TO DETERMINE THE EFFECTIVENESS OF THE INTRODUCTION OF THE SYSTEM OF OPERATIONAL CONTROL OF LOCOMOTIVES MOVEMENT IN RAILWAY STATIONS TO JSC "UZBEK RAILWAYS"

Pulatov Maruf Murodulla ugli
Assistant, Tashkent State Transport University
marufpolatov4@gmail.com
Sadullaev Bekhzod Alisher ugli
sba151226@gmail.com
Master, Tashkent State Transport University
Mustafaeva Kamola Nuriddin kizi
Student of Tashkent state transport university
kamolamustafayeva@gmail.com
Soliyev Tokhirbek Sahobiddin-ugli
Student, Tashkent State Transport University
tohirbeksoliyev88@gmail.com

ABSTRACT

The locomotive economy is one of the most important elements of the railway transport infrastructure, as well as one of the major subjects of the railway services market, which has its own regulatory mechanism, the components of which are the supply and demand for traction services. This article provides a broad overview of the work performed on the research topic and identifies the need for the development of theoretical and practical recommendations to determine the priority areas for the modernization of the locomotive economy in the system of Uzbekiston Temir Yullari JSC, taking into account the experience of developed countries. The performance of the main indicators of locomotive fleets is analyzed. Revealed, the main reasons for non-fulfillment of certain indicators of operational work. The goal of development and the stages of implementation of operational control systems for the dislocation of locomotives (OCLD) are formulated. In order to determine the economic efficiency and assess the functioning of the OCLD, simulation modeling of the operation of locomotives was carried out on the territory of the RRJ - Tashkent. On the example of a simulation model, it is substantiated that the operational control of the dislocation of locomotives makes it possible to increase the useful work of freight locomotives. It is proved that on the territory of RRJ-Tashkent will increase the useful work of freight locomotives by 3.83 hours from its actual value, the economic effect of which will amount to 2,161,167,920 sums per year.

Keywords: *operational control of the dislocation of locomotives, useful work of a locomotive, idle time of locomotives, unproductive consumption of diesel fuel, JSC "Uzbekiston Temir Yullari".*

АННОТАЦИЯ

Локомотивное хозяйство - один из важнейших элементов инфраструктуры железнодорожного транспорта, а также один из основных субъектов рынка железнодорожных услуг, имеющий собственный регуляторный механизм, составляющими которого являются спрос и предложение на тягу. Сервисы. В данной статье представлен широкий обзор проделанной работы по теме исследования и выявлена необходимость разработки теоретических и практических рекомендаций по определению приоритетных направлений модернизации локомотивного хозяйства в системе АО «Узбекистон темир йуллари» с учетом опыт развитых стран. Проанализирована работа основных показателей локомотивного парка. Выявлены основные причины невыполнения отдельных показателей оперативной работы. Сформулирована цель разработки и этапы внедрения систем оперативного управления дислокацией локомотивов (OCLD). С целью определения экономической эффективности и оценки функционирования ЦОД было проведено имитационное моделирование работы локомотивов на территории ДЖД - Ташкент. На примере имитационной модели обосновано, что оперативный контроль дислокации локомотивов позволяет увеличить полезную работу грузовых локомотивов. Доказано, что на территории RRJ-Ташкент увеличится полезная работа грузовых локомотивов на 3,83 часа от фактического значения, экономический эффект от чего составит 2 161 167 920 сумов в год.

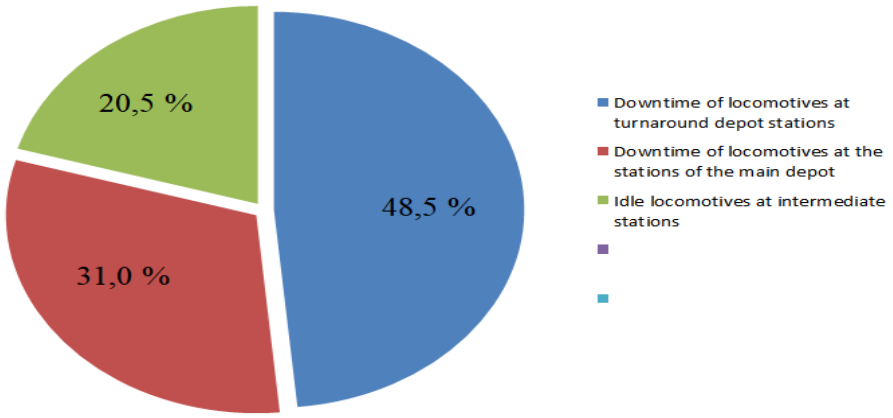
Ключевые слова: *оперативный контроль дислокации локомотивов, полезная работа локомотива, простой локомотивов, непроизводительный расход дизельного топлива, АО «Узбекистон темир йуллари».*

