ISBN 978-5-901722-96-1

УДК 656.6

ФОРМИРОВАНИЕ АДАПТИВНОЙ ЛОГИСТИЧЕСКОЙ СХЕМЫ ПРИ ВНЕЗАПНОМ ЗАКРЫТИИ УЧАСТКА ВОДНОГО ПУТИ (АВАРИЯ, ЛЕДОСТАВ, РАЗЛИВ)

Николаева Елизавета Андреевна[1], бакалавр
e-mail: lizochka.nikolaeva.nikolaeva@mail.ru
Ерофеева Алина Салаватовна[1], бакалавр
e-mail: alya.yerofeeva.07@mail.ru
Мясникова Алина Олеговна[1], бакалавр
e-mail: amyasnikova07@gmail.com

[1] Национальный исследовательский университет Московский государственный строительный университет, Москва, Россия

Аннотация. Водные пути часто закрываются внезапно из-за аварий, ледостава или разливов рек. Это нарушает доставку грузов. В статье предлагается простая адаптивная логистическая схема, состоящая из четырёх этапов: мониторинг, поиск альтернатив, выбор наилучшего варианта с помощью формулы и контроль. Схема может использоваться даже в условиях ограниченной информации и подходит для обучения студентов.

Ключевые слова: адаптивная логистика, водный транспорт, закрытие маршрута, ледостав, авария, разлив, альтернативный маршрут, перегрузка грузов.

FORMATION OF AN ADAPTIVE LOGISTICS SCHEME FOR THE SUDDEN CLOSURE OF A WATERWAY SECTION (ACCIDENT, ICE COVER, SPILL)

Elizaveta A. Nikolaeva[1], Bachelor's Degree Student
e-mail: lizochka.nikolaeva.nikolaeva@mail.ru
Alina S. Erofeeva[1], Bachelor's Degree Student
e-mail: alya.yerofeeva.07@mail.ru
Alina O. Myasnikova[1], Bachelor's Degree Student
e-mail: amyasnikova07@gmail.com

[1] Moscow State University of Civil Engineering (National Research University), Moscow, Russia

Abstract. Waterways often close suddenly due to accidents, ice cover, or river spills. This disrupts cargo deliveries. The paper proposes a simple adaptive logistics scheme consisting of four steps: monitoring, finding alternatives, choosing the best option using a formula, and control. The scheme can be used even with limited information and is suitable for teaching students.

Keywords: adaptive logistics, water transport, route closure, ice cover, accident, spill, alternative route, cargo reloading.

Introduction

Water transport plays a big role in Russia. Rivers and seas carry oil, coal, construction materials, grain, and containers. The main advantages are low cost and high carrying capacity. One ship can replace several dozen trucks or a whole railway train.

However, waterways have a disadvantage – they depend on weather and technical conditions. In winter, rivers freeze (ice cover). In spring, due to snow melting, spills occur and the navigable channel may change its position. Accidents are also possible: ship collisions, oil spills, damage to locks or bridges. In any of these situations, a section of the route may be closed for several days or even weeks.

If the logistics scheme does not adapt to changes, cargo is delayed. Companies pay fines, lose customers, and suffer losses. Therefore, it is important to think in advance about how to act in case of a sudden closure.

1. Reasons for sudden closure of waterways

Let us look at three main reasons in more detail.

Accidents. This can be a technical breakdown of a ship, grounding, collision, or spill of dangerous substances. For example, if an oil tanker runs aground, traffic on the river is completely stopped until the spill is cleaned up. Such a situation occurred on the Lena River in 2020 – traffic was closed for three days.

Ice cover. In winter, rivers freeze. Icebreakers can maintain navigation, but not on all sections. When ice thickness reaches 50–70 cm, ordinary ships cannot pass. In northern rivers (Pechora, Ob, Yenisei), ice cover lasts up to 6–7 months. However, even in southern regions (Volga, Don), ice cover can occur suddenly during a sharp cold spell.

Spill. In spring, water levels rise sharply. The current changes, and flooded obstacles appear. Bridges may become too low for ships to pass. Also, a spill can flood berths, making it impossible to load or unload cargo.

2. Concept of an adaptive logistics scheme

An adaptive logistics scheme is a plan of action that changes in real time depending on the situation. It consists of four main blocks:

1. *Monitoring*– constant observation of the waterway condition.
2. *Analysis* – assessment of whether passage is possible or a detour is needed.
3. *Alternative selection* – decision on how exactly to deliver cargo around the closed section.
4. *Implementation and control* – execution of the new plan and cargo tracking.

Such a scheme does not require expensive software. It can be implemented using simple tables and a phone.

