LEAN PRODUCTION AND ITS ROLE IN DEVELOPING RAILWAY TRANSPORT ORGANIZATIONS

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Review Article

Abstract

This study examined the results of implementing lean production practices at enterprises in the Volga region. The proposals and solutions we introduced proved successful, leading to improved productivity and internal management, as well as enhancements to organizational processes, production workflows, technology integration, and performance monitoring systems. These measures generated 142 million rubles in revenue and yielded 384 million rubles in benefits from railway repairs.

Keywords: Lean manufacturing ; production quality; railways; organization ;FMEA; transportation.

1. Introduction

Railway organizations prioritize effective management to enhance output and mitigate risks associated with operational inefficiencies [1]. There is a continuous need for these organizations to adopt modern methods to improve management and achieve production success [2,3]. Lean production plays a significant role in elevating organizational output and overall performance; implementing this management model leads to sustained increases in production volume, product quality, and operational precision, while resolving general management issues. Following implementation, production output increased by 25%, production costs fell by 40%, and lead times were reduced by 75%

[4,5]. This study is quality of implementing these models to enhance organizational productivity.

2. Methodology

This study presents Lean production models and evaluates their performance quality through an analysis of the associated tools. Results are compared—before and after the model's implementation—as outlined in Table 1. Additionally, the study addresses issues related to production stages and systems to derive modern insights aimed at developing and improving the production process through enhanced management quality within enterprises located in the Volga region.

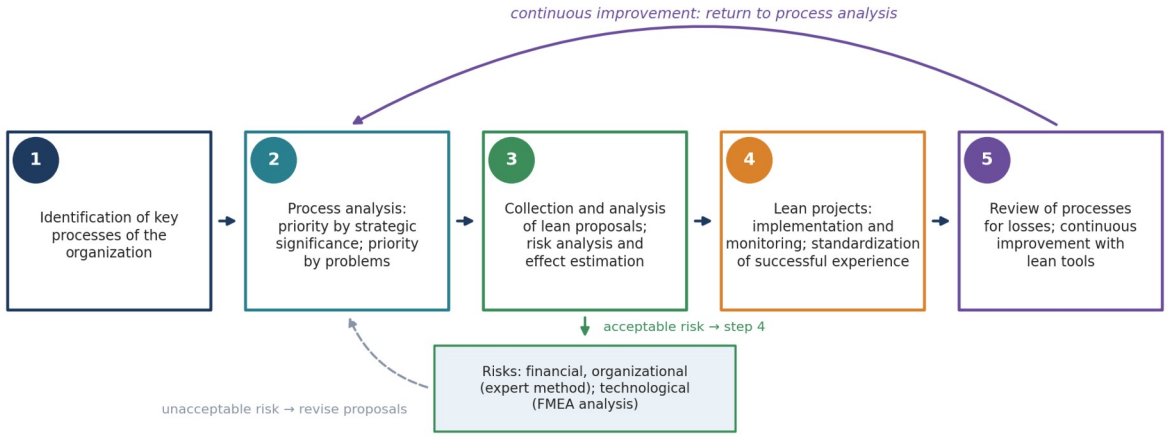


Figure 1. Application of the Lean model in rail production.

In figure 1 also illustrates that the PDCA productivity improvement cycle comprises several stages that must be traversed to achieve significant productivity gains and generate profits and revenues exceeding production costs—thereby minimizing potential risks and losses—as further analyzed using FMEA [6, 7].Following the implementation of strategies and process improvement tools, it is essential to monitor the production stages to resolve any issues or obstacles immediately—thereby preventing them from escalating—with the aim of enhancing the efficiency of process [8,9]. This also entails the integration of technologies [10].

Table 1. Results of Lean and QMS Implementation

Group of indicators	Indicators	Group value
Efficiency (E)	E1 labor productivity in rolling stock repair; E2 labor productivity in operation (locomotive crews); E3 reduction of direct costs of KR-1 overhaul of rail buses RA-2; E4 transportation cost.	$E = \Sigma w_i \cdot E_i$
Safety (S)	S1 derailments; S2 accidents; S3 train crashes; S4 collisions of rolling stock; S5 fatalities; S6 specific number of unscheduled repairs; S7 availability coefficient of traction rolling stock.	$S = \Sigma w_i \cdot S_i$
Quality (Q)	Customer satisfaction: passenger complaints; passenger commendations; on-time arrival of suburban trains. Process quality: stock norm not exceeded; overtime of locomotive crews; days-off cancellations; overhaul of buildings and structures; efficiency of energy use for traction; maintenance of the operated fleet; hours above the norm per crew member; crew utilization. Service quality: average section speed of suburban trains; damage to wagons; train delays caused by failures of technical means and by technological violations.	$Q = \Sigma (w_i \cdot Q_i$ of the three blocks)
Development (D)	D1 staff involvement; D2 cases of cargo theft with staff participation; D3 staff qualification upgrading.	$D = \Sigma w_i \cdot D_i$
Overall value	Generalized indicator of QMS process efficiency after lean implementation	$EF = E + S + Q + D$

By categorizing the indicators into several groups and aggregating their results, we obtain an indicator of the success of their application in managing productivity within organizations.

Table 2. Evaluation of the Effectiveness of Indicator Implementation

Plan fulfilment	up to 60 %	60–80 %	80–100 %
Score of an indicator (E, S, Q, D)	0.8 – 1.4	1.5 – 1.7	1.8 – 2.0

Increase in results: 60% of the plan – 0.8–1.4; 80–100% of the plan – 1.8–2.0.