INTRODUCTION

The introduction of advanced technology in railway transport is inextricably linked with the development of the locomotive economy, which holds one of the main places in the transportation process. The development and improvement of the locomotive economy is closely connected with the increase in the efficiency and efficiency of the locomotive and locomotive crews.

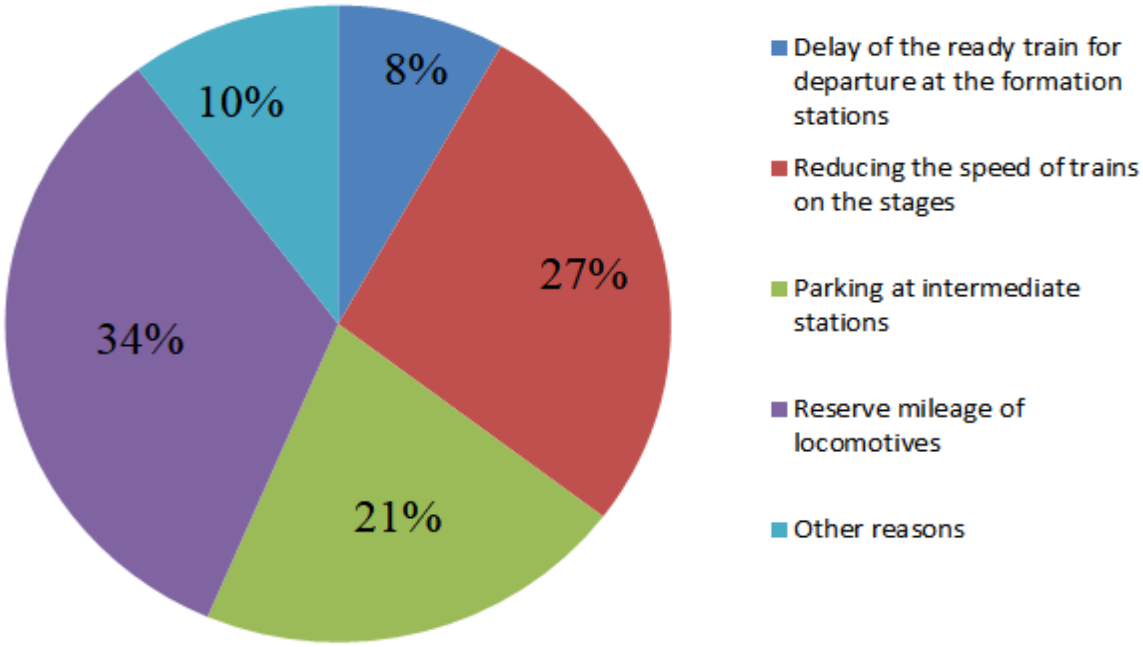
According to statistics, on average, at "Uzbekiston Temir Yulari" JSC, the train locomotive is only 45% (10.8 hours) of the time busy in useful traffic, and the rest of

the time (13.2 hours) is at the stations of the main depot and at intermediate stations (fig. 1).



Rice. 1. Downtime of locomotives of JSC “Uzbekiston Temir Yullari”.

From fig. 1. we can conclude that almost half of the idle time of locomotives falls on waiting for work at some stations. At the same time, at other stations, there are often cases of shortages of locomotives or locomotive crews. In turn, due to the untimely arrival of locomotives with crews, there are long downtime of freight trains at train formation stations. All this leads to the reserve run of the locomotives. Therefore, a large amount of electricity or diesel is consumed. At the end of 2020, compared to 2019, 20.8% of electricity and 2% of diesel fuel were spent on traction. The main causes of excess costs are shown in Fig. 2.