3. Step-by-step algorithm for forming an adaptive scheme

Step 1. Detecting the closure

Information can come from three sources:

- Official notifications from the waterway administration or the River Register.
- Data from captains of other ships (by radio or messengers).
- Satellite images and ice maps (free services are available).

Example: A ship is sailing along the Volga. The captain learns that the bridge downstream is closed due to an accident. He reports this to the company dispatcher.

Step 2. Determining the boundaries of the closed section

It is necessary to understand which kilometer of the river is blocked and for what distance. For example, a section from city A to city B (length 40 km) is closed. It is also important to know whether it is possible to pass through another branch or tributary.

Step 3. Finding alternative routes

The following detour options are possible:

- Water detour – through another river, canal, or channel. For example, there are many branches in the Volga delta.

- Reloading to another transport mode – cargo is unloaded above the closed section, transported by land (truck or rail), and loaded again onto a ship below the closure.

- Complete transfer to land transport – if the closure is long-term, it may be cheaper to send the cargo entirely by trains or trucks.

Step 4. Assessing costs and time

$$C = (T_{alt} \times V_{cost}) + D_{extra} + P_{trans} \quad (1)$$

where C– total additional costs (rubles);

T_{alt}– additional time on the alternative route (hours);

V_{cost}– cost of one hour of transport operation (rubles/hour);

D_{extra} – costs for the extra distance (fuel, wear and tear);

P_{trans} – cost of reloading the cargo (if needed).

The option with the smallest C is chosen.

Example. A 30 km section is closed. Option A: detour through another river + 50 km, no reloading needed. Option B: reloading onto trucks + 20 km by road. We calculate the costs. If reloading is cheap and fast, Option B may be better.

Step 5. Implementation and control

After selecting the route, it is necessary to:

- Contact ports and terminals for reloading.

- Assign a person responsible for cargo tracking.

- Receive reports on cargo location every 2–4 hours.

- If new problems arise (for example, a truck breaks down), restart the algorithm.

4. Practical example (case study)

Initial data: A barge with 500 tons of crushed stone is sailing along the Kama River. Point of departure – Perm. Point of destination – Chistopol. Distance by water – 600 km. A section 80 km long between the city of Sarapul and the village of Karakulino is suddenly closed due to ice cover.

Actions of the logistics specialist:

1. Notification received from the River Register at 10:00.

2. It is determined that the closed section begins 200 km from Perm.

3. Three alternatives are found:

- A: wait 5 days for the ice to melt (cost of barge idle time – 15,000 rubles/day).

- B: reload the crushed stone onto 25 trucks (20 tons each), drive around by road (80 km), reload onto another barge below the ice.

- C: send the crushed stone entirely by rail (but the nearest station is 40 km from Perm).

4. Calculation:

- Option A: 5 × 15,000 = 75,000 rubles + loss of customer due to delay.

- Option B: reloading (40,000 rubles) + truck operation (25 trucks × 4 hours × 800 rubles/hour = 80,000 rubles) = 120,000 rubles.

- Option C: very expensive due to transport to the station.

5. Option B is chosen, despite the costs, because it is faster (1 day instead of 5).

6. Control: the dispatcher contacts the truck drivers and receives the cargo at the port below the ice.

5. Advantages of the proposed scheme

- *Simplicity* – no complex computer programs are needed.
- *Speed*– a decision is made within a few hours.
- *Flexibility* – the scheme works for any cargo and any river.
- *Learnability* – students and young specialists can easily master the algorithm.

Conclusion

Sudden closure of a waterway section is a serious problem, but it can be solved using an adaptive logistics scheme. The main thing is to quickly obtain information, find detour options, compare them using a simple formula, and organize control. Even a first-year student can apply such an algorithm in practice. In the future, these skills will help future logistics specialists and dispatchers work efficiently and avoid large losses.

References:

1. Gagaev S. Yu. Problems and prospects of inland water transport development in the Russian Federation // Scientific look into the future. – 2016. – Vol. 1. – No. 2. – P. 46-50.

2. Vessels of inland and mixed (river-sea) navigation. Sanitary rules and regulations: SanPiN 2.5.2-703-98. – Moscow: Ministry of Health of Russia, 1998. – 144 p.

3. Rules for preventing environmental pollution. Russian River Register. Moscow. – 2016.

4. Economic-mathematical methods and models in maritime transport management: Textbook for students of maritime universities / E.N. Voevodusky, N.A. Konvetseva, G.S. Makhurenko, I.P. Tarasova; edited by E.N. Voevodusky. – M.: Transport, 1988. – 384 p.