Routing of Empty Cars at Offloading Stations

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Abstract. This paper identifies large-scale offloading stations and analyzes the process of emptying cars with breakdown by rolling-stock composition and by owners; it also tracks changes in the number of empty cars with breakdown by owners at dedicated stations and at destination stations. The research identifies the primary groups of cars that can be routed for exit. Thus, it produces criteria for optimizing the routing of empty cars and improving the operating performance for OAO RZD.

1. Introduction
Eastern Russia’s railways follow the latitudes and barely branch. The key line that links Central Russia to the Urals, Siberia, and Far East is the 9,332-km Transcontinental Railway: Moscow-Ryazan-Ruzayevka-Syzran-Samara-Ufa-Chelyabinsk-Irkutsk-Chita-Khabarovsk-Vladivostok. There has been constructed the Baikal-Amur Railway: from Ust-Kut to Komsomolsk-on-Amur.

Of importance for Russia are the South Siberian, Mid-Siberian, and Turkestani-Siberian Railways that go through Kazakhstan. The Tyumen-Surgut-Urengoy line follows a meridian.

Russia’s railway network is rather scarce at 5 km to 1,000 square kilometers, which is why the cargo traffic is heavy. It is the heaviest on the major routes: Central Russia to North-West; Central Russia to the Urals; Central Russia to Caucasus; Central Russia to South-West; Volga to the Urals; the Urals to Siberia; and Siberia to Far East.

2. Theory
Coal constitutes the bulk of railway cargo. Below is the analysis of railway operations for 2016–2018:

Cargo traffic breakdown by type of cargo

![Figure 1](image-url)
Since early 2017, the Far Eastern Territorial Branded Transport Service Center (TBTSC) has carried out a number of projects to reduce traffic carried by the infrastructures of classification yards on the Far Eastern Railway. Consignment to a single loading station effectively eliminates the need for shunting along the route, which means that a full departmental train can travel a full distance without extra switching.

Over the twelve months of the last year, the seaport and border stations of the Far Eastern Railway dispatched 1,736 trains that passed by classification yards without shunting.

Reducing the infrastructural load saved more than 37 million rubles over the same period. This was enabled by a nearly total exclusion of train shunting at seaport stations as well as by eliminating the need to buffer and switch at the classification yards of the Far Eastern Railway.

Besides, the effort improved the operating performance. On some routes, the turnaround time of a car dropped by 1.5 days. For some destinations, the actual delivery time became 1 to 3 days shorter. This saved over 9 million rubles in potential risks of being charged for late delivery.

As the Far Eastern ports are now tasked to full capacity, so is the infrastructure of the Far Eastern Railway. Processing facilities can be freed up not only by constructing new stations, passing loops, etc., but also by optimizing the empty car operations. Empty cars used to return back to loading stations as part of departmental trains, but this procedure is no longer applicable. Using the non-public port infrastructure for shunting is not an option. At the same time, classification yards are no longer in capacity to process empty cars en route.

Given that the seaport lines of the Far Eastern Railway are limited in capacity, it is important to optimize the logistics to return empty cars, as well as to modify the procedure for handling empty cars on the Eastern railroads.

The Far Eastern Railway is in continuous cooperation with the carriers; the chart below shows their fleet:

![Figure 2](image-url)

The research effort is to find and propose various options for optimizing the car management, specifically that for empty cars. The proposed solutions are:

1. to effectively exclude backhauling by intensifying double operation and dispatching cars in the same direction only.
2. to cooperate with major shippers to minimize the number of owners whose cars are used for loading cargo.
3. for some routes, to implement an intra-railway ‘circular’ traffic technology, i.e. to return unloaded cars back to loading stations.

The main problem is still the same though: documentation and reporting of unloaded empty cars may force the carrier to perform nearly 100% shunting of empty cars en route. Consolidating empty
cars under a single carrier, owner, or operator to dispatch them from seaport stations is not an option, as neither shippers nor ports are willing to do such work.

Below is the chart of average monthly cargo unloaded at major seaport stations of the Far Eastern Railway; another chart shows how many rolling-stock owners operate at these stations. The charts make it clear that the more cars are unloaded at seaports, the more car owners and operators work there.

**Figure 3**

Cargo Traffic to Seaport Stations

The paper analyzes the following approaches to optimizing the return of empty cars from Far Eastern ports:

1. Consolidating the rolling stock of different owners when dispatching an empty trainset;
2. reducing car turnaround time by shunting empty cars to be hauled by departmental trains with an option to redirect them to loading stations.

