Tyre Manufacturing Process Cost Reduction and Productivity Improvement through Operational Excellence

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Abstract

The tyre manufacturing industry operates within an increasingly competitive global environment where cost efficiency, productivity, and sustainability are critical success factors. Rising raw material and energy costs, technological advancements, and customer demands for quality and environmental responsibility necessitate innovative operational strategies. Drawing from both global industry examples and personal experience in establishing the Loadstar Production System (LPS) in Sri Lanka, this paper reviews how operational excellence frameworks can be applied to achieve cost reduction and productivity improvement. It explores lean manufacturing principles, energy management, digital transformation, and workforce empowerment as drivers of efficiency. Real-world examples from leading tyre manufacturers highlight how continuous improvement initiatives have enhanced process flow, reduced waste, and improved overall equipment effectiveness. Additionally, the review considers sustainability imperatives, including recycling and energy-efficient operations, and outlines the potential of emerging technologies such as artificial intelligence, robotics, and Industry 4.0 tools. The findings reinforce operational excellence as a holistic approach to securing competitive advantage while ensuring long-term growth and environmental stewardship.

1. Introduction

Tyre manufacturing is a resource-intensive process involving compounding, mixing, building, curing, and inspection stages. Global competition and cost pressures have driven manufacturers to adopt operational excellence as a strategic tool. Operational excellence integrates lean manufacturing, advance reliability centered maintenance management, and continuous improvement methodologies to optimize cost and efficiency (George, 2003). This paper reviews how cost reduction and productivity enhancement can be achieved through practical frameworks and industry practices. From a Sri Lankan perspective, a key milestone was the establishment of the Loadstar Production System (LPS) at Camso Loadstar under my leadership. This system was developed in line with the Toyota Production System (TPS) and has been sustained as the backbone of production excellence at Camso Loadstar. Even today, the LPS (though it may operate under a different name today) continues to drive cost efficiency, defect reduction, and productivity improvements, demonstrating the long-term impact of operational excellence frameworks when embedded in corporate culture. In my experience, the real success of LPS was not only the technical alignment with TPS principles but also the cultural shift it brought. Engaging operators, supervisors, and managers in continuous improvement created a strong sense of ownership, which has been vital for sustaining results.

2. Industry Overview

Tyre demand is projected to grow steadily, with increasing adoption in emerging markets (Smithers Rapra, 2022). Key challenges include raw material volatility, energy-intensive curing processes, and labor dependency in developing economies. Global leaders like Michelin and Bridgestone are addressing these with smart factories and automation investments (Michelin, 2023).

3. Cost Reduction Strategies

Lean Manufacturing Applications: Waste elimination practices based on the Toyota Production System (Ohno, 1988) can streamline operations. Case studies,

such as Goodyear's Kaizen initiatives, report 15% reductions in cycle times (Jones et al., 2019). Energy Efficiency: Energy costs represent 10–15% of total production expenses (IEA, 2021). Solutions include high-efficiency curing presses, waste heat recovery, and renewable integration. Raw Material Optimization: Recycling rubber scraps, using devulcanized rubber, and compounding innovations reduce dependency on virgin inputs (Rane & Kiran, 2020). Automation and Digitalization: Robotics in tyre building and predictive maintenance systems enhance quality and minimize downtime (Bridgestone, 2022).

4. Productivity Improvement

Total Productive Maintenance (TPM): Increases Overall Equipment Effectiveness (OEE). Case evidence from Indian tyre plants shows OEE gains from 65% to 80% (Kumar & Sharma, 2021). Workforce Development: Training in A3 ,why -why problem-solving methods and employee suggestion systems (kaizen) foster continuous improvement. Process Standardization and Quality: ISO/TS 16949 systems and Statistical Process Control (SPC) ensure consistency and reduce variability. Smart Manufacturing Technologies: AI-driven inspections, IoT sensors, and digital twins streamline production and reduce defect rates.

5. Case Studies and Industry Experiences

Michelin: Achieved 20% energy savings since 2015 by combining lean practices with sustainability targets. Apollo Tyres (India): Implemented TPM and raised productivity by 18% (Apollo Tyres, 2022). Goodyear: Leveraged AI predictive analytics to reduce maintenance costs by 12%. Camso Loadstar (Sri Lanka): The Loadstar Production System (LPS), designed and implemented as a customized operational excellence framework, has been central to sustaining world-class tyre manufacturing standards. Inspired by TPS principles but adapted to local conditions, LPS enabled significant reductions in waste, streamlined material flows, and improved overall equipment effectiveness. Importantly, the system remains active today, proving its robustness as a long-term productivity and cost management model in the tyre industry.

Principle / Focus Area	Toyota Production System (TPS)	Loadstar Production System (LPS)
Waste Elimination	Focus on seven forms of waste (muda)	Adapted to tyre-specific wastes such as excess rubber usage and rework and other process waste
Workforce Involvement	Operators trained in standardized work	Deep engagement of operators, supervisors, and managers in kaizen while standardization
Continuous Improvement	Kaizen events driven by lean teams	Embedded culture of daily problem-solving using A3 and why-why analysis
Supply Chain	Optimized for global sourcing and JIT	Localized and globalize supply chain focus to suit Sri Lankan context
Sustainability	Efficiency and cost as primary drivers	Added emphasis on long-term sustainability, cost and energy efficiency

6. Operational Excellence Frameworks

Lean manufacturing TPS principles: Merges waste elimination with statistical quality control. Continuous Improvement (Kaizen): Empowers small, incremental changes across all levels. Balanced Scorecard and KPIs: Metrics such as energy intensity, scrap rate, and OEE support informed decision-making from small cell level to business line.

7. Sustainability and Environmental Benefits

Circular Economy: Recycling tyres into crumb rubber, superfine activated crumb powder, and energy recovery reduces waste. Carbon Neutrality Goals: Continental AG aims for net-zero production by 2050 (Continental, 2023).

8. Challenges and Limitations

High capital requirements for automation, cultural resistance to change, and supply chain vulnerabilities remain significant hurdles.

9. Future Outlook

Industry 4.0 adoption with AI, robotics, and blockchain-enabled supply chains will transform operations. Growing emphasis on ESG compliance and bio-based materials will reshape tyre production.

10. Conclusion

Operational excellence offers a comprehensive approach to cost reduction and productivity in tyre manufacturing. Integrating lean philosophy, TPM, and smart technologies enhances competitiveness while aligning with sustainability imperatives. Furthermore, the Sri Lankan experience with the Loadstar Production System (LPS) at Camso Loadstar illustrates how locally developed, TPS-inspired systems can serve as enduring models of operational excellence. LPS continues to demonstrate the sustainability of structured frameworks in delivering both cost reduction and productivity improvement, making it a benchmark for the tyre industry regionally and globally. From my perspective, one of the critical lessons is that operational excellence is as much about people and culture as it is about tools and systems. The long-term sustainability of the Loadstar Production System highlights the importance of leadership commitment and workforce involvement in making excellence a way of life, not just a project.

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