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SUPPLY CHAIN MANAGEMENT

Analysis of Value Stream Mapping for the Optimization of Supply Chain Efficiency

Case Study: INDTRAV

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Abstract

In response to rising performance demands in the food and beverage sector, this study examines how Value Stream Mapping (VSM) can be applied to improve supply chain efficiency at INDTRAV, an Algerian bottled water company. Despite the full automation, INDTRAV's 1.5L production line faces persistent inefficiencies, including machine downtime and inventory build-up. Adopting a qualitative case study methodology, the research combines Gemba Walks, interviews, and internal document analysis. Guided by Rother and Shook's structured VSM approach, the study mapped the current state, identified key forms of waste, and proposed a leaner future state using tools such as Heijunka, Kanban, and FIFO lanes.

The results show a potential reduction in lead time, improved workflow synchronisation and global defects rate reduction confirming the relevance of VSM in automated environments.

Keywords: Value Stream Mapping, Lean Management, Supply Chain, Waste Elimination.

Résumé

Face aux exigences croissantes de performance dans le secteur agroalimentaire, cette étude explore l'application du « Value Stream Mapping » pour optimiser l'efficacité de la chaîne d'approvisionnement au sein de l'entreprise algérienne INDTRAV, spécialisée dans l'eau minérale. Malgré une ligne de production entièrement automatisée pour les bouteilles de 1,5L, INDTRAV fait face à des inefficacités récurrentes, telles que des arrêts machines et une accumulation de stock. À travers une méthodologie qualitative basée sur des visites « Gemba walks », des entretiens et l'analyse documentaire, l'étude suit l'approche structurée de Rother et Shook pour cartographier l'état actuel, identifier les gaspillages, et concevoir une cartographie cible intégrant des outils Lean comme Heijunka, Kanban, et les lignes FIFO.

Les résultats révèlent un potentiel de réduction des délais, une meilleure synchronisation des flux et réduction des défaillances.

Mots clés : Cartographie de la chaîne de valeur, Lean Management, Chaîne d'approvisionnement, Élimination des gaspillages.

ملخص

تهدف هذه الدراسة إلى توظيف أداة "تخطيط تدفق القيمة" لتحسين كفاءة سلسلة التوريد في شركة INDTRAVالجزائرية المتخصصة في إنتاج المياه المعدنية. على الرغم من الأتمتة الكاملة لخط إنتاج قارورات 1.5 لتر، تواجه الشركة مشاكل تشغيلية مستمرة مثل التوقفات المتكررة وتراكم المخزون. اعتمدت الدراسة منهج دراسة حالة نوعية باستخدام الملاحظة من خلال جولات الجيمبا، مقابلات شبه موجهة، وتحليل الوثائق الداخلية. ومن خلال منهجية أداة تخطيط تدفق القيمة ووفق نموذج Rother and Shook ، تم تحليل الوضع الحالي للشركة، وتحديد مصادر الهدر واقتراح خريطة مستقبلية أكثر انسيابية باستخدام أدوات مثل الهجونكا والكانبان وممرات التدفق الداخل الأول يخرج أولا.

أظهرت النتائج إمكانية تقليص زمن الدورة الاجمالي وتحسين تناغم العمليات بالإضافة الى تخفيض معدلات الإنتاج المعيب.

الكلمات المفتاحية :رسم خارطة تدفق القيمة، الإدارة الرشيقة، سلسلة التوريد، تقليص الهدر.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

- **VSM:** Value Stream Mapping
- **MRP:** Material Requirements Planning
- **FIFO:** First In, First Out
- **TPM :** Total Productive Maintenance
- **OEE:** Overall Equipment Effectiveness
- **CT:** Cycle Time
- **CO:** Changeover Time
- **LT:** Lead Time
- **Takt:** Takt Time
- **PAC:** Pacemaker Process
- **Gemba:** Gemba Walk
- **5S:** Sort, Set in order, Shine, Standardise, Sustain
- **CIP:** Clean-In-Place
- **HACCP**: Hazard Analysis and Critical Control Points
- **ISO:** International Organization for Standardization
- **ERP:** Enterprise Resource Planning
- **5M:** Methods, Materials, Machines, Manpower, Milieu
- **WIP:** Work In Progress

GENERAL INTRODUCTION

Introduction

In a globalised industrial landscape, the pressure on companies to optimise production systems and supply chain eliminating inefficiencies has never been greater. This is particularly true in the food and beverage sector, where consumer expectations in terms of quality, cost, and responsiveness continue to rise. Against this backdrop, Lean Management has emerged as a widely adopted philosophy for improving operational performance. It aims to eliminate all forms of waste and create value in every process step by relying on tools and methods grounded in continuous improvement (Womack & Jones, 2010).

Among these tools, Value Stream Mapping (VSM) is one of the most effective techniques for identifying and visualising value-added and non-value-added activities. VSM helps companies map their current flow of materials and information, detect inefficiencies, and design an improved future state based on Lean principles (Romero & Arce, 2017). Numerous academic studies have demonstrated the ability of VSM to reduce lead times, increase productivity, and support decision-making in diverse supply chain settings.

This study seeks to apply Value Stream Mapping to INDTRAV's water production line to diagnose existing inefficiencies and propose a more balanced and responsive process design. The specific objectives of this research are:

- To visualise the current production process through VSM and identify value-adding and non-value-adding steps;
- detecting the main types of waste affecting productivity;
- realistic recommendations development that supports continuous improvement and operational excellence.

Research problem and question

The company under study, INDTRAV, an Algerian producer of bottled mineral water, operates in a highly competitive market where production efficiency and timely response to customer demand are essential. Despite its automated production line and robust technical infrastructure, INDTRAV faces several operational challenges, including excessive inventory, machine downtime and gaps in real-time traceability. These problems effect the company's ability to maintain flow, meet customer expectations consistently, and optimise resource use; thus, it becomes necessary to rethink the current supply chain model using a structured Lean approach.

- **Problem statement**

How can Value Stream Mapping be applied to analyse and optimise the supply chain efficiency of INDTRAV's bottled water production line?

In order to conduct an effective topic analysis, we are going to parcel it into several research questions.

- **Research questions**
  - What are the current material and information flows within INDTRAV’s production process, and how do they affect lead time and responsiveness?
  - What types of wastes are present in INDTRAV’s supply chain, and how do they impact operational performance?
  - How can Lean tools be integrated into INDTRAV’s production system to address identified wastes and inefficiencies?
- **Significance of the study**

This study is significant as it highlights the role of Value Stream Mapping (VSM) in addressing operational inefficiencies in a real-world production environment. While INDTRAV benefits from an automated production system, it still suffers from recurring issues such as machine downtime, inventory accumulation, and lack of synchronisation between process flows. The research demonstrates how Lean principles when applied through a structured VSM approach can help visualise these inefficiencies, identify their root causes, and propose realistic, practical improvements. Beyond its contribution to INDTRAV, this case study provides valuable insights for other Algerian manufacturers seeking to enhance supply chain performance through Lean methods, especially in high-demand, fast-moving consumer sectors like bottled water production.

- **Research Methodology**

This research adopts a qualitative case study approach and is based on a combination of field visits (Gemba Walk), semi-structured interviews, direct observation, and analysis of internal documents. The methodology follows the structured steps of VSM proposed by Rother and Shook (1999), including current state mapping, calculation of takt time, identification of pacemaker processes, analysis of information flow, and design of a future state map.

In line with these steps, key data was collected from different departