

OPE20525A: LOGISTICS




Inventory Management Workshop


The www.nineties-memorabilia.com scenario

Guidelines

The context

www.nineties-memorabilia.com is a web retailer specialized in 90's memorabilia. The company's portfolio of products includes 90's popular toys (e.g. G.I Joes, Barbies, Lego sets), CDs, VHS cassettes, videogames and consoles, and all kinds of TV show and movie mementos. One the company's most popular product line is memorabilia from the popular sit com Seinfeld. In particular, the company sells 7 items that are best sellers among the show's diehard fans. These items are bought from 5 different suppliers. The following tables present the description of the products.

Coffee table book (about coffee tables)	
	Supplier: Pendant Publishing Ordering cost: \$20.0 Holding cost rate: 10.0% Target service level: 100.0% Lead time: 0 days Initial stock: 0 units Price: \$30.00
Himalayan Walking Shoes	
	Supplier: J. Peterman Ordering cost: \$15.0 Holding cost rate: 12.0% Target serv. level: 100.0% Lead time: 0 days Initial stock: 0 units Price: \$120
King Edward VIII's wedding cake replica	
	Supplier: J. Peterman Ordering cost: \$15.0 Holding cost rate: 12.0% Target serv. level: 100.0% Lead time: 0 days Initial stock: 0 units Price: \$95

Soup Nazi bubble head	
	Supplier: KramERICA Industries Ordering cost: \$20.0 Holding cost rate: 12.0% Target serv. level: 100.0% Lead time: 0 days Initial stock: 0 units Price: 100
Puffy Shirt replica	
	Supplier: Vandelay Industries Ordering cost: \$150 Holding cost rate: 10.0% Target serv. level: 90.0% Lead time: 2 days Initial stock: 800 units Price: \$100
SP2000 Slicer miniature	
	Supplier: Kruger Industrial Smoothing Ordering cost: \$20.0 Holding cost rate: 20.0% Target serv. level: 100.0% Lead time: 0 days Initial stock: 0 units Price: \$5 (between 1 and 649 units), 4.5 (between 650 and 999 units), 3.9 (1000 units or more)
Urban Sombrero	
	Supplier: J. Peterman Ordering cost: \$15.0 Holding cost rate: 12.0% Target serv. level: 100.0% Lead time: 0 days Initial stock: 0 units Price: \$225

The excel spread sheet [nineties-memorabilia.com.xlsx](#) reports the daily sales for the 7 products in the last three years.

The company is having troubles managing the inventory for these 7 items. The logistics manager has observed that the stocks carried for some of the products is too high while sales for other products are sometimes lost due to understocking. He has requested your help to implement more efficient inventory managing (IM) policies for this best-sellers.

The workshop

The objective is to put into practice the what you learned in sessions 2 and 3 of the class. You must analyze the sales data, select appropriate IM policies for **each** product and compute the optimal parameters for those policies. To evaluate your policies, you can

rely on IMSim V.0.0.1, a discrete event simulation software developed at HEC Montréal specially for this workshop. In a nutshell, IMSim V.0.0.1 allows you to define IM policies for the 7 products and simulate the operation the policies during a time horizon of one year. The software reports performance metrics such as: product fill rate, number of placed orders, average inventory levels, total ordering cost, total holding cost, and total acquisition cost. It also provides a detailed view of inventory levels and IM decisions for each simulated day.

IMSim V.0.0.1

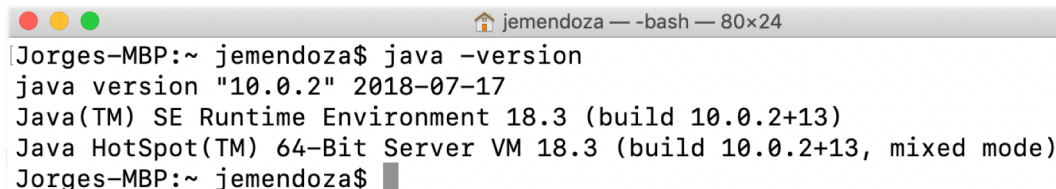
Installing the application (before the session)

IMSim V.0.0.1 was developed in Java; it is therefore multi-platform (e.g., Mac OS, Windows, Linux). The only requirement to run the application is to have the Java Runtime Environment (JRE) – version 8 or superior – installed in your system. Most computers already have a version of the JRE installed. It is, however, important that you make sure that your computer is equipped with the right version of the JRE before the session.

To check if Java is installed in your computer, follow these instructions

1. Start the Command Prompt (Windows) or Terminal (Mac). If you do not know how to accomplish this, you can find quick tutorials for [Windows](#)¹ and [Mac OS](#)² by clicking on the corresponding links³.
2. Type the following command and press enter: `java -version`.