**3. Research findings**

Consider the largest seaport Station A that accounts for 40% of the total cargo unloaded at seaport stations of this railway. Since the station is crucial to the whole railway’s operation, Station A should optimize the return of empty cars from it, a high-priority task in the context of general empty car traffic optimization problem.

To develop and implement the solutions for this part of the Far Eastern Railway, the research team analyzed the incoming laden cars and outgoing empty cars; they also had meetings with port operators and rolling-stock owners. It was found out that upon unloading at Station A, up to 80% of empty cars is routed to one railroad, whereas the remaining 20% is distributed between five different railroads.

Station A dispatched empty cars to over 15 destinations. The dispatched empty cars routed to the stations of a single railroad have to be shunted at a classification yard en route to further split them into 8 different destinations. Other classification yards operate similarly.
Given that one of the railways loads gondola cars by pooling, and each rolling-stock operator has its own post-offloading dispatching arrangements, we herein propose:

1. That Station A dispatch empty trains to a single railroad.
2. That empty cars be pooled into, and hauled by, departmental trains from Station A to a specific railroad, then diverted to the loading stations, which will require consolidating the gondola car owners for dispatch an empty train.
3. Dispatching empty gondola cars from stations to the loading stations of the Eastern railroads.
4. Dispatching fully loaded trainsets composed of a single owner’s cars with the same destination port, then returning the empty cars back to the loading station.

This procedure will enable Station A to dispatch up to 20 departmental trains hauling empty cars every day, which will improve the transit of empty cars, unload the backbone classification yards of the Eastern railroads, and guarantee that the railway stations of the adjacent railroad always have some free loading capacity.

Similarly, consider Port D, where the shippers, the seaport, and the car owner are all part of the same holding.

Shipments to Port D are dispatched from two railroads. Coal delivery operations use a fleet comprising cars owned by up to 14 different companies. Once unloaded, the loading stations has to dispatch the empty cars to a variety of consignees. The proposed solution is to:

1. Use cars from only three to five owners to deliver coal to Port D.
2. Pool empty cars and consolidate them under a single carrier (Port B); dispatch them as part of departmental trains from loading stations as shippers might need.

When optimizing the dispatching of empty cars, focus is made on transport hubs and their stations; like many other near-port stations, transport hubs lack consolidation of logistics to return empty cars.

Analysis reveals that from a single major non-public route, empty cars are dispatched to 56 stations on 8 railroads. In total, some 25 thousand cars is unloaded per annum. Dispatching unloaded empty cars at B is done similarly: 56 stations, 5 railroads, 6 thousand cars per month. While the loaded cars reach their destinations by following the delivery routes most of the time, empty cars return in groups or even as single-wagon trains [1-10].

To optimize the return of empty cars, car operators have agreed that gondola cars from the seaport Station B be dispatched as part of departmental trains comprising the company-owned cars. Shunting will be done at an approach adjacent to Station B, with trains to be dispatched to stations of multiple railroads; it has been proposed to consolidate the dispatching of empty cars by having departmental trains of different owners haul such cars to the loading stations of a single railroad.

The arrangement will thus be similar to that of Port D.

4. Conclusion
The technology can be deployed at any major seaport station in Russia, e.g. that of the Port of Novorossiysk. There are 21 companies operating there.

Criteria for this technology may vary depending on a number of factors, e.g. number of tracks on the yard, number of classification of owners (see below), cargo structure and amount.

Car fleet classification:
1. **By ownership:**
   - Private
   - Operator-owned
2. **By the size of rolling stock:**
   - Small companies. Account for >50% of the railway freight market. A maximum of 20 cars per company. Total car ownership is only 3% of the total fleet of private cars.
   - Medium-sized companies. 40% of the market actors. Each has either 21 to 100 cars (Group 2) or 101 to 500 cars (Group 3). The second most important category of railway cargo carriers and the most competitive one.
Major companies: 501 to 1,000 cars (Group 4) and > 1,000 cars (Group 5). 59 companies own and operate > 1,000 cars each; in total, they own more than half of all private cars.

3. **By scale of operation:**
   - Regional
   - Interregional
   - International

4. **By form of ownership:**
   - Independent company
   - Part of a company group

5. **By composition of rolling stock:**
   - One type of rolling stock
   - Two types of rolling stock
   - Three or more types
   - All types of rolling stock

6. **By nature of cargo:**
   - One kind of cargo
   - Various kinds of cargo

7. **By services provided:**
   - Cargo transport
   - Transportation, transshipment, warehousing, customs clearance, shipping, etc.
   - Delegating trains to other companies for operation.
   - Traction, leasing train paths and personnel.

8. **By type of operation:**
   - Transport company
   - Rolling-stock owners
   - Carriers
   - Shipping companies

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