single Point Inventory System

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Abstract

Maintaining normal stock amount can reduce ordering cost and improve service level, but excessive stock needs expensive inventory holding costs and occupies too much floating capital, so it is necessary to seek a balance between the stock holdings and inventory cost. Using AnyLogic software, the single point inventory system simulation model is built based on Agent method in this paper. Through comparing the two continuous replenishment strategies, the (R, S) and (Q, R) strategies, the simulation results show that (R, S) strategy is better than (Q, R) strategy. Then the optimal inventory policy to minimize inventory cost with a certain service level is analyzed by the optimization experiment.

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Keywords: Inventory system; System simulation; (R, S) polic; (Q, R) polic; AnyLogic software

1. Introduction

Inventory is the term used for the future, temporarily idle resources, which can be used to maintain normal operation, reduce order costs and improve service level while the supply and demand changes constantly. Too much stock needs expensive inventory holding costs and occupies too much floating capital, so inventory control in logistics engineering is more important than other logistics activities and it is necessary to seek a balance between the stock holdings and inventory cost to minimize the total inventory cost with a certain service level or maximize demand service level with an acceptable cost.

At present, research works about inventory system simulation are very popular. Many papers focus very much on the impact of information coordination and information-sharing on inventory control in supply chain, the bullwhip effect, and the optimal inventory strategy, etc. There are four major methods to model the complex system: Agent-based Modeling and Simulation, System Dynamics model, Petri Net and Object-Oriented Technology. Paper [1] researched on the information coordination in the activities of

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decision making of production planning and procurement planning in order to fulfill process using the means of multi-agent based modeling and simulation. Papers[2,3] developed a basic model in a production-inventory control system using difference equations to discuss the relationship between stability and bullwhip effect in the supply chain system. Paper[4] studied the integrated stochastic inventory problem for a two-stage supply chain consisting of a single retailer and a single supplier. By using batch shipment policy, the paper obtained the result that the expected total cost can be significantly reduced. Paper[5] investigated the effect of product perishability and retailers' stockout policy on system total cost, net profit, service level, and average inventory level in a two-echelon inventory–distribution system. In addition, the paper developed an approximate inventory model to the system performance measures. Paper[6] showed how to model a problem to find optimal number of replenishments in the fixed-order quantity system as a basic problem of optimal control of the discrete system. Paper[7] studied the inventory system of an online retailer with compound Poisson demand. The retailer normally replenishes its inventory according to a continuous review (Q, R) policy with a constant lead time.

Multi-location inventory models are one of the most widely investigated fields in mathematical inventory theory, but the analytically tractable models suffer from various restrictive assumptions. To overcome these restrictions simulation can be used^[8].

Paper [9] described a simulation model of a multi-echelon inventory cost optimization problems using Arena and OptQuest to gain the reorder point and order size of the retailers.

The above literature shows that great progress has been made in research on inventory system in supply chain. This paper describes the single point inventory system simulation model using AnyLogic software and adds comparison of two continuous inventory policies based on paper [9].

2. Agent-based Simulation Modeling

Agent is a unit of model design that have behavior, memory, timing, contacts, etc. Agents can represents people, companies, projects, assets, vehicles, cities, animals, ships, products, etc.

The agent-based simulation modeling broke the traditional top-down study mode. It starts at basic unit of the model to realize independent interaction and to imitate the behavior of the complex systems through the effective communication between the Agents. It is an effective method of top-down analysis and bottom-up synthesize.

2.1. Description and Hypothesis

Inventory system simulation model mainly imitates warehouse, but it also contains suppliers and customers on a certain supply chain. The top-layer model of inventory system is shown in figure 1 below. In the model, there are three modules: customer, warehouse and supplier. The warehouse accepts customers' demands, handles orders according to the principle of first come first serve, checks storage and makes a count, then sends replenishment requirement to suppliers. Goods are issued by the supplier according to the replenishment requirement, accepted by the warehouse and sent to customers.

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