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# Experimental Design of Beer Game Based on AnyLogic 8

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## Abstract

**The beer game is mainly used to validate the bullwhip effect problem in supply chain management. In this paper, individual and group games are designed based on the beer game module in AnyLogic8 software, in sequence. Each student chooses to role-play and interact with either human or role by submitting an order in both games. The game experiment results can help students experience the distortion and amplification of demand information transmission in the supply chain and intuitive understand the bullwhip effect. Students will also be able to dynamically compare the group and individual games' results, helping them deepen their knowledge of inventory management, contract coordination, and global optimization in supply chain management.**

## Keywords

**Beer game, Bullwhip effect, Supply chain management, AnyLogic.**

## 1. The Beer Game in supply chain management

In the early 1960s, MIT's Sloan institute created the "Product Distribution Game" to study the production and marketing relationships between firms at the supply chain's nodes. The Beer Game, which is a strategy game, simulates the logistics and information flow of beer in the production and distribution process[1]. The logistics of beer distribution are passed downstream from upstream in the supply chain, and the information flow of demand orders is passed from downstream to upstream of the supply chain.

The bullwhip effect refers to the phenomenon of demand variation amplification, which is described by Professor Han L Lee, a leading American supply chain management expert, as a cascading distortion of demand information along the supply chain[2]. Small changes in consumer demand may increase demand information fluctuations for retailers, wholesalers, distributors, manufacturers along the supply chain, and out-of-stock or over-stock phenomena throughout the supply chain system. Statistically, the costs caused by the bullwhip effect account for 12%-25% of the cost of each member's supply chain. Information at the point of sale were communicated to all members of the supply chain in a timely and continuous manner, the bullwhip effect would be significantly reduced.

## 2. Experimental design of beer games based on AnyLogic 8

### 2.1. Purpose of the Beer Game

Throughout the Beer Distribution Game model in AnyLogic 8, the purpose of the beer game is twofold. Firstly, through an individual simulation game, students can experience the distortion and amplification of the demand information passing in the supply chain under the asymmetric information, so that they can intuitively understand the bullwhip effect. Secondly, through a group simulation game, they can experience the concentration of the demand information. Optimize the whole picture under decision-making and exercise student's awareness.

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## 2.2. Description of the Experimental environment

Consider a four-layer beer supply chain consisting of a retailer, a wholesaler, a distributor, and a factory, where the factory produces beer, the time to transfer information about beer orders between nodes is 2 days, as is the time to ship beer, and the initial inventory at each node is 50 bottles, the unit cost of beer storage is assumed to be $ 0.50, and the loss of reputation due to out-of-stock is $ 1.0 per bottle, as shown in Figure 1.

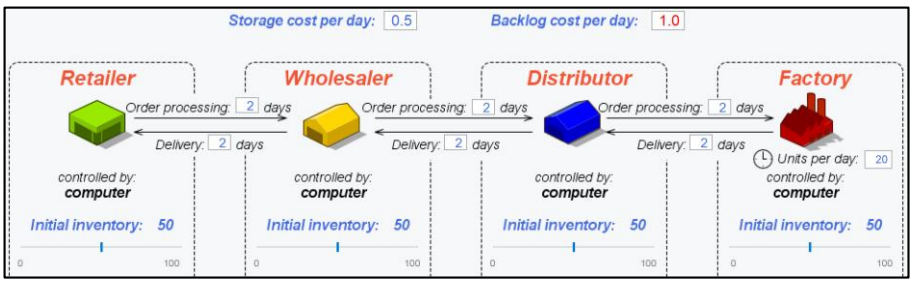
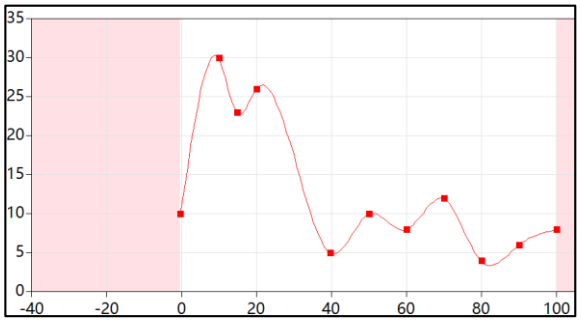