Rice. 2. Reasons for unproductive consumption of diesel fuel in 2015

For the most rational use of train locomotives and locomotive crews on the sections of "Uzbekiston Temir Yullari" JSC, it is necessary to introduce a set of tasks of the automated control system in the locomotive economy. It is important to note that the correct establishment of the distribution of the locomotive fleet and its rational regulation on the trains has a significant impact on the acceleration of carriage turnover.

It should be noted that at present the theoretical aspects of the innovation policy in railway transport and in the locomotive economy are not fully disclosed, in particular, in the scientific and practical provisions there is no single approach to their solution, especially for the market of traction services for the locomotive fleet of railway transport.

Thus, there is a need to develop theoretical and practical recommendations to determine the priority areas of modernization of the locomotive economy in the system of JSC "Uzbekiston Temir Yullari" taking into account the experience of developed countries. The introduction of the OCLD system will improve the efficiency of locomotive management, reduce the cost of maintaining and servicing traction rolling stock, increase labor productivity and traffic safety, and improve working conditions for workers in repair and operational depots.

ANALYSIS OF LITERATURE AND METHODS OF SOLUTION

JSC "Russian Railways" uses the OCLD system (operational control of the location of locomotives), which in turn makes it possible to determine the location of locomotives in real time on a mass scale. Separately, time, on the move (with trains and reserves), being at stations awaiting work and at the depot. In this case, you can analyze the entire inventory of locomotives. For these groups, the availability of locomotives is calculated depending on the factors established above. The system displays data about the locomotive, including its history, which reflects: what trains it followed over the last 2-3 months (up to 1500 last events with the locomotive), when and in what types of maintenance and repair it was. Before obtaining data from the OCLD tables, it is necessary to set the time period of interest to the user, the roads and the depot of the registration of locomotives,[1]. For locomotives, including roads, home depots and series, the operating time budget, productivity and average daily mileage are calculated. You can get a list of locomotive crews according to the depot of their registration, indicating the time of arrival, departure and departure times, as well as determine the crews following from the turnover, using a special symbol in 200 messages. The time of the work of the brigades is also monitored when taking a certificate of the train.

The implementation of the system solves the problems of switching to a paperless technology for the operation of the locomotive economy, automated generation of reporting forms and analysis of work, support and control of management decisions, identification and elimination of causes that lead to poor-quality repairs or improper operation of rolling stock. Also, the tasks of complete control of the use of locomotive crews, at all stages of their production activities, are being solved.

Many works . As domestic and foreign practice shows, the results of many years of scientific and practical research on the operation of train locomotives are insufficient. Studies on the implementation of operational control systems for the dislocation of locomotives in JSC "Uzbekiston Temir Yullari" have not been sufficiently studied.

The purpose of the development and implementation of a complex of tasks of the automated control system is to improve the system for collecting and providing information on the state and location of the locomotive fleet and crews on the road using the technical means of the information and computing center (ITC), rationalizing operational planning and regulating the work of locomotives of locomotive brigades of freight traffic, increasing efficiency and the reliability of information about control objects.

The development, design and implementation of a complex of tasks of the automated control system is carried out in stages in four stages [20]:

First of all"Operational control over the presence, condition and location of freight locomotives and the organization of their supply for maintenance (OCLD)" includes a set of tasks functionally combined into the following main groups: objects, as well as the actual mileage of locomotives (in kilometers) or the time of their work (in hours); calculation of a plan for setting up locomotives for current types of repair and maintenance and tracking it; formation of daily data on operational control of the condition and use of the locomotive fleet; control over the movement of inactive locomotives.

Second stage"Operational control of the dislocation and work of locomotive crews (OCDW)" includes a set of tasks functionally combined into the following main groups of information and reference services, which also provides for the delivery of certificates on the presence of locomotive crews at facilities, as well as on the actual production of hours by crews; formation of daily data on operational control over the condition and work of locomotive crews.

Third stage "Operational regulation and standardization of the operated fleet of freight traffic locomotives (RFLP)" should ensure the automation of the choice of control actions on the transportation process, that is, rational options for the regulation of locomotives.

Fourth stage "Operational regulation of the work of locomotive crews of freight traffic (RLB)" is intended to automate the choice of rational options for regulating the work of locomotive crews.

