# 2021 MCM-SJTU

## Problem C: Intelligent pricing of container shipping space

In recent years, factors such as low freight rates, high costs, and pressure from the trade war have led to a continued downturn in the domestic shipping market. From the perspective of transportation demand, the slowdown in domestic economic growth and the peak period of insufficient production capacity will lead to a continuous decline in transportation demand. What's more, under the high pressure of environmental protection and real estate policies, the volume of bulk supply markets such as coal, building materials, and strip steel will continue to decline. From the perspective of capacity supply, new capacity, especially the capacity of private enterprises, has been entering the market. Restrictions on development policies in some regions and the effects of extreme weather changes have further increased transportation pressure and intensified fierce competition in the domestic container shipping market.

With the rise of e-commerce, shipping companies have established their own online transportation space sales e-commerce platform, and have published freight prices to customers in an open and transparent manner so as to achieve promotion of the sales. Shipping company X pointed out that the prices of online goods are no longer fixed in recent years. According to market demand and their own supply capabilities, many companies usually adopt dynamic pricing strategies, that is, to sell the same products to different consumers or different market segments in time at different prices in order to achieve the goal of maximizing revenue. Dynamic smart pricing has become one of the new economic characteristics of e-commerce.

In order to respond to the rapidly changing domestic container shipping market and to increase revenue, shipping company X plans to develop an intelligent shipping space[1] pricing system. This system is one of the ways for the company to achieve a rapid transition from the traditional manual mode to the artificial intelligence mode. It is supposed to free up manpower, and to give quick, accurate and automatic responses to high-frequency changes in the market, thereby effectively improve the efficiency of shipping.

As a consultant, your team needs to complete the design of the new system, including flow direction selection, customer booking habits research, pricing strategy, etc. Please complete the following tasks respectively.

To help your team complete the design, shipping company X offers seven files:

1. Transaction data of container in October 2019,

2. Transaction data of ordinary goods in October 2019,

3. Container route data,

4. Labels of contract orders and spot orders,

[1] For problem C, you could consider shipping space and container have the same meaning.

5. Container information,

6. Existing pricing strategy of shipping company X,

7. Interpretation of some nouns.

In order to establish such a system, the following steps are needed: flow direction[2] selection, pricing influencing factors research and pricing strategy design. For shipping company X that operates a large number of routes, you need to identify some valuable flow directions for testing the intelligent pricing system first. Next, you need to determine some factors that affect pricing and study the characteristics of these factors, such as the law of change. Finally, you need to combine the influencing factors to give a pricing strategy to maximize the revenue. In order to simplify the model, the revenue here can be understood as income, that is, the cost is not considered.

Your tasks are the following:

**Task 1:** In the case that the performance of the intelligent pricing system cannot be guaranteed, shipping company X hopes to screen out some flow directions for testing the new system. Please help shipping company X select 10 valuable flow directions according to historical revenue, sales volume, freight rate, region and other factors, and explain reasons.

**Task 2:** In the actual production and operation, many factors could affect the company's container pricing strategy, such as macro market changes, competitors' strategies[3] and customers' booking habits. Shipping company X would like your team to study the following two issues:

- The booking habits of customers in each flow direction are different. For example, customers in flow direction 1 prefer to book containers before sailing, while customers in flow direction 2 prefer to book containers at the beginning of the sale[4]. Please study and describe the booking habits of the customers in the 10 flow directions that you select.

- Revenue can be simply considered as composed of sales volume and freight rate. Please study the relationship between sales volume and freight rate in combination with customers' booking habits, macro market changes and other factors in one or more flow directions that you select. Note that the relationship here is not necessarily the one between the daily sales volume and the corresponding freight rate. The discovery of the relationship between the sales volume and the freight rate of any time scale is considered to be beneficial.

- Prediction of market conditions, especially short-term forecasts, is very meaningful for formulating pricing strategies. Please try to forecast the sales volume in one or more flow directions that you select.

**Task 3:** Eventually, the goal of shipping company X is to maximize revenue by formulating reasonable pricing strategies. Please note that the pricing strategy here refers to the strategy of adjusting the

[2] Please see Appendix 1.4 for the explanation of the spot market.
[3] To simplify the model, you could not consider the influence of competitors.
[4] Please see Appendix 1.6 for the explanation of selling period.

container price for the spot market[5] according to the market changes.

- Shipping company X has designed a simple pricing strategy for some flow directions. Please select one of the flow directions to judge whether the existing strategies of shipping company X are appropriate.

- Please design a more reasonable pricing strategy for the spot market according to the macro market changes, space utilization rate, customer booking habits, and relationship between sales volume and freight rate for one or more flow direction you select. You need to explain the rationality of your pricing strategy.

**Task 4:** Write a one-page memo to show the advantages of your pricing strategy to the project leader of shipping company X based on your previous conclusions.

Your submission should consist of:
- One-page Summary Sheet,
- One-page memo,
- Your solution of no more than 25 pages, for a maximum of 26 pages with your memo.
- Note: Summary Page, Outline, Reference List, and any appendices DO count toward the page limit. You should not make use of unauthorized images and materials whose use is restricted by copyright laws. Ensure you cite the sources for your ideas and the materials used in your report.