If Java is correctly installed in your computer, you should obtain an output similar to that displayed in Figure 1.



```
Jorges-MBP:~ jemendoza$ java -version
java version "10.0.2" 2018-07-17
Java(TM) SE Runtime Environment 18.3 (build 10.0.2+13)
Java HotSpot(TM) 64-Bit Server VM 18.3 (build 10.0.2+13, mixed mode)
Jorges-MBP:~ jemendoza$
```

Figure 1: executing the `java -version` command

If your computer does not recognize the `java -version` command, Java is not installed on your system. You can download the current version of the JRE for free from this address: <https://www.java.com/download/>. To install the JRE in your computer simply follow the instructions. After completing the installation, run the test again to make sure that your computer is ready for the workshop.

Once you have installed and tested the JRE, you can download IMSim V.0.0.1 from the following link: <https://github.com/jemendoza/IMSim/releases/download/V.0.0.1.EN/IMSim-V.0.0.1.zip>. Unzip the contents of the .zip file to an easy-to-remember location in your file system. To launch the application, simply double click on the IMSim-V.0.0.1.jar file.

¹ <https://www.digitalcitizen.life/7-ways-launch-command-prompt-windows-7-windows-8>

² <https://www.idownloadblog.com/2019/04/19/ways-open-terminal-mac/>

³ Last access: August 20, 2019

Using the application

The graphical user interface has 4 tabs: Product, Suppliers, Policies, and Simulation. As the name suggest, in the Product tab you can access product information. Figure 2 shows an example. The Suppliers tab presents the list of suppliers and their parameters. Table 1 describes the parameters for products and suppliers.

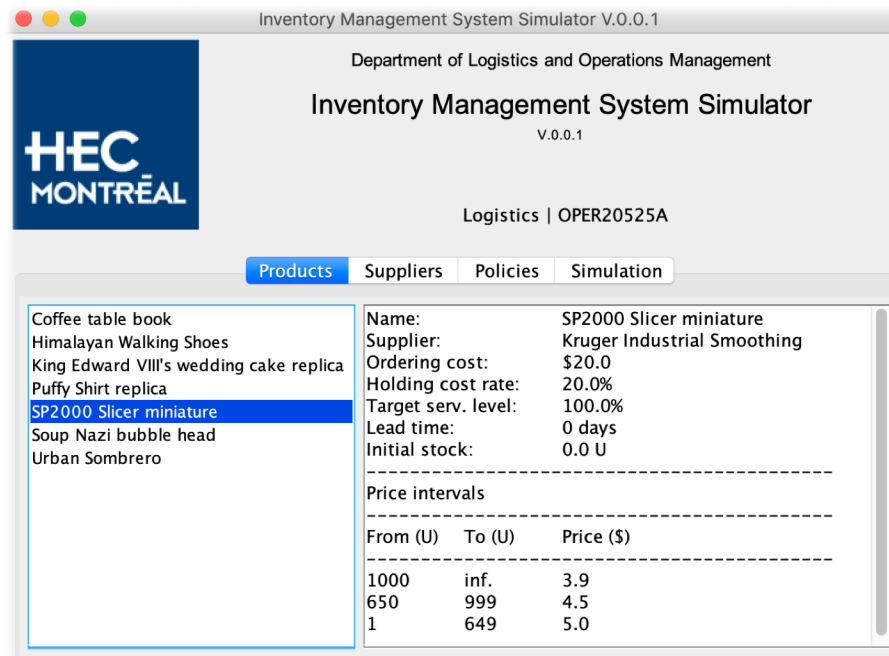


Figure 2: IMSim V.0.0.1 graphical user interface

Products	
Name	Name of the product.
Supplier	Name of the supplier from whom the product is bought.
Ordering cost (\$)	Cost of ordering the product. The company incurs in this cost every time they order the product (independently of the ordered quantity).
Holding cost rate (%)	The cost of holding to one unit of the product for one year as a proportion of the price of the product. For instance if the cost of a product is \$100 and the holding cost rate is 12%, keeping a unit of that product in inventory for a year would cost the company \$12.
Target serv. level	Target cycle service level for the product. The fraction of replenishment cycles that end with all the customer demand being met. In the simulation, a replenishment cycle is the time between two consecutive orders. If the target service level for a product is, for instance, is 0.90, then you need to find an IM policy allowing the web not to run out of inventory in 9 out of 10 replenishment cycles.
Lead time (days)	The time needed to replenish the product. In the simulation, orders are assumed to be placed at the end of the day.