The main sources of the effect obtained from the implementation of the complex of tasks of the automated control system are a reduction in the time spent by trains in the departure yards of sorting and divisional stations, a decrease in the need for a locomotive fleet, as well as in the staff of locomotive crews.

The new initial data for determining the economic effect from the development and application of a complex of tasks of the automated control system and its individual stages were established on the basis of an analysis of the work of the roads, the results of modeling the organization of the work of locomotives and locomotive crews, as well as the experience of functioning of individual tasks of the automated control system.

When operating on the road of the first stage of the ASULP - OCLD - a reduction is achieved [21]:

- the required fleet of locomotives;
- the number of unscheduled repairs (NR) of locomotives, the fleet of locomotives in motion for repairs to factories and back to the depot;
- idle time of trains in departure fleets;
- mileage of locomotives in a single sequence (reserve mileage).

Reducing the need for locomotives is achieved due to operational control over their condition, dislocation and the organization of timely supply of locomotives for their maintenance. As a result, cases of "overrun" of locomotives between TO-2 and current types of repairs are eliminated, which leads to a reduction in their downtime.

Reducing the need for locomotives

$$\Delta M_{нр} = \Delta\alpha_{л} M_{Э} \qquad (1)$$

where $\Delta\alpha_{л}$ - a coefficient characterizing a decrease in the fleet of locomotives (in the first year of operation $\Delta\alpha_{л}$ = 0.3-0.5%, in subsequent years $\Delta\alpha_{л}$ = 0.5-0.8%);

Mae- operated fleet of locomotives, determined by the formula

$$M_{Э} = \sum MS_{СУТ} / S_{п.э} \quad (2)$$

where $\sum MS_{СУТ}$ - average mileage of all locomotives per day within the considered road;

Spe - the average daily mileage of locomotives of the operated fleet (taken according to the reported data before the implementation of the automated control system);

$$\sum MS_{СУТ} = 2 \cdot n_г \cdot l_{уч} \cdot n_{уч}(1+\beta_{од}+\beta_{дв}+\beta_{ме}) \quad (3)$$

$n_г$ **- the average daily volume of freight traffic on the road for the year,**

pairs of trains;

$l_{уч}$ **- the average length of sections of work of locomotive crews of freight traffic (according to the train schedules of the Ministry of Railways);**

$n_{уч}$ - the number of work areas of the brigades on the road;

$\left.\begin{matrix}\beta_{од},\beta_{д}\\ \beta_{ме}\end{matrix}\right\}$ - coefficient representing the ratio of the mileage of locomotives, respectively, in single following, double traction and operating on the system of many units to the mileage in the head of trains (taken according to reporting data before the implementation of the automated control system)

A decrease in the number of unscheduled repairs is achieved by providing the dispatching office with information about locomotives that are candidates for TO-3 and current repairs of HP is reduced by $\alpha_{нр}$ = 10%.

Continuous monitoring at the road level of the location of locomotives, which are going to the factories for repair and back, makes it possible to bring the average daily mileage of such locomotives $S_{пр}$ to the average daily mileage of the operated fleet $S_{пэ}$.

The release in this connection of the fleet of locomotives can be calculated by the formula

$$\Delta M_{п} = M_{о}\alpha_{з.р}\frac{S_{п.э}-S_{п.р}}{S_{п.э}} \quad (4)$$

where Mo is the total locomotive fleet, determined by the formula

$$M_{о} = M_{э}\frac{k_{и.г}}{1-\beta_{п}} \quad (5)$$

where $k_{и.г}$ - the coefficient of the transition from the average annual operating fleet to the total need for serviceable locomotives for freight traffic (taken according to reporting data, and in the absence of the latter - at the diesel traction range $k_{и.г}$ = 1.22, electric $k_{и.г}$ = 1.19);

$\beta_н$ - the proportion of faulty locomotives (accepted according to the reporting);

$\alpha_{з.р}$ - the share of locomotives sent for repairs to factories and from factories to depots (accepted according to reporting data before the implementation of the automated control system).

Due to constant monitoring of locomotives, including those under maintenance and current types of repairs, timely delivery of locomotives from the depot for trains is ensured, which reduces the downtime of trains in the departure fleets $\Delta t_c'$ for 0.005 ÷ 0.009 h.

