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Systematization of factors influencing train movement

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Abstract: The main goal of the work is to identify and systematize the factors that determine the quality indicators of railway transport, affecting traffic safety, and to develop directions for increasing the level of traffic safety. Factors influencing the safety of train traffic have been identified and systematized according to 7 criteria. In order to increase the level of train safety, based on the results of analysis and assessment of the factors influencing them along the route, the main directions of measures to improve the level of safety were developed based on the Hoshina-Kanri principle. The developed mechanism determines what measures should be implemented at stations, terminals and freight facilities to improve train safety.

Keywords: Train movement, factor, systematization, traffic safety, transportation process, productivity

1. Introduction

Efficient and safe management of train traffic during transportation is important to ensure the efficiency and reliability of the transport system [1-8].

The timely delivery of trains (without excessive loss of time at stations, freight facilities and terminals) to their destinations (cargo receivers, passengers and designated disembarkation points) while ensuring the safe movement of trains along the route is determined by the image of this transport in the market [6-8]. Of course, to achieve this, one of the pressing issues is the search for continuous integrated solutions in the process of railway transportation and their implementation. In this case, the first main task is to identify factors that have a negative impact on the transport process, their systematization (in the source) and the search for comprehensive solutions to eliminate them.

The following factors are of great importance in this process:

saving time - accurate planning of train movements allows passengers and goods to reach their destination on time;

economic efficiency – ensures the rational use of resources, including fuel, electricity and employee working time;

ensuring safety - train collisions, delays and other emergency situations can be prevented through clear organization of traffic;

increasing the capacity of passenger and cargo transportation – effectively organized traffic increases the capacity of passenger and cargo transportation;

reliability of the transport system – the stability of train traffic increases the confidence of passengers and customers, since all processes are carried out on the basis of a clear schedule;

environmental efficiency – optimal operating mode reduces fuel consumption, which helps reduce environmental damage.

Also, the introduction of automation and train traffic control systems using modern technologies will make this process more efficient. Through them, traffic schedules can be constantly monitored and, if necessary, quickly changed.

To assess the efficiency of organizing train traffic, the following indicators are used (Table 1).

Table 1

Indicators for assessing the efficiency of train traffic management

Indicator name	Evaluation Mechanisms	Explanation
Time indicators	Level of compliance with train schedules	It evaluates how accurately trains adhere to specified time intervals.
	Delays	Number of delays and their total duration
	Average movement speed	Determines the average speed of the train along the track.
Indicators of cargo and passenger transportation	Load capacity	Amount of cargo transported per unit of time (tons/km)
	Passenger capacity	Number of passengers transported per unit of time (passenger/km)
	Level of wagon capacity utilization	Overloading (loading) of passenger (freight) carriages
Safety indicators	Number of emergencies	Number of road safety violations
	Performance of traffic control systems	Level of operation of security automation systems
Economic indicators	Amount of fuel or energy consumed	Fuel or electricity used for propulsion
	Total costs for organizing traffic	Road infrastructure, maintenance, staff salaries and other expenses

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	Income/cost ratio	Ratio of income from train traffic to expenses
System stability and efficiency	Flexibility of train schedules	Stable adherence to the schedule, despite the intensity of train traffic
	Number and duration of stops	Time of stops along the way and their brevity
Environmental indicators	Exhaust gases	The amount of CO_2 emitted while a train is moving
	Energy efficiency	Ratio of energy consumed to cargo or passenger transported

Based on these indicators (Table 1), the efficiency of organizing train traffic and the possibilities for their improvement are analyzed and appropriate decisions are made.

2. Methods and materials

Organization and management of railway transportation, development of systems and methods for ensuring train traffic safety, increasing the productivity of participants in the transportation process, as well as identifying, assessing and eliminating factors affecting traffic safety, laboratory scientists have conducted scientific research [1-8].

Scientific works [2-6] made the following conclusions: strict adherence to the placement of workers at work places in accordance with their qualifications; establishing constant control over the movement of trains; optimization and digitalization of processes; comprehensive mechanization of loading and unloading operations; improvement of railway transport management systems, etc. However, most scholars have not specified the exact mechanisms of how these measures should be implemented. In addition, the systematization of factors influencing the movement of trains throughout the entire traffic cycle has not been sufficiently studied.

3. Results and discussion

The indicators of train traffic organization are influenced by various factors [1-6]. Assessing their impact is important to improve efficiency and eliminate problems. It is important to use monitoring systems and data analysis techniques to determine the level of impact of each factor and manage them effectively. This allows you to organize traffic more efficiently.

As a result of the analysis of scientific works [1-6, 10], various factors were identified that influence the movement of trains along the route, which, based on the results of the analysis, were conditionally divided into 7 criteria (technical factors, organizational factors, natural factors, human factors, load factors , economic factors, information factors) and systematized (Fig. 1).

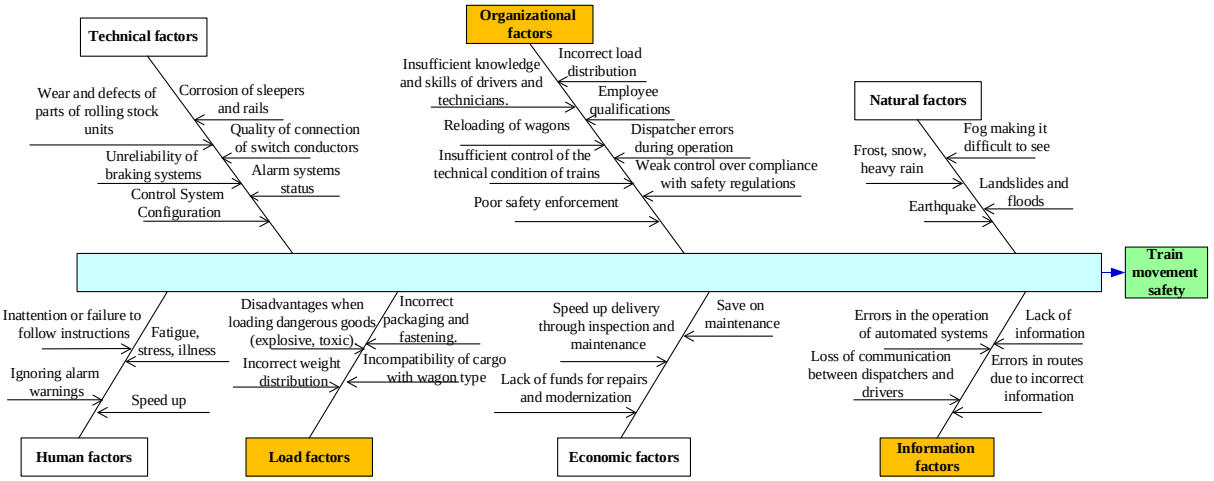

Fig. 1. Factors influencing the movement of trains along the route

Description of the factors influencing the movement of trains in this form allows us to determine which group each factor belongs to, assess the level of their impact and develop appropriate measures for timely elimination.

These factors (Fig. 1) have different effects on trains during their movement. Therefore, comprehensive approaches are needed to eliminate them.

A number of factors listed in Figure 1, which took place in the process of organizing train traffic at the stations of Uzbekistan Railways JSC and adjacent branches and stations, were studied. The study was carried out on the site of the railway departments (Fig. 2).

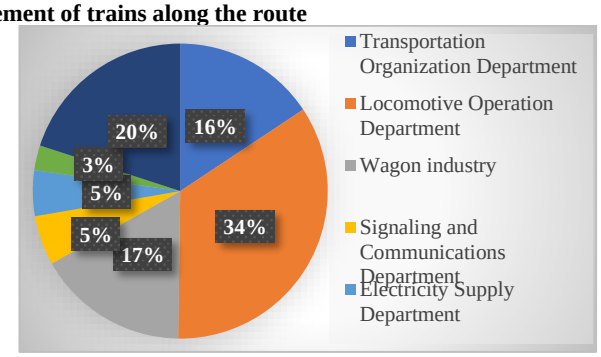

Fig. 2. Share of road safety violations attributable to organizations of the joint stock company "Uzbekistan Railways"

The largest share of traffic safety violations occurs in the "Use of Locomotives" (34%) and "Road Maintenance" (20%) divisions. Therefore, it is important to develop the necessary measures to improve the level of road safety in these departments.

Effective provision of transport safety in transit is carried out through a combination of technical, organizational and technological measures aimed at preventing emergency situations and minimizing their consequences.

The safety of trains during transportation at stations requires taking into account many factors related to the characteristics of the infrastructure, the movement of rolling stock, the organization of station operations and the human factor.

To improve safety at stations, it is necessary to combine the efforts of all participants in the process: from drivers and dispatchers to engineering services. This ensures stable and safe operation of the station when transporting passengers and cargo.

In addition, the safety of trains when transporting goods by rail depends on many factors related to the state of infrastructure, rolling stock, organization of loading and unloading operations and compliance with regulatory requirements. Below are the main aspects.

1. Infrastructure factors:

condition of roads of cargo facilities: condition of railway tracks, switches and loading platforms; absence of deformations and obstacles on the roads.

loading and unloading areas: lack of modern equipment for loading and unloading (cranes, conveyors, etc.); lack of clearly organized areas for equipment operation.

engineering structures: unreliability of warehouses, bridges and platforms; unsuitability of access roads to branches.

2. Moving content:

technical condition of cars: presence of defects in freight car bodies, brake systems and wheel pairs; without taking into account the maximum load capacity to avoid overloading.

load securing: failure to use secure securing methods to prevent cargo from shifting; failure to maintain proper weight distribution in the carriage.

use of special wagons: do not use tanks, platforms and semi-open wagons for the transportation of certain types of cargo (dangerous, volatile, container).

3. Organization of the transportation process:

route planning: without taking into account the condition of roads along the entire route; not taking into account capacity when choosing the optimal traffic schedule.

compliance with the speed limit: not taking into account the weight of the train and the types of cargo transported when controlling the movement of trains.

loading and unloading operations: non-compliance with technology when loading and unloading cargo; idle time of rolling stock.