3. Results

Our study revealed that organizations employing planned strategies and modern systems in their lean production operations achieved a clear improvement in operational productivity—as illustrated . Furthermore, the organization saw an increase in profits and

revenues, alongside enhanced productivity from new rail lines and the refurbishment of old, previously abandoned trains and metro units; this resulted in profits of 142 million rubles, as shown in.

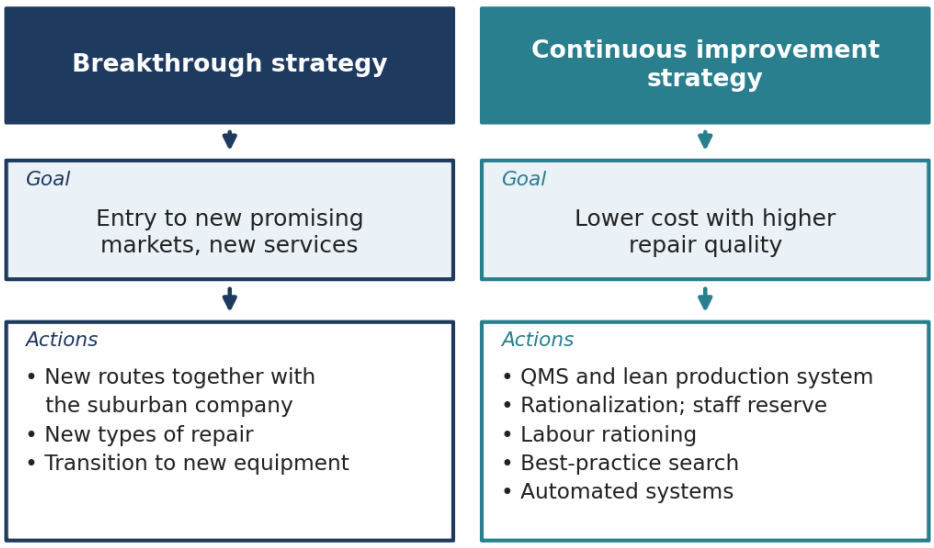


Figure 2. Application of Strategies in Railway Production Processes

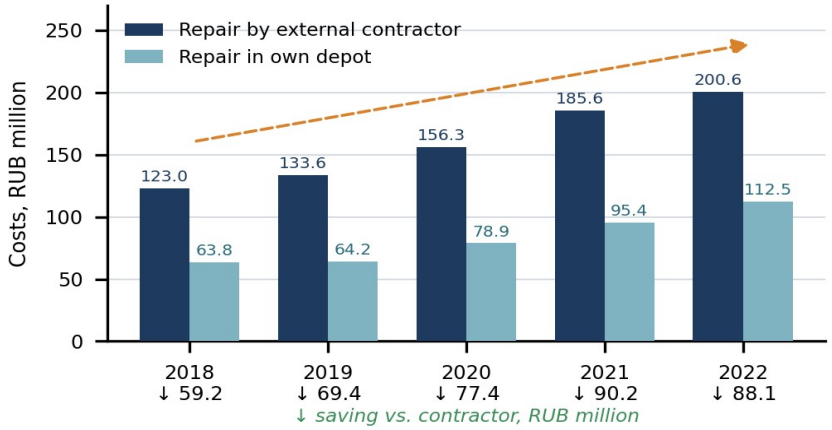


Figure 3 – Repair production costs

Repairs were carried out at a cost of 384 million rubles, and railway work at 233 million rubles, with a reduction in repair costs of 275,000 rubles.

Table 3. Application of "Alean" and its effectiveness.

Project	Year of launch	Income, RUB million
Suburban train service on the new route Astrakhan-1 – Astrakhan-2	2021	0.2

Project	Year of launch	Income, RUB million
Suburban train service on the new route Astrakhan-1 – Kharabalinskaya	2021	1.3
Suburban train service on the new route Saratov – Tarkhany (Gagarin airport)	2022	7.7
New suburban routes Saratov – Ovrazhnaya and Ovrazhnaya – Volgograd	2022	0.9
Optimization of wheelset repair (forming motor wheelsets of rail buses)	2023	1.3
Organization of KR-1 overhaul of AC electric trains at Anisovka motor-car depot	2023	16.2
Optimization of KR-2 overhaul of RA-1 rail buses (organization of overhaul)	2025	12.9
Organization of KR-2 overhaul of ED9M electric trains at Anisovka motor-car depot	2025	15.6

We observed that Aniskova's revenues stood at 16, 12, and 15 million rubles, while revenues from modern railway operations were 7.7 and 0.2 million rubles, with total profits reaching 142 million rubles. These results were achieved following the implementation of approved organizational policies and the setting of target objectives—facilitated by the introduction of new technologies and the fostering of a motivating work environment within the institutions. Consequently, a total of 7,627,000 rubles was realized, and further development and productivity growth are projected through 2025.

4. Conclusion

Our study concludes that developing and enhancing the effectiveness of Lean Production—and implementing this model within railway organizations—yields significant results. These outcomes stem from applying the associated organizational frameworks and strategies, analyzing results, evaluating models, monitoring production stages in detail, and improving management practices, all of which positively impact production quality. Furthermore, the implementation led to the refurbishment of aging railway lines and a marked increase in revenue, as demonstrated by a comparison of conditions before and after the adoption of the Lean Production system in Russia's Volga region.

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