When introducing the second stage of ASULP-OCLD on the road, a reduction is achieved:

idle time of trains in departure fleets $\Delta t_c''$ by 104–0.008 hours due to the timely delivery of crews for trains;

time of unproductive downtime of locomotive crews $\Delta t_c''$ by 0.05 ÷ 0.09 h / train by reducing the waiting time for departure and reducing the number of crews following passengers, which is ensured by continuous monitoring of the work of crews and their deployment.

With the introduction of the third stage of the ASULP-ROLP on the road, a reduction is achieved:

- idle time of trains in the departure fleets of district marshalling yards $\Delta t_c'''$ due to the elimination of untimely dispatch of locomotives for adjustment, as well as better coordination of the time of issuing locomotives for trains;

- reserve run of locomotives $\Delta\beta_{оо}'''$ by 2 ÷ 3% of their total reserve run as a result of more rational organizational work of locomotives.

- idle time of trains in the departure fleets of district and marshalling yards Δt_c^{IV} due to the timely dispatch of the adjustment teams and their entry to work at the registration points;

- time of unproductive downtime of locomotive crews, $\Delta t_{бр}^{IV}$ at each section of their work by reducing the waiting time for departure, as well as reducing the number of their journeys by passengers.

RESULTS AND DISCUSSION

The results of simulation modeling of the operation of locomotives and locomotive crews on the RRJ-Tashkent section are given in table.

No.	Locomotive series	Work on the go	Simple (out of employment)	Useful work
1	O'zbekiston-0001	14:10	4:31	14.17
2	O'zbekiston-0004	14:34	4:48	14.56
3	O'zbekiston-0006	16:27	3:35	16.45
4	O'zbekiston-0007	8:38	-	8.63
5	O'zbekiston-0008	16:47	3:20	16.78
6	O'zbekiston-0003	19:28	3:11	19.46
7	O'zEL-0211	18:26	3:34	18.43
eight	O'zEL-0208	18:55	1:24	18.91
nine	O'zEL-0210	07:04	2:43	7.06
ten	O'zEL-0209	15:36	3:35	15.06
eleven	O'zELR-0304	13:34	6:03	13.56
12	O'zELR-0304	13:05	6:32	13.08
13	O'zELR-0304	15:24	3:50	15.40
fourteen	O'zELR-0304	12:15	4:48	12.25
15	3VL80s-2670	15:32	1:35	15.53
16	3VL80s-2672	12:26	1:31	12.43
17	3VL80s-2673	12:32	1:12	12.53
eighteen	3VL80s-2677	14:34	2:46	14.56
19	3VL80s-2678	19:02	3:40	19.03
Total				**277.88**
Average				**14.63**

The table shows that due to the complex operational work of train locomotives on the considered section of RRJ-Tashkent, the useful work of freight locomotives was 14.63 hours. The actual useful work of freight locomotives, according to the fulfilled traffic schedule and statistical data, was 10.8 hours. Thus, we can conclude that the introduction of OCLD on the territory of RRJ-Tashkent will increase the useful work of freight locomotives by 14.63-10.8 = 3.83 hours. According to the data of the Department of Statistics and Accounting for 2020, the expense rate for downtime for one locomotive-hour is 52,944 sums and the expense rate for downtime for a team-hours is 28,422 sums. Consequently, the total expense rate for downtime for one locomotive and brigade hours is 81,366 sums. Then the savings on

locomotive and crew hours for downtime will be 3, 83 * 81366 = 311632 sums per day for one locomotive. 19 locomotives operated on the section RRJ-Tashkent under consideration. Then, the total annual savings from the introduction of OCLD on the territory of RRJ-Tashkent will be 19 * 311632 * 365 = 2 161 167 920 sums.

CONCLUSION

1. The goal of development and the stages of implementation of the complex of tasks of the OCLD are formulated.

2. In order to determine the economic efficiency and assess the functioning of the OCLD, simulation modeling of the operation of locomotives was carried out on the territory of the RRJ - Tashkent.

3. On the example of a simulation model, it is substantiated that the operational control of the dislocation of locomotives makes it possible to increase the useful work of freight locomotives. It is proved that on the territory of RRJ-Tashkent will increase the useful work of freight locomotives by 3.83 hours from its actual value, the economic effect of which will amount to 2,161,167,920 sums per year.