4. Dangerous goods:

compliance with safety standards: non-compliance with the rules for transporting dangerous goods; Do not use labels or danger signs on carriages.

cargo condition monitoring: failure to check packaging and tightness of tanks and containers; failure to check the tightness and packaging of containers and tanks; failure to control the possibility of leakage or explosion.

supporting documents: incorrect execution of the waybill and instructions for working with it.

5. Human factor:

personnel qualifications: lack of knowledge among personnel on how to safely unload (load) and handle cargo from(to) freight trains.

loading and unloading teams: lack of instructions for working with certain types of cargo; lack of constant monitoring of compliance with the rules.

dispatch control: problems of coordination of work between the departure and arrival stations; inaccuracies in the traffic schedule.

6. Natural and external threats:

weather conditions: without taking into account precipitation, temperature and wind when transporting goods, especially bulk or liquid cargo; slowness of cargo protection from external influences.

external interference: lack of security systems at cargo transportation facilities; Insufficient work has been done to prevent theft and vandalism.

7. Economic and legal aspects:

security funding: do not allocate resources to modernize rolling stock and freight infrastructure.

Regulatory regulation: non-compliance with international and national shipping standards; lack of constant monitoring of compliance with cargo terminals and rolling stock.

From the above factors, we can conclude that to ensure the safety of transportation at cargo facilities, an integrated approach is required, including modernization of infrastructure, strict control over the condition of cars, the introduction of automated technologies, and ensuring a high level of professional training for employees.

In order to increase the level of train traffic safety, areas of action were developed to analyze the results and assess the factors influencing them (Fig. 1).

Measures to improve the level of train safety, that is, the main directions, were developed taking into account the principles of Hoshina-Kanri [9] (Fig. 3).

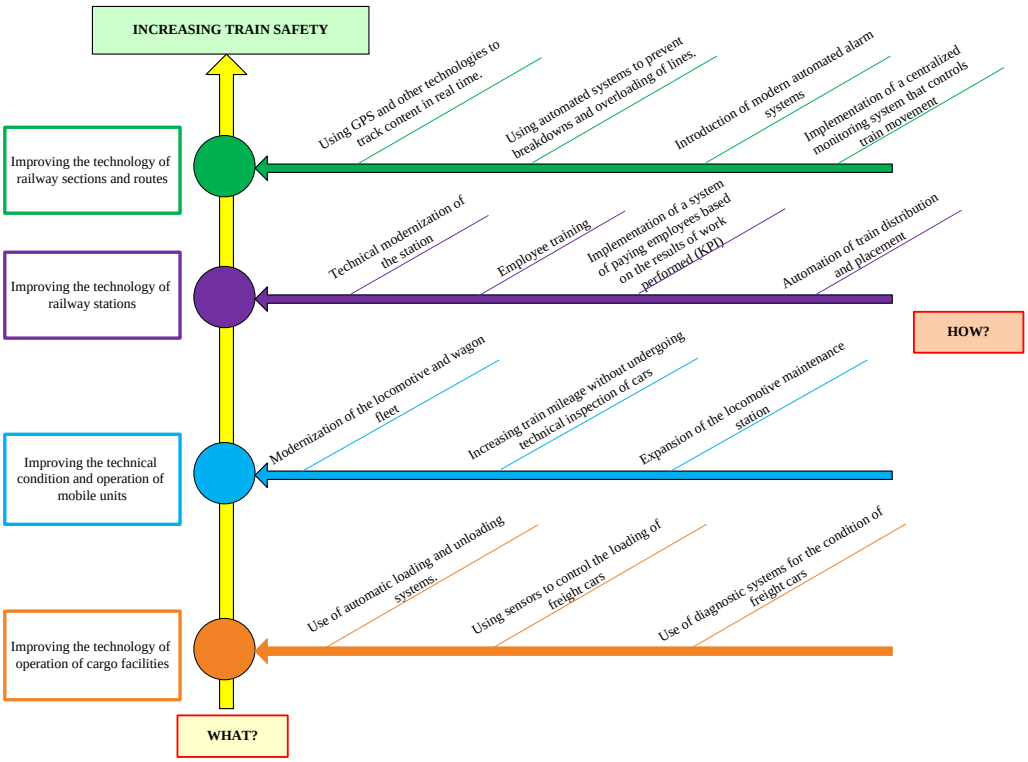

Fig. 3. Main directions for improving train safety along the route

Through this developed mechanism (Fig. 3), trains determine which measures should be implemented at each stage (train, station, freight facility, etc.) to improve traffic safety.

4. Conclusion

Ensuring the safety of train traffic at each stage determines the level of implementation of complex indicators of the quality of railway transport. Ensuring traffic safety significantly influences the performance of important indicators of railway transport and determines the position of the industry in the transport market.

Systematization of factors affecting the safety of trains along the route in the area of stations, stations and freight facilities, their systematic analysis, assessment and development of operational measures for their timely elimination, creates opportunities for effective assessment of the work of transport and the transport process of each of its participants.

The implementation of the proposed measures will lead to an increase in the productivity of railway transport and increase the attractiveness of the industry.

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