	However, if the lead time for a product is 0, an order placed at the end of day t is assumed to be during t and the new stock can be used to cover the demand of t . If the lead time is greater than 0, the stock corresponding to an order placed in day t is assumed to be available at the end of day $t + \text{lead time}$. For instance if the lead time of a product is 15 and an order is placed in day 2, the fresh stock becomes available at the end of day 17, but it can be used to cover the demand of that day.
Initial stock (units)	The stock available for product p at the beginning of the simulation.
Price intervals	The price structure for the product. IMSim V.0.0.1 allows products with both a fix price or a price that varies according to the ordered quantities (i.e., products with quantity discounts). The latter is modeled using price intervals. A price interval is defined by a triplet (From, To, Price), where From is the number of units marking the beginning of the interval, To is the number of units marking the end of the interval, and Price is the price paid for each unit of an order, if the order quantity lays between From and To. For instance, if the price intervals for a given product are defined as $\{(1, 999, \$150), (1000, \text{inf.}, \$100)\}$ the cost for a unit of the product is \$150 if the ordered quantity lays between 1 and 999 units, and \$100 if the latter is larger than or equal to 1000.

Suppliers	
Name	The name of the supplier.
Fees (\$)	The administrative fees charged by the supplier for processing an order. These fees are added to the ordering costs on top of the individual ordering cost for each product included in an order. For example, if we order product p from supplier s , the total ordering cost for a given order would be: the ordering cost for p + the administrative fees of s . On the other hand, if an order contains products p and q , the total ordering cost for a given order would be: the ordering cost for p + the ordering cost for q + the administrative fees of s . During the simulation, the administrative fees for a given order are equally distributed among the products included in the order independently of their ordered quantities. For instance, if the ordering cost for product p is \$10, the ordering cost for product q is 20\$, the administrative fees of supplier s are \$40, and we jointly order p and q from s , the total ordering cost for p will be \$30 ($=\$10+\$40/2$) and that of q will be \$40 ($=\$20+\$40/2$).

Table 1: description of the product and supplier parameters in IMSim V.0.0.1

The Policies tap allows you to define IM policies for one or more products (i.e., joint replenishment policies). IMSim V.0.0.1 handles two types of policies: continuous review policies (CRPs) with a fixed reorder point and a fixed order quantity, and periodic review policies (PRPs) with a fixed review interval and a variable order quantity. For theoretical background on these policies, please (re)read the pedagogical note on inventory management [1] available in ZoneCours.

Defining IM policies

After selecting the type of policy, click on the “Add new inventory control policy” button. Depending on the type of policy a different type of pop-up menu will emerge. Figure 3 shows the menu for CRPs. Using the combo box, select the product for which you want to define the policy. Note that only products for which no policy has been defined will show on the menu. Next, set the two parameters for the CRP: the reorder point and the order quantity. The example shown in Figure 3, defines a reorder point of 100 units and an order quantity of 500 for the SP2000 Slicer miniature. During the simulation, every time the sum of physical and virtual stock (i.e., orders placed in the past that are yet to arrive) reaches 100 units, a new order for 500 units is placed. To save the CRP, click on the “Save policy and close” button. To abort the operation simply click on Cancel. It is worth noting that in IMSim V.0.0.1 CRPs are limited to a single product.

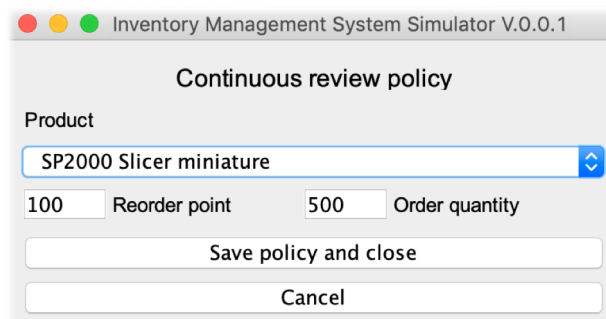


Figure 3: Continuous review policy menu

The newly defined policy will be displayed on the bottom panel of the Policies tap using the following convention:

Continuous review | PRODUCT_NAME (REORDER_POINT | ORDER_QUANTITY)

To delete a policy, select the policy on the bottom panel in the Policies tap and click on the “Delete control policy” button. Please note that IMSim V.0.0.1 does not allow users to edit (i.e., change the parameters of) an existing policy.

Figure 4 shows the pop-up menu for defining PRPs. Contrary to CRPs, PRPs can be jointly defined for multiple products (as long as they are bought from the same supplier). To add a product to a PRP, select it from the combo box, set the value for its target stock, and click on the “Add to policy” button. To add more products to the policy, repeat the procedure. After the first product is added to the policy, the combo box will only display the products that are sold by the same supplier. After adding all the products to the policy, set the cycle length (also known as review interval) field and click on the “Save policy and close button”. According to the example displayed in Figure 4, during the simulation, the application will check the stocks for the Himalayan Walking Shoes and the Urban Sombrero every 20 (simulated) days and orders enough of each product to reach their corresponding target stocks (700 and 300 units, respectively).