REFERENCES

1. Лемешко В.Г., Шапкин И.Н. Инновационные технологии на железнодорожном транспорте (теория, практика, перспективы). М.: ВИНИТИ РАН, 2012. – 416 с.

2. Суюнбаев Ш. М. Оперативное планирование эксплуатационной работы в условиях организации движения грузовых поездов по твердому графику // Известия Петербургского университета путей сообщения. 2010. №3. URL: https://cyberleninka.ru/article/n/operativnoe-planirovanie-ekspluatatsionnoy-raboty-v-usloviyah-organizatsii-dvizheniya-gruzovyh-poezdov-po-tverdomu-grafiku (дата обращения: 20.11.2021).

3. Suyunbayev, Sh.M. and Butunov, D.B. (2019) “Development of classification of the reasons of losses in the work sorting stations” Journal of Tashkent Institute of Railway Engineers: Vol. 15: Iss. 2, Article 23. Available at: (https://uzjournals.edu.uz/tashiit/vol15/iss2/23)

4. Кудрявцев В. А., Кукушкина Я. В., Суюнбаев Ш. М. Новый подход к расчету затрат вагоночасов на накопление // Известия Петербургского университета путей сообщения. 2010. №1. URL: https://cyberleninka.ru/article/n/novyy-podhod-k-raschetu-zatrat-vagonochasov-na-nakoplenie (дата обращения: 15.11.2021).

5. Кудрявцев, В. А., Кукушкина, Я. В., & Суюнбаев, Ш. М. (2010). Определение суточных затрат вагоно-часов на накопление составов. Железнодорожный транспорт, 3, 29-31.
6. S.K. Khudayberganov, Sh.M. Suyunbayev, Sh.B. Jumayev. Results of application of the methods “Sologub” and Combinator sorting in the process of forming multi-group trains at the sorting station // Journal of Tashkent Institute of Railway Engineers, 15 (4), 62-72 (https://uzjournals.edu.uz/tashiit/vol15/iss4/11/).
7. Суюнбаев Ш.М., Жумаев Ш.Б., Ахмедова М.Д. Процесс расформирования и формирования многогруппного поезда на железных дорогах АО «Узбекистан темир йуллари» // Транспорт шёлкового пути. – 2020. – №3.– С. 30-38 (http://srt.aitm.uz/upload/iblock/ddc/ddc3db10135b604290f6f0bc1c363857.pdf#page=30).
8. Суюнбаев Шинполат Мансуралиевич, Саъдуллаев Бехзод Алишер Угли Формирование многогруппных составов на двустороннем сортировочном устройстве // Universum: технические науки. 2020. №9-2 (78). URL: https://cyberleninka.ru/article/n/formirovanie-mnogogruppnyh-sostavov-na-dvustoronnem-sortirovochnom-ustroystve (дата обращения: 10.11.2021).
9. Rasulov, M. X., Masharipov, M. N., Rasulmuhamedov, M. M., & Suyunbaev Sh, M. (2019). The provision terms of train with locomotives and their standing time. International Journal of Advanced Research in Science, Engineering and Technology, 6(9), 10963-10974.
10. Куанышбаев Ж.М., Суюнбаев Ш.М., Машарипов М.Н. Исследование локомотивных составляющих в интермодальных и юнимодальных перевозках // Наука и мир. – 2019 – №6. С. 49-52 (http://en.scienceph.ru/f/science_and_world_no_6_70_june_vol_i.pdf#page=49).
11. Шинполат Мансуралиевич Суюнбаев, Шерзод Баҳром Ўғли Жумаев, Шухрат Хамроқул Ўғли Бўриев, Ахмаджон Акромжон Ўғли Туропов ТЕМИР ЙЎЛ УЧАСТКАЛАРИДА МАҲАЛЛИЙ ВАГОНЛАР ОҚИМИНИ ТУРЛИ ТОИФАДАГИ ПОЕЗДЛАР БИЛАН ТАШКИЛ ЭТИШ УСУЛЛАРИНИ ТЕХНИК-ИҚТИСОДИЙ БАҲОЛАШ // Academic research in educational sciences. 2021. №6. URL: https://cyberleninka.ru/article/n/temir-y-l-uchastkalarida-ma-alliy-vagonlar-o-imini-turli-toifadagi-poezdlar-bilan-tashkil-etish-usullarini-tehnik-i-tisodiy-ba (дата обращения: 14.11.2021).
12. Rasulov, Marufdjan Xalikovich; Suyunbayev, Sh.M.; and Masharipov, M.N. (2020) "RESEARCH OF DEVELOPMENT PROSPECTS OF TRANSPORTATION