*About data: The attached data in this problem is confidential. Any team who would like to use the data has to sign a non-disclosure agreement (will all team-member signatures). Please name the signed agreement with Team No. and send it back in PDF format to tutor Mr. Yucen Gao via QQ (1243436048) or find him in QQ group to get the data. Only the team leader is asked to contact with the tutor. Please remark your Team No. and name in the standard form (e.g., 000-张三) when adding QQ friends. The tutor will not send the data packets until the team leader sends back the signed agreement. Please be noticed that do not share the data packets to anywhere.*

*Acknowledgement: This problem was inspired by a leading shipping enterprise in China. It is proposed and formalized by Prof. Xiaofeng Gao (gao-xf@cs.sjtu.edu.cn) from Department of Computer Science and Engineering at Shanghai Jiao Tong University, and was integrated, reorganized, and finalized by Ph. D. Student Yucen Gao(guo_ke@sjtu.edu.cn) from DCE Lab. He also collected the related data.*



## Appendix 1: Interpretation of terms

1. Contract market and spot market: For shipping company X, the sales market is divided into contract market and spot market. The order price in the contract market can be regarded as constant for a period of time, while the order price in the spot market fluctuates with the market. In the spot market,

[5] Please see Appendix 1.1 for the explanation of the spot market.

there are two kinds of goods:

- Special goods: steel, fly ash, mineral powder, quartz sand, coal[6] and related goods.
- Ordinary goods: goods in the spot market other than special goods. The freight rate of ordinary goods can be regarded as the same.

**Intelligent pricing system is used for ordinary goods in spot market.** Contracts and special goods have impacts on sales.

2. Container type: Shipping company X has two types of containers, 20 units and 40 units. Suffixes GP and HQ have no effect on the freight rate. For example, 40GP and 40HQ have the same freight rate. **To simplify the model, you could focus on the containers that are 20 units.**

3. Freight rate: Container transportation cost includes many items. Here we only discuss ocean freight. The data provided is the freight rate.

4. Voyage and flow direction: Voyage stands for a sailing ship, while the flow direction refers to the transportation route from a fixed port a to a fixed port B. For a voyage, there will be multiple flow directions of shipping space. For each flow direction, a certain proportion/quantity of shipping space will be allocated.

5. Off season and peak season: Off season represents a relatively poor sales or revenue position. October 2019 belongs to the peak season. **Since there are few rules for peak season in the existing rules, you could not consider the factors of the off and peak seasons when solving task 3.1.**

6. Selling period: Generally speaking, the sale of shipping space will start 14 days before departure. The real selling period of voyage should be obtained according to the data.

**Appendix 2: Interpretation of data**

1. Transaction data of container in October 2019: The table includes the transaction data of all containers in October 2019.
    1) WBL_CNTR_UUID: the ID of one waybill;
    2) CNTR_TYFE: container type;
    3) WBL_NUM: the number of one waybill;
    4) WBL_AUD_DT: the transaction time of one waybill;
    5) GGO_BRIEF_DESC_NME: name of goods;
    6) SVVD: S represents route, the first V represents the name of vessel, the second V represents voyage number, D represents direction. In summary, SVVD can be considered as the unique identifier of a voyage.

[6] Please refer to file 7 for Chinese interpretation.

7) AMT: the freight rate;

8) PORT_BEGIN: the departure port of the container;

9) PORT_END: the arrival port of the container.

2. Transaction data of ordinary goods in October 2019: The table includes the transaction data of all containers for ordinary goods in October 2019.

   1) IS_EMPTY: 0 represents the container is filled with goods, while 1 represents the container is empty.

   2) SOC: 0 represents the container belongs to the shipping company X, while 1 represents the container is owned by the customer. Generally speaking, the total freight of the customer's own container will be cheaper. To simplify the model, you can only consider the containers whose SOC=0.

3. Container route data: Route information for all containers.

   1) CNTR_NUM: the number of the container;

   2) SEQ_NUM: It represents the number of voyages the container has gone through.

   3) TRANS_TYPE: ‘Trunk’ represents big ship, while ‘Barge’ and ‘Feeder’ represents small ship.

   4) POL_CDE: code of departure port;

   5) POL_NME: name of departure port;

   6) LDD_SVVD: SVVD of departure port;

   7) POD_CDE: code of arrival port;

   8) POD_NME: name of arrival port;

   9) DSCH_SVVD: SVVD of arrival port.

4. Labels of contract orders and spot orders.

   1) BKG_MTHD: ‘CSO’ represents the order is contract order, while ‘TF’ represents the order is spot order.

5. Container information: The table is used to link waybill, container type, empty container and SOC information.

6. Existing pricing strategy of shipping company X: The table contains many price adjustment rules. When the sales in a certain direction of a certain voyage meet the conditions of a certain rule, the price increase or price decrease will be triggered.

   1) Product name: ‘ordinary’ represents the rule is suitable for ordinary goods.

   2) Start/end day: Generally, the container sale starts 14 days before the departure of a ship, and the start/end day specifies the applicable time interval of one rule.

   3) Space utilization rate: the proportion of the sold space to the total space allocated to the flow direction for a voyage.