Figure 1. Description of Experimental parameters

Each round of the game simulates 100 days of ordering decisions, for which the market demand at ten nodes is assumed in turn in intervals of 10 days as shown in Figure 2(a), and then the market demand for 100 days is simulated using the sample line difference method as shown in Figure 2(b).

| 参数 | 值 |
|---|---|
| 10 | 30 |
| 15 | 23 |
| 20 | 26 |
| 40 | 5 |
| 50 | 10 |
| 60 | 8 |
| 70 | 12 |
| 80 | 4 |
| 90 | 6 |
| 100 | 8 |

(a)




(b)

Figure 2. Market demand for 100 days

## 2.3. Experimental procedures

In the beer game, students are required to analyze and understand the changing patterns of market demand. Accordingly, they submit orders to the upstream, where orders from downstream companies can affect their ordering decision, inventory levels, and even their costs.

### 2.3.1. Individual games

In the individual games, the student chooses any one role and the computer controls the remaining three roles. During the game, the student submits 100 orders to the upstream based on downstream demand, and after each order submission, the student needs to read the data from the AnyLogic 8 game interface and enter it into Table 1.

Table 1. List of individual games

| Players | Round | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | …… | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | Others |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 姓名：<br>扮演： | Inventory | | | | | | | | | | | | | | | | | | | | | | | |
| | Expected | | | | | | | | | | | | | | | | | | | | | | | |
| | Order amount | | | | | | | | | | | | | | | | | | | | | | | |
| | Shotage costs | | | | | | | | | | | | | | | | | | | | | | | |
| | Backlog costs | | | | | | | | | | | | | | | | | | | | | | | |

As an example of a student choosing a retailer, the experimental procedure is shown as follows.

Step 1. Click on the Retailer icon, the background becomes dark and shows controlled by users, click on Run the model, as shown in Figure 3(a).

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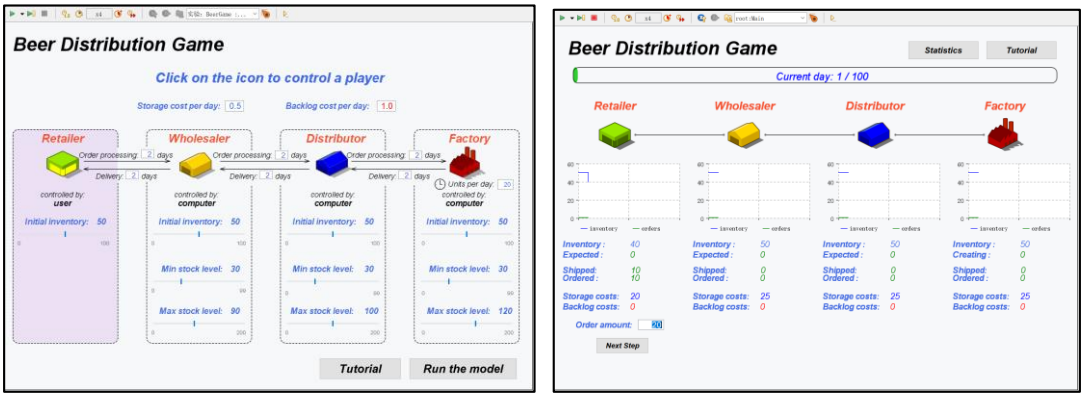
Step 2. In the pop-up game interface shown in Figure 3(b) (paying attention to the Current day is 1/100), find the data required for Table 1, and in the first column in order to fill in 40, 0, 20, click Next Step.

Step 3, repeat Step 2 unit Current day: 100/100 appears.