HUB IN JSC "UMC"," Journal of Tashkent Institute of Railway Engineers: Vol. 16 : Iss. 3 , Article 9. Available at: https://uzjournals.edu.uz/tashiit/vol16/iss3/9 .
13. Машарипов М.Н., Расулов М.Х., Расулмухаммедов М.М., Суюнбаев Ш.М. Расчет эксплуатируемого парка грузовых локомотивов графоаналитическим методом на языке программирования C# // Интеллектуальные технологии на транспорте. 2019. №1 (17). URL: https://cyberleninka.ru/article/n/raschet-ekspluatiruemogo-parka-gruzovyh-lokomotivov-grafoanaliticheskim-metodom-na-yazyke-programmirovaniya-c (дата обращения: 30.10.2021).
14. Кудрявцев В. А., Суюнбаев Ш. М. Возможность и условия применения твердого графика движения грузовых поездов на Российских железных дорогах //Актуальные проблемы управления перевозочным процессом. – 2012. – С. 43-49.
15. Rasulov, Marufdjan Xalikovich; Rasulmukhamedov, Makhamadaziz Makhamadaminovich; Suyunbayev, Shinpolat Mansuralievich; and Masharipov, Masud Numonzhonovich (2020) "AUTOMATION OF THE PROCESS OF ATTACHING LOCOMOTIVES TO TRAINS IN CONDITIONS OF A NON-PAIRING GRAPHICS," Journal of Tashkent Institute of Railway Engineers: Vol. 16 : Iss. 2 , Article 7. Available at: https://uzjournals.edu.uz/tashiit/vol16/iss2/7.
16. Masharipov, M.N.; Suyunbaev, Sh.M.; and Rasulmukhamedov, M.M. (2019) "ISSUES OF REGULATION OF TRAIN LOCOMOTIVES OF THE RAILWAY SECTION CHUKURSAY-SARYAGASH," Journal of Tashkent Institute of Railway Engineers: Vol. 15 : Iss. 3 , Article 21. Available at: https://uzjournals.edu.uz/tashiit/vol15/iss3/21.
17. Расулов Маруфджан Халикович, Машарипов Маъсуд Нуъмонжонович, Расулмухамедов Махамадазиз Махамадаминович, Суюнбаев Шинполат Мансуралиевич Выбор рациональной технологии увязки локомотивов на приграничном пункте пропуска «Ок куприк - железнодорожный» // Universum: технические науки. 2019. №10-1 (67). URL: https://cyberleninka.ru/article/n/vybor-ratsionalnoy-tehnologii-uvyazki-lokomotivov-na-prigranichnom-punkte-propuska-ok-kuprik-zheleznodorozhnyy (дата обращения: 30.10.2021).
18. Суюнбаев Ш.М. Влияние расписания грузовых поездов по отправлению в условиях твердого графика движения на показатели составообразования / Ш.Б. Жумаев, Ш.М. Суюнбаев, М.Д. Ахмедова // Сборник материалов VII Международного межвузовского научно-практического конференции-конкурса научных докладов студентов и молодых ученых «ИННОВАЦИОННЫЕ

ТЕХНОЛОГИИ И ПЕРЕДОВЫЕ РЕШЕНИЯ» – МУИТ в Республики Киргизия, 2019. – С. 25-29.
19. Суюнбаев Ш.М. Возможности применения твердого графика движения грузовых поездов на ГАЖК «Узбекистон темир йуллари» / Ш.М. Суюнбаев, Г.Г. Айрапетова // Материалы XIV Международной научно-практической конференции «Логистика: современные тенденции развития». – Санкт-Петербург: ГУМРФ, 2015. – С. 5-6.
20. Шаров В.А. Технологическое обеспечение перевозки грузов железнодорожным транспортом в условиях рыночной экономики. – М.: Интекст. – 2001. – 198 с.
21. Некрашевич В.И., Апатцев В.И. Управление эксплуатацией локомотивов. Учебное пособие – М.: РГОТУПС, 2004. – 257 с.