Evaluation Of The Introduction Of Lean Manufacturing Elements In The Track Management Units

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Abstract: Objective is to assess the effects of implementing a lean production project to change the technological process of delivering attachments to the site of track work. We con-firm that the proposed solutions make it possible to increase the efficiency of a transport organization through the use of lean manufacturing tools. Methods: the re-search methodology is based on the analysis of projects and assessment of the effects of their implementation as part of the implementation of the Lean Production program at JSC Russian Railways using the main provisions of the instrumental approach and the method of cumulative economic efficiency. The information base of the study includes reports and the regulatory framework of JSC Russian Railways and methods of planning and rationing costs when carrying out track work. Results: a change in the technological process of delivering attachments to the site of track work was justified, a roadmap for its improvement was developed; the effects from the implementation of the proposed project were determined; recommendations have been developed to im-prove the efficiency of a transport organization through the use of lean manufacturing tools; prospects for the development of the program at JSC Russian Railways have been established.

1 INTRODUCTION

Improving production processes significantly saves time and reduces operating costs by minimizing or eliminating waste. To date, based on the results of the implementation of the Lean Production program of JSC Russian Railways, stable positive dynamics in the implementation of the plan in an accelerated manner are observed annually. For the period from 2020 to 2021, the confirmed effect from the implementation of cost-effective production technologies amounted to more than 3 billion roubles, with the plan fulfilled by 140%. According to estimated data for 2022, despite sanctions restrictions and a shift in the geography of transportation, the plan is expected to be fulfilled by 100-120% of the annual target as a whole [1, 2].

This is confirmed by the effective implementation of projects based on proposals and decisions of employees of linear structural divisions of JSC Russian Railways, the growth of which over the past 6 years has reached 20 thousand units. The coherence of the work of all links in the technological chain makes it possible to reduce unnecessary downtime and failures of technical equipment, improve the quality and reliability of production processes, and eliminate unnecessary transportation. Presumably, the total effect from the implementation of rationalization measures of JSC Russian Railways by 2025 will be about 12 billion rubles.

2 MATERIALS AND METHODS

New guidelines for the activities of JSC Russian Railways accumulate the processes of searching for new multifunctional solutions and introducing innovative lean manufacturing technologies (hereinafter referred to as LP). The positive effects from the implementation of most projects include the real release of existing resources, optimization of technological processes, improvement of the quality of railway transportation in general, along with savings in operating costs.

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The object of this study is the branch of JSC Russian Railways - Northern Railway, at the site of which the Lean Production program has been implemented since 2011. For the period until 2019, more than 3 thousand projects were implemented aimed at improving technological processes, increasing work efficiency and a reduction in costs by 860 million roubles. At the end of 2021, the Northern Railway took a leading position in the corporate competition for lean production projects [3]. The plans for 2022 included the implementation of 84 projects with a total economic effect of 130 million rubles, most of which have now been effectively implemented into production processes. A comprehensive assessment of the lean production projects implemented at the Northern Railway site is presented in Table 1.

Table 1: The largest lean production projects implemented at the Northern Railway site.

Characteristics of a lean production project	Site name	Implementation time frame	Economic effect
Reducing travel time for transit trains	"Losta" - "Obozerskaya"	Q2 2018	5.5 million rubles / year
Revision of the shunting equipment operating schedule	"Textilnyi" - "Yuryev" - "Polskyi" - "Kolchugino"	July 2018	7 million rubles / year
Reducing the labor intensity of the process of replacing defective reinforced concrete sleepers	Station "Yaroslavl - Glavnyi"	September 2019	0,3 million rubles / year
Preventing wear and tear on boiler rooms	Station "Losta"	Q3 2019	0,5 million rubles / year

However, within the framework of the activities of the Northern Railway, it is possible to highlight insufficiently expedient work related to the delivery of attachments. This technological process entails losses such as unnecessary transportation and movement, insufficient use of human potential and delays. The purpose of this study is to evaluate the effects of implementing a lean production project to change the technological process of delivering attachments to the site of track work and to develop recommendations for improving the efficiency of the Northern Railway through the use of lean production tools. Our task is to evaluate the main lean production projects implemented at the Northern Railway site and analyse the lean production tools being introduced into production work.

When assessing the effectiveness of the implementation of a lean production project, the main provisions of the instrumental approach and the method of cumulative economic efficiency were used, which made it possible to conduct a comparative assessment of the effects of time and costs before and after the implementation of the project. The main lean manufacturing tools used at the Northern Railway site include mapping, Just in Time, 5S place management, visual management, built-in quality, total productive service and standard operating procedures, which are also reflected in our research during development project road map and mapping the current and target state of the work process for the delivery of attachments to the site of track work.

3 RESULTS

1. The change in the technological process of work on the delivery of attachments is justified

Particular attention in the ongoing research is paid to the analysis of the technological process of delivering attachments to the place of track work with an excavator of the kgt-4rs model, the feasibility of using which is ensured by a strong mechanism, easy and safe maintenance, and the quality of the repair work carried out on the upper structure of the track, subgrade, and artificial structures. engineering communications, etc. [4]. Optimization of the technological process of an excavator involves the economic manufacture of a device installed on the boom of the excavator and allowing to transport two units of attachments at the same time, which eliminates the number of unproductive movements and, as a result, reduces time costs (Fig. 1, 2).