The newly added PRP will be displayed on the bottom panel of the Policies tab using the following convention:

Periodic review (INTERVAL) | PRODUCT_1_NAME (TARGET_STOCK),
 PRODUCT_2_NAME (TARGET_STOCK), ..., PRODUCT_P_NAME (TARGET_STOCK)

Figure 4: Periodic review policy menu

Figure 5 shows the Policies tab after adding the CRP and the PRP discussed in this section.

Figure 5: The Policies tab after adding a CRP and a PRP

Evaluating IM policies

The Simulation tab allows the user to evaluate the defined policies using discrete event simulation. To simulate the operation of a policy, select the policy from the top list and click on the “Evaluate policy button”. The application will run the simulation and

report, for each product included in the policy, i) the performance metrics, and ii) the detailed simulation data. The performance metrics include: the fill rate, the cycle service level, the total number of orders, the average daily stock, the total ordering cost (C_o), the total holding cost (C_h), the total acquisition cost (C_a), and the total cost (CT). Figure 6 shows the evaluation of the CRP defined in the previous section.

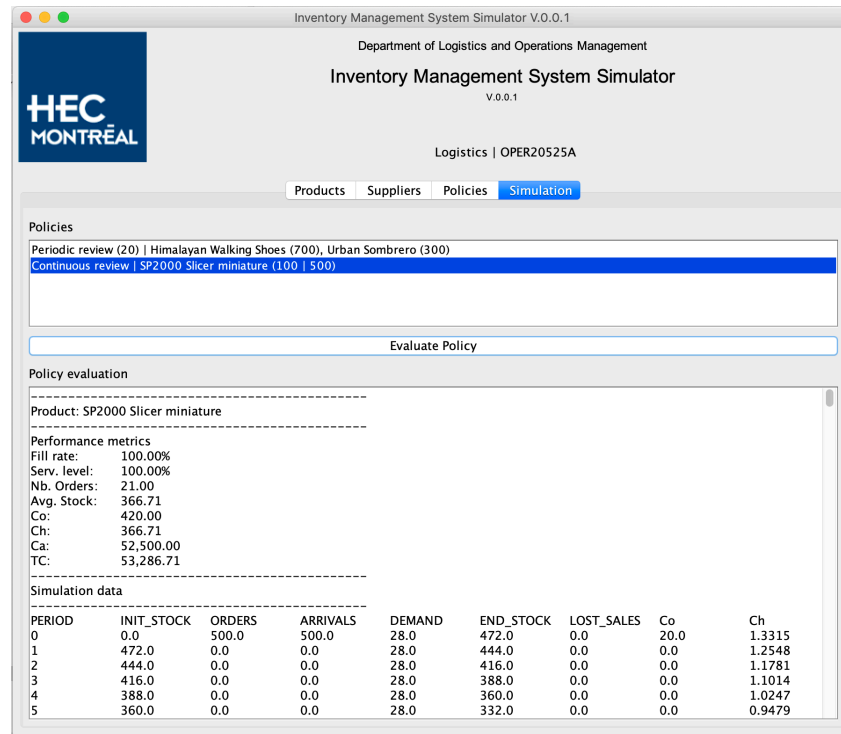


Figure 6: evaluation of a CRP

The detailed simulation data shows for every (simulated) day the following fields: stock at the beginning of the day (INIT_STOCK), the number units ordered during the day (ORDERS), the number of units that arrived during the day (ARRIVALS), the demand for the day (DEMAND), the stock at the end of the day (END_STOCK), the unfilled demand (LOST_SALES), the ordering cost associated to orders placed during the day (C_o), and the cost of holding inventory for that day (C_h). To help understanding this data, let us examine the case for day 0 in the example displayed in Figure 6. The initial stock for the product is 0. Since the policy fixes the reorder point to 100, an order for 500 units is immediately placed. Because the lead time of the product is 0, the order is received right away and the fresh inventory can be used to serve the 28 units of demand observed on the day. The final stock is then 472 ($=500-28$). Since the ordering cost for the product is \$20 and the supplier applies no administrative fees, the total ordering cost for the day is \$20. The holding cost is slightly more difficult to understand. Since the order is placed and received during the day and the demand is 28 units, the average inventory is 486 ($=472+28/2$). The holding cost rate for the product is 20% and its price is \$5.0 -- note that the order quantity belongs to the (0, 649, \$5.0) price interval. Therefore, holding a unit of inventory for a day costs \$0.0027 and the total holding cost of the day is 1.3315 ($=0.027 \times 486$).

References

[1] Y. Adulyasak. Pedagogical Note on Inventory Management. HEC Montréal, 2017.