2020 Fall: Project I for Operation Management

1. Background

With the rapid development of Internet, global payment techniques, and international logistics, international trade has shifted from the traditional B2B model to B2C model. Consumers are able to purchase at favorable prices by dealing directly with the vendors, cutting out multiple middle layers in the supply chain. Many E-commerce platforms sprung up and flourish upon this opportunity. More and more Chinese manufacturers and vendors use all sorts of E-commerce platforms internationally or regionally to conduct international business with end customers. However, together with explosive growth come also a large number of problems, among which the inventory management problem is one of the worst. Even with almost a decade's development of this industry, the inventory management problem is still very difficult to tame, due to the instability of international relations, the endless change of platform regulations, the uncertainty of customer demands, and the prolonged international logistics.

2. Introduction of Company X

Founded in 2011, Company X was initially established to provide software services to cross-border e-commerce companies. However, as its reputation in the industry grew, Company X gradually began to engage in its own cross-border e-commerce export business and build up its own ecosystem. With its strong technology and system capabilities, company X's cross-border export business developed quickly, becoming one of the most well-known e-commerce companies in the industry. Headquartered in Shenzhen, Company X has subsidiaries and branches in many countries and regions, such as India, the United States, Japan, Brazil and Southeast Asia, with annual sales of more than RMB 2 billion.

Company X currently has several business modules. The biggest part is B2C sales. It is divided into a boutique model and a distribution model according to the mode of operation. The boutique model focuses on Company X's own brands, including dozens of well-known and less well-known brands. The distribution model mainly deals with unbranded products. Both of the above two operating models use the following two types of sales channels: type one is selling through third-party platforms such as Amazon, Ebay, Lazada, etc. Company X has leveraged more than 30 global or regional e-commerce platforms; type two is selling through independent sites, especially after Company X has successfully acquired a well-known e-commerce company. It operates a full range of products including clothing, 3C, household, LED, toys, cosmetics, etc., totaling a whopping number of more than 300,000 SKUs (store keeping units). Apart from B2C business, Company X

also run some B2B business, international business and service. In this project, we will focus on its B2C cross-border e-commerce business.

3. Inventory Management in Company X

Company X's supply center is divided into 4 departments - procurement, quality, warehousing, and logistics. The procurement department issues purchase orders to a supplier, and the supplier delivers the product to the warehouse. After passing the quality inspection by the quality department, it is registered into the inventory information system, and it becomes the inventory in stock. Company X's order system obtains sales orders from various platforms, and pushes product, quantity, and recipient address information to Company X's warehouse to secure the inventory and fulfill it. The logistics department then selects the corresponding shipping method for the order delivery, and the products in the order are shipped from the warehouse and deducted from the inventory information system.

Due to the lack of inventory management expertise, currently Company X is facing many stock management problems, such as no safety stock, no demand forecasting, etc. which lead to not only high order placing costs, but also great loss in sales. After careful investigations, here is some information highly relevant to implement effective inventory management policies.

1. Order placing cost. When placing an order to a supplier, there is a fixed cost per order, regardless of the amount of units ordered. This fixed cost mainly consists of the labor cost related to manual creation and confirmation of the order, the order processing cost of the information system, and the fee related to packaging, labeling, tracking, and other processing of the shipment. The costs of labor and information system processing are roughly the same across SKUs, a rough estimation of which is about 3 RMB together. As for the fixed shipment processing fee, it is a part of the agreement between the supplier and the logistics company, but the charge is forwarded to Company X, which ranges from 2 RMB to 6 RMB, differing by SKUs. Therefore the total fixed order placing cost ranges from 5 RMB to 9 RMB.

2. Stock holding cost. The stock holding cost is the cost of holding one unit in the warehouse for one year. There are two major sinks of stock holding cost: the financial cost and the warehousing cost. The financial cost is simply the interest cost of the capital spent in purchasing the stock, which accounts for 15% of the purchasing cost. The warehousing cost is more complex, because it is determined by a number of factors, such as the volume of the SKU, whether it needs low temperature or ventilation, etc. To simplify things up for the sake of our project, we assume this part accounts for another 5% of the purchasing cost. So the total stock holding cost is 20% of the purchasing cost for our project.

3. Stockout cost. Stockout cost is the lost income and expense associated with a shortage of

inventory in stock. In Company X, this cost mainly arises in sales-related way, instead of the internal process-related way. When a customer wants to place an order and there is no inventory available to sell to the customer, the company loses the gross margin or gross profit related to the sale. In addition, the customer may be lost permanently, in which case the company also loses the margins associated with all future sales. What's more, platforms also implement regulations to discourage stockouts by reducing traffic or putting order restrictions on products if customers experiences a certain level of stockouts. It is not always easy to discern the stockout costs incurred by the business, however, as lost sales do not appear on the income statement. The estimation is that for each occurrence of stockout, the cost is about 8.0 times the gross margin of that product. Stockout issues can be mitigated by maintaining a high level of inventory record accuracy and a reasonable safety stock level that is adjusted to match ongoing changes in customer demand.

4. Project requirement

The goal of this project is to reduce the total cost incurred over a certain period of time, which includes the order placing costs, the stock holding costs, and the stockout costs. You will implement the inventory management policy to determine when to order and how many units to order for a SKU. The project includes two phases:

Phase 1: SKU information will be given to the students. The teams are required to calculate 1) the reorder point and 2) the replenishment level. Your policy will be evaluated by the total inventory costs in simulations with a randomly picked set of SKUs and randomly generated stream of daily demands. The teams are required to implement the function reorder_upto(sku_info, …) in the project python code file "p1team.py" that is to be submitted. Note that in order to finish the simulation for testing your policy in reasonable amount of time, the total execution time of your function should not exceed 1 hour. Please refer to the comments in the code for more details.

Phase 2: Some of SKUs and their demand history data will be provided for you to decide on when to order and how many units to order in the beginning of each day. The teams are required to implement the function order_decision(sku_info, …, ctx) in the project python code file "p1team.py" that is to be submitted. If the team would like to keep some data or intermediary results in between calls to order_decision(sku_info, …, ctx) for later use, it is good to also implement the function initialize((sku_info, …, ctx), which is called only once before the first call to the function order_decision(sku_info, …, ctx). Please see the code in 'p1team.py' for a reference implementation.

Your phase 2 submission will be evaluated against a randomly picked set of SKUs with their demand history. Note that in order to finish the simulation for testing your policy in reasonable amount of time, the total execution time of your function should not exceed 1 hour in the simulated management of a SKU over a period of 360 days. Please refer to the comments in the code for more details.

You will be provided some SKU and demand history data in comma separated values (CSV) files ("SKU_DATA.csv" and "DEMAND_DATA.csv"), as well as some preliminary testing code in "p1test.py" for testing your implementation. You may run "p1test.py" to see the results of a very rough policy implemented in the "p1team.py" file distributed to you. Please also read "p1test.py" carefully and enhance it for your testing needs.

The submission deadline for phase 1 and phase 2 will be announce later. You should refer to the slide "Tentative Schedule" for a feeling of when they are about to due.

Enjoy!

P.S. You may use external libraries that don't contain any code or logic of inventory management, such as general math libraries, graphing libraries, or statistics libraries. Please list any external libraries used in the designated place in the code file "p1team.py", and explain how to set them up there so that your submission can be tested successfully by the TA and teacher.