RZESZOW UNIVERSITY OF TECHNOLOGY

TET

CHAPTER 1

INTRODUCTION

LEAN MANUFACTURING

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Definition and Essence of Lean Manufacturing

Lean Manufacturing is a production management philosophy focused on eliminating waste (Muda) in processes while delivering value to customers.

The main goal of Lean is to improve efficiency, quality, and customer satisfaction while simultaneously reducing costs. The foundations of Lean are based on principles of flow, continuous improvement (Kaizen), and team engagement in optimization processes.

Shah, R., & Ward, P. T. (2003*).* *Lean manufacturing: context, practice bundles, and performance*. Journal of Operations Management, 21(2), 129-149.

Durakovic, B., Demir, R., Abat, K., & Emek, C. (2018). *Lean manufacturing: Trends and implementation issues.* Periodicals of Engineering and Natural Sciences (PEN), 6(1), 130-143.

Dilanthi, M. G. S. (2015). *Conceptual evolution lean manufacturing: a review of literature*. International Journal of Economics, Commerce and Management, 3(10).

History of Lean (Toyota Production System)

Lean Manufacturing originated from the Toyota Production System (TPS), introduced by Taiichi Ohno in his book „*Toyota Production System: beyond large-scale production*”. TPS revolutionized manufacturing by introducing concepts such as Kanban, Just-In-Time (JIT), and autonomation (Jidoka). Toyota's success inspired other industries to adopt Lean principles, transforming it into a universal model for process management.

Ohno, T. (2019). *Toyota Production System: Beyond Large-scale Production*. Productivity Press.

Jayanth, B. V., Prathap, P., Sivaraman, P., Yogesh, S., & Madhu, S. (2020). *Implementation of lean manufacturing in electronics industry*. Materials Today: Proceedings, 33, 23-28.

Wada, K. (2020). *The Evolution of the Toyota Production System*. Berlin, Heidelberg, Germany: Springer.

Types of Waste (Muda)

Lean identifies the following **types of waste** that reduce efficiency:

1. **Overproduction**
2. **Unnecessary motion**
3. **Waiting**
4. **Excess inventory**
5. **Defects**
6. **Unnecessary transportation**
7. **Unnecessary storage**
8. **Underutilized employee potential**

The goal of Lean is to eliminate these wastes, leading to improved quality and reduced costs.

Leksic, I., Stefanic, N., & Veza, I. (2020). *The impact of using different lean manufacturing tools on waste reduction*. Advances in production engineering & management, 15(1).

Rahmanasari, D., Sutopo, W., & Rohani, J. M. (2021, March). *Implementation of lean manufacturing process to reduce waste: a case study.* In IOP Conference Series: Materials Science and Engineering (Vol. 1096, No. 1, p. 012006). IOP Publishing.

Paramawardhani, H., & Amar, K. (2020). *Waste Identification in Production Process Using Lean Manufacturing: A Case Study*. Journal of Industrial Engineering and Halal Industries, 1(1), 39–46. https://doi.org/10.14421/jiehis.1827

Lean Philosophy: Value, Flow, Continuous Improvement

Lean is built on three key pillars:

- **Value**: Defining what is important to the customer.
- **Flow**: Creating an uninterrupted stream of value in processes.
- **Continuous Improvement (Kaizen)**: Engaging teams in the ongoing pursuit of improvements.

All activities are focused on eliminating actions that do not add value.

Valente, C. M., Sousa, P. S. A., & Moreira, M. R. A. (2020). *Assessment of the Lean effect on business performance: the case of manufacturing SMEs*. Journal of Manufacturing Technology Management, 31(3), 501-523.

Franken, J. C., van Dun, D. H., & Wilderom, C. P. (2021). *Kaizen event process quality: towards a phase-based understanding of high-quality group problem-solving*. International Journal of Operations & Production Management, 41(6), 962-990.

Lean Principles

The main principles of Lean are:

- **Focus on customer needs** – Prioritizing value as defined by the customer.
- **Pull system** – Producing on demand rather than using a "Push" system.
- **Waste elimination** – Removing waste at every stage of the process.
- **Visual management** – Using visual tools to manage and monitor processes.
- **Continuous improvement (Kaizen)** – Constantly seeking ways to improve processes.

These principles form the foundation of sustainable and flexible production systems.

