2021 MCM-SJTU

Problem F: Safety risk bearing capacity model and decision-making direction of Shanghai dangerous goods waterway transportation

Background: Safety management is the base line of Shanghai's urban development. In recent years, with the rapid development of economy, especially the rapid development of petroleum, chemical, natural gas, energy and other industries, the volume of dangerous goods transported by water in Shanghai has continued to increase, and the number of dangerous goods transport ships and dangerous goods loading and unloading terminals has also increased. Here dangerous goods refer to chemicals with poisonous, corrosive, explosive, burning, combustion-supporting, and other properties.

The means of transportation of dangerous goods by waterways in Shanghai are usually ships. The corresponding transportation links of ship transportation are channel-anchorage-harbor-terminal-pipe network-storage tank or container yard, or ship transfer. The transportation water area is Shanghai Port. The area under its jurisdiction is coastal, Yangtze and inland rivers. Security risk categories often include traffic construction and transportation safety, natural disasters, public health safety, and social security. Among them, the types of safety risks caused by the transportation of dangerous goods often include fire and explosion risks, major pollution risks, risks of damage to vehicles and storage and transportation facilities, and risks of imported overseas epidemics for crew members. Because the water transportation of dangerous goods has the characteristics of large volume, variety, and complex characteristics, once a traffic accident or pollution accident occurs, it spreads rapidly, is difficult to control, and has a wide range of impact. Emergency assistance and pollutant removal are very difficult and destructive.

After clarifying the importance, we will further discuss some shortcomings and difficulties in the transportation of dangerous goods by waterways in Shanghai. In terms of major pollution risks in the storage and transportation of dangerous goods, the first shortcoming is that there are many difficulties in regulations, technology, management, and policies around the construction and safety of oil and gas recovery facilities. The second shortcoming is the difficulty in receiving and disposing of ship pollutants (oily sewage, solid hazardous waste, and dangerous goods washing water), receiving, transporting, disposing of dangerous goods, meeting discharge standards, regulatory technology, and qualified institutions. In terms of tolerance for extremely large and major hazardous cargo pollution accidents, the third shortcoming is the lack of response capacity for extremely large and major hazardous cargo pollution. There are difficulties in recovering from deaths, casualties and economic losses.

The transportation of dangerous goods by water in Shanghai has high risks and high pressure on safety management. Therefore, it is necessary to formulate policies to ensure the safety of transportation by water in Shanghai. In order to further solve the risk problem, experts put forward a new concept for the transportation of dangerous goods at Shanghai port——**Safety risk bearing capacity.** Risk bearing capacity is the limit of risk that an organization or individual can bear, referring to the risk tolerance capacity on all levels of risk. Safety risk bearing capacity refers to the maximum value of the graded security risk according to the risk category, and the Safety risk bearing

capacity of this type (Safety risk bearing capacity= safety risk/ risk bearing capacity), which can be given as excellent/good/medium/poor. (The Safety risk bearing capacity is only a suggested formula. It is not mandatory to use in the actual problem solving process, and the team is encouraged to expand and innovate).

Problem: The safety supervision and management of the maritime transportation of dangerous goods is highly professional, and the responsibility is heavy. Any negligence may lead to disastrous consequences. Therefore, it is necessary to firmly grasp the principle of "safety first, prevention first", focus on the maritime transportation of dangerous goods, and ensure the safe progress of dangerous goods maritime transportation with strict supervision, gradually enter the legal and standardized track, and promote the healthy and orderly development of my country's shipping economy. To create a good shipping development environment. Therefore, we invite you to make policy suggestions on the waterway transportation of dangerous goods in Shanghai.

This problem is complicated and probably your submission will not fully consider all the aspects described in the problem file. However, considering the aspects you want to solve, the team's paper should at least include:

Task 1: Please evaluate the safety risk category (source item), transportation process link (source item) of waterway transportation of dangerous goods at Shanghai port, and the risk resistance capabilities of storage and transportation enterprises of different sizes in Shanghai. (Risk assessment only analyzes risk factors qualitatively, without involving quantitative sources; All we're asking is to determine if there's a risk, and if there's a risk, to identify where the risk comes from. If you are interested, you can explore further and quantify the risk based on probability. Risk resistance comprehensively considers management, organization and other soft power and technical hard power).

Task 2: Risk management and control means that risk managers take various measures and methods to reduce the possibility of risk events to occur, or to reduce losses the consequence of risk events. Risk management and control usually have four major measures, namely risk avoidance, loss control, risk transfer and risk retention. Could you please give a decision-making model for storage and transportation enterprises to deal with risks when they meet the maximization of enterprise utility (self-risk, purchase insurance, etc.).

Task 3: According to the decision model you obtained in 3, now consider the distinction between large and small companies. For companies with insufficient risk bearing capacity, the occurrence of risk events will cause externalities to overflow, which will cause significant social, economic and people's livelihoods. Therefore, it is necessary to introduce the government to supervise and promote. The government often uses command and control (pollution control, output control, technology control, process control, etc.), legislation to increase taxation, compulsory purchase of insurance, accountability system, or establishing government governance funds to resist risks. Considering the goal of maximizing social utility, please explain how to use your model design to provide policy recommendations to the Shanghai Municipal Transportation Commission, and please explain what policy recommendations are there.

Task 4: Write a two-page policy memo to the decision maker on the utility, results, and recommendations based on your policy modeling on this issue. Because the policy design is oriented to experts in maritime affairs, ports, environmental protection, marine, public security and other departments, your interpretation needs to be not only scientifically literate but also diversified.

Your submission should consist of:

- One-page Summary Sheet
- Two-page memo
- The MCM/ICM Contest now have a 25 page limit. The 25 page limit applies to the entire submission including the Summary Sheet, Solution, Reference List, Table of Contents, Notes, Appendices, Code and any problem specific requirements

This problem is proposed by Prof. Jie Gao, the previous director of the Environmental Protection Center of the Ministry of Transport, and now he is the senior expert of the Scientific Research Institute of the Ministry of Transport, the regular expert of the Evaluation Center of the Ministry of Ecology and Environmental Protection, and the bid evaluation expert of the Ministry of Finance. It is then formalized by Prof. Xiaofeng Gao (gao-xf@cs.sjtu.edu.cn) from Department of Computer Science and Engineering at Shanghai Jiao Tong University, and scribed, modified, and finalized by Yuan Luo, Yuxuan Huang, Zuoyu Qiu, from Team-96 of SJTU-MCM Group. Mr. Tongxin Ren (rentongxin@sjtu.edu.cn, Outstanding Winner of MCM2018 Problem C) helped proof reading and provided many suggestions.