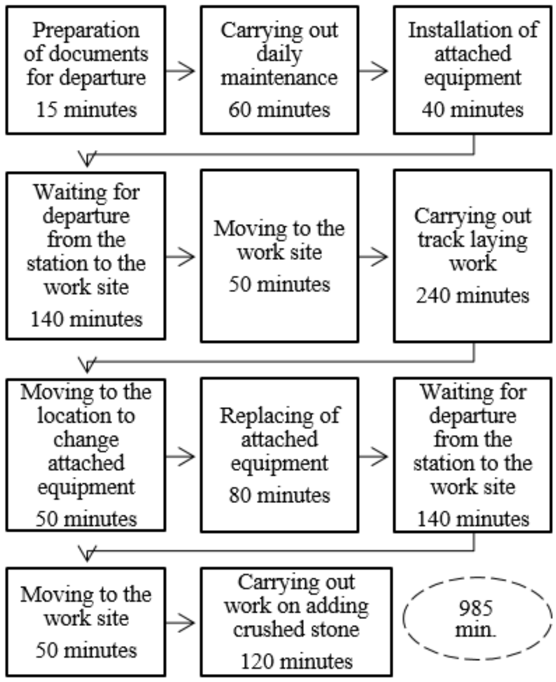

Figure 1: Time spent before project implementation.

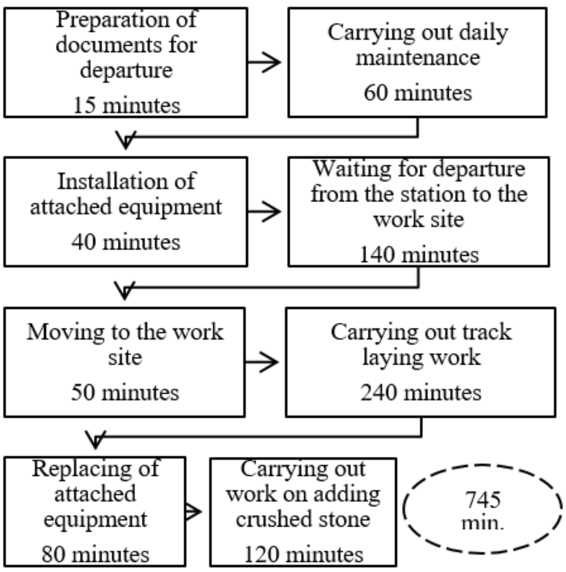

Figure 2: Time spent before project implementation.

Thus, the proposed measures make it possible to reduce the labour intensity of performing 1 specified job/operation by 4 hours.

2. A roadmap has been developed to improve the process of delivering attachments to the site of track work

The effective implementation of the lean production program and the need to increase the volume of transported goods and passengers along the railway network pose the task of improving the track equipment fleet, among other things. That is, the task is to increase the volume of track repair and maintenance work using multifunctional machines, allowing to reduce the number of units of equipment working in the "window" and decommission low-productive outdated models. When developing the road map, we largely relied on this logic, since the proposed model can significantly increase the productivity of repair and ongoing track work (Fig. 3).

	Action	Terms	Responsible persons
Preparatory activities for the project implementation	Development of proposals for the introduction of the kgt-4rs model excavator into the technological process	1 month	Chief engineer, technical department, finance department
	Registration of necessary documents	5 days	Legal department, chief engineer, technical department
	Coordination of the implementation of the project to introduce the kgt-4rs model excavator into the technological process	1 day	Technical department, finance department
Project implementation process	Carrying out daily technical inspection	1 day	Chief engineer, technical department
	Installation of attached equipment	2 days	Track foreman, repairman
	Carrying out track laying work	2 days	Track foreman, repairman, track linemen
	Replacing of attached equipment	1 day	Track foreman, repairman
	Carrying out work on adding crushed stone	1 day	Repairman

Figure 3: Roadmap for implementing a lean manufacturing project.

3. The effects of implementing a lean manufacturing project have been identified.

The list of expenses taken into account includes cost elements per 1 specified work/operation (Table 2).

Table 2: Grouping of costs before and after the implementation of a lean manufacturing project.

Cost elements, roubles	Costs before project implementation	Costs after project implementation
Salary	5107,3	3799,32
Social contributions	1552,6	1154,99
Fuel	7234,19	5967,21
Total	13894,1	10921,52

Details of the types of expenses for wages for the driver of a railway construction machine of the 7th category before the implementation of the project are presented in Table. 3.

Table 3: Details of labour costs.

Cost details	Amount, roubles
Labor costs per hour, incl.	311,42
– tariff	131,4
– bonus	144,5
– zonal surcharge	35,5
Total costs for 16.4 hours	5 107,3

Fuel consumption costs take into account the cost of 1 kg of fuel - 44.3 roubles and the volume of fuel consumed for track work - 14.2 kg/hour [7]. Moving two pieces of equipment simultaneously with a kgt-4rs excavator will reduce time spent from 16.4 to 12.2 hours and reduce fuel consumption from 163.3 kg to 134.7 kg per 1 specified job/operation. Thus, the total economic effect will be 2972.58 roubles per 1 specified work/operation.