(a) (b)

Figure 3. Individual games for selecting retailers

### 2.3.2. Group games

Four students are required to form a team, and each student chooses a different role from the other. During the game, the four students share the order information and submit 100 orders to their respective upstreams simultaneously.

Table 2. List of group games

| Players | Round | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | …… | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 零售商 | Inventory | | | | | | | | | | | | | | | | | | | | | | |
| | Expected | | | | | | | | | | | | | | | | | | | | | | |
| | Order amount | | | | | | | | | | | | | | | | | | | | | | |
| 批发商 | Inventory | | | | | | | | | | | | | | | | | | | | | | |
| | Expected | | | | | | | | | | | | | | | | | | | | | | |
| | Order amount | | | | | | | | | | | | | | | | | | | | | | |
| 分销商 | Inventory | | | | | | | | | | | | | | | | | | | | | | |
| | Expected | | | | | | | | | | | | | | | | | | | | | | |
| | Order amount | | | | | | | | | | | | | | | | | | | | | | |
| 工厂 | Inventory | | | | | | | | | | | | | | | | | | | | | | |
| | Expected | | | | | | | | | | | | | | | | | | | | | | |
| | Order amount | | | | | | | | | | | | | | | | | | | | | | |

All Players
Shotage costs
Backlog costs

The experimental procedures for the group game are shown as follows.

Step 1. In the same game module, four students choose different roles in turn. When the background all changes to dark and shows controlled by users, click Run the model, as shown in Figure 4(a).

Step 2. In the pop-up game interface shown in Figure 4(b) (paying attention to the Current day is 1/100), look for the data required for Table 2, and in the first column for each role in order to the corresponding data, click Next Step.

Step 3, repeat Step 2 unit Current day: 100/100 appears.

## 3. Conclusion of the experiment

By completing the beer game in both Individual and group games, students can achieve two experimental goals. The first is to deeply appreciate the impact of their self-interested decisions on other members and the changes in information transfer, inventory levels, and costs throughout the supply chain. The second is to gain a deep understanding of the concept of the supply chain system globalization and experience inventory management, contract coordination, and global optimization in supply chain management by dynamically comparing the results with those of Individual games.

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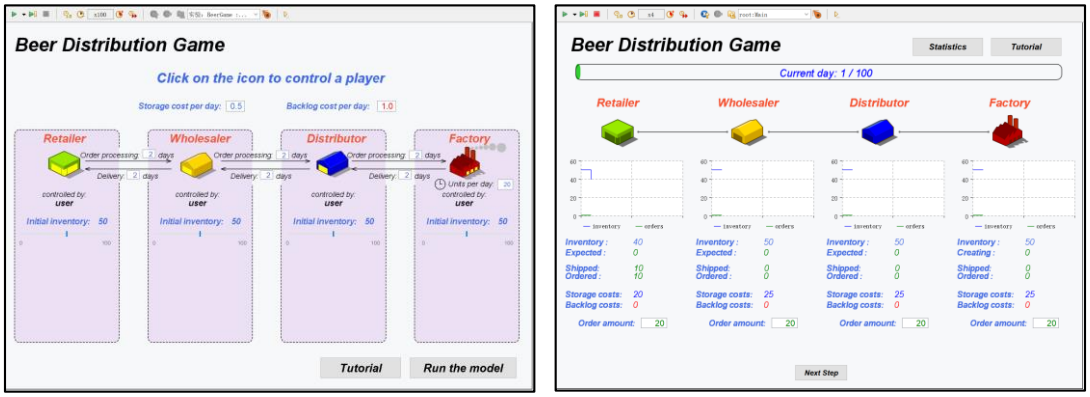


(a) (b)

Figure 4. Experimental interface for the group games

## Acknowledgments

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## References

[1] David Simchi-levi, Philip Kamnishy, and Edith Simchi-levi. Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies (3rd ). Publisher: McGraw-Hill/Irwin, 2013.

[2] Lee H L, Padmanabhan V, Whang S. The Bullwhip Effect In Supply Chains. Sloan Management Review, 1997, 38(3): 93-102.