Martins, B., Silva, C., Silva, D., Machado, L., Brás, M., Oliveira, R., ... & Lima, R. M. (2021). *Implementation of a pull system–a case study of a polymeric production system for the automotive industry*. Management Systems in Production Engineering, 29(4), 253-259.

Kathem, A. S., Al-Kindi, L. A., & Al-Baldawi, Z. (2023). *Adopting Value Stream Mapping as a Lean Tool to Improve Production Performance*. Engineering and Technology Journal, 41(6), 793-806.

Key Concepts: Muda, Mura, Muri

Lean identifies three key sources of waste:

- **Muda**: Waste (e.g., defects, excess inventory).
- **Mura**: Unevenness in processes (e.g., variable workloads).
- **Muri**: Overburdening of people or machines.

Optimization requires the simultaneous elimination of all three issues.

Soliman, M. H. A. (2023). *Toyota Production System Concepts: Identifying Mura-Muri-Muda in the Manufacturing Stream*. Mohammed Hamed Ahmed Soliman.

Hosen, M. I., Tushar, S. R., Alam, M. F. B., & Syduzzaman, M. (2025). *Strategies for economic sustainability: An empirical study on Muri, Mura, and Muda in the readymade garment sector*. Green Technologies and Sustainability, 3(1), 100115.

Role of Employees in Lean

Employee engagement is crucial in Lean. Success relies on their knowledge, ideas, and collaboration. Employees are not just implementers but also creators of change—they participate in Kaizen workshops, propose improvements, and monitor process efficiency.

Without their contribution, implementing Lean is impossible.

Sosa-Perez, V., Palomino-Moya, J., Leon-Chavarri, C., Raymundo-Ibañez, C., & Dominguez, F. (2020, March). *Lean Manufacturing Production Management Model focused on Worker Empowerment aimed at increasing Production Efficiency in the textile sector*. In IOP Conference Series: Materials Science and Engineering (Vol. 796, No. 1, p. 012024). IOP Publishing.

Agarwal, R., Bajada, C., Brown, P. J., & Green, R. (2021). *People management practices that underpin lean management outcomes*. Global Journal of Flexible Systems Management, 22, 75-94.

Benefits of Lean

Lean delivers measurable benefits:

- **Productivity**: Reduced production cycle times.
- **Quality**: Fewer defects and higher customer satisfaction.
- **Cost**: Decreased excess inventory and waste.
- **Time**: Improved delivery timeliness and faster processes.

Lean enables organizations to achieve a competitive advantage.

Díaz-Reza, J. R., García-Alcaraz, J. L., Figueroa, L. J. M., Vidal, R. P. I., & Muro, J. C. S. D. (2022). *Relationship between lean manufacturing tools and their sustainable economic benefits*. The International Journal of Advanced Manufacturing Technology, 123(3), 1269-1284.

Susilawati, A. (2021). *Productivity enhancement: lean manufacturing performance measurement based multiple indicators of decision making*. Production Engineering, 15(3), 343-359.

Quiroz-Flores, J. C., & Collao-Díaz, M. F. (2022, October). *Application of lean manufacturing principles to increase productivity in SMEs manufacturers of baby clothes*. In 2022 Congreso Internacional de Innovación y Tendencias en Ingeniería (CONIITI) (pp. 1-5). IEEE.

Lean vs. Traditional Production Approach

In the traditional approach, production relies on large batches and inventory, often resulting in waste.

Lean emphasizes flexibility, aligning production with actual demand, and eliminating unnecessary activities.

The key difference lies in focusing on customer value and minimizing costs through process simplification.

Palange, A., & Dhatrak, P. (2021). *Lean manufacturing a vital tool to enhance productivity in manufacturing*. Materials Today: Proceedings, 46, 729-736.

Ioana, A. D., Maria, E. D., & Cristina, V. (2020). *Case study regarding the implementation of one-piece flow line in automotive company*. Procedia Manufacturing, 46, 244-248.

Sekhar, R., Solke, N., & Shah, P. (2023). *Lean manufacturing soft sensors for automotive industries*. Applied System Innovation, 6(1), 22.

Gebeyehu, S. G., Abebe, M., & Gochel, A. (2022). *Production lead time improvement through lean manufacturing*. Cogent Engineering, 9(1), 2034255.

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