4. Proposed measures to improve operational efficiency through the use of lean manufacturing tools.

Having analyzed the volume of track work for the period from 2019-2021 carried out at the Northern Railway site, it is recommended to equip 3 excavators with the proposed mechanism, each of which will perform 180 operations per year with the required volume of 540 operations.

In order to improve the efficiency of the Northern Railway, within the framework of the ongoing study, measures are recommended to achieve positive results through the use of lean manufacturing tools, in particular the replacement of attachments (Fig. 4).

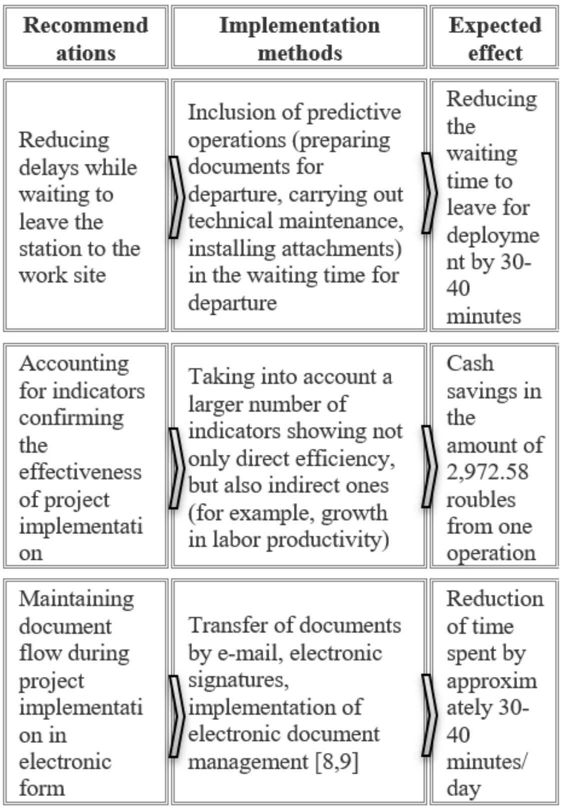

Figure 4: Recommendations for improving the efficiency of Northern Railways through the use of lean manufacturing tools.

5. Prospects for the development of the Lean Production program at JSC Russian Railways have been established.

Prospects for the development of the Lean Production program in the structural divisions of JSC Russian Railways, taking into account the areas presented in Fig. 5.

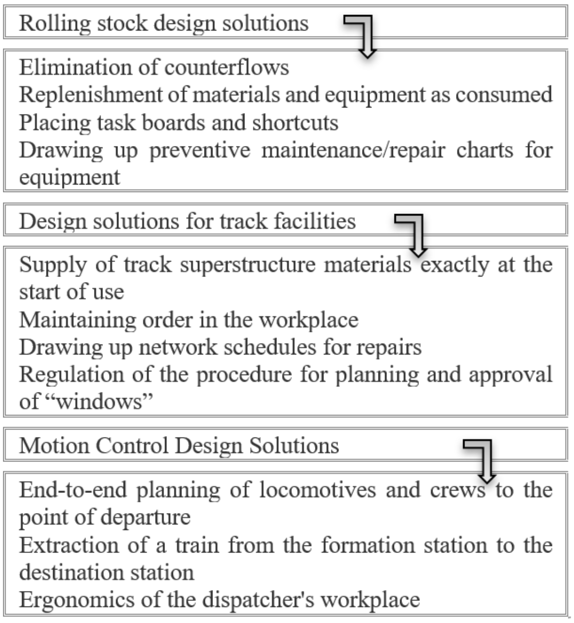

Figure 5: Prospects for the Lean Production program at JSC Russian Railways.

4 CONCLUSIONS

In the context of reforming the railway industry, the use of lean production tools is one of the key areas for increasing the efficiency of JSC Russian Railways. The studied operating experience of track machines of leading organizations, such as "Plasser and Theurer" (Austria), "Speno", "Matiza" (Switzerland), etc., as well as an analysis of the domestic track machine industry (JSC "192 Central plant of railway equipment", JSC “PA "Bezhitsa Steel"”, Tver Carriage Building Plant, etc.) convinces us of the need for further prospects in terms of creating high-performance machines and multifunctional technologies for track work that meet the new operating conditions of railways.

Undoubtedly, “lean” solutions in terms of track repair and maintenance using new generation machine complexes depend on the level of technical re-equipment of manufacturing enterprises, the speed of development and implementation of technical regulations and certification systems, the quality of the developed high-tech technologies in the created track machines, the study and adoption of weapons of advanced foreign experience, etc. Thus, intensifying the development of practical tools for lean production, more productive use of hidden reserves and cost reduction ensures the sustainability of the activities of Russian Railways, which is confirmed not only by domestic, but also by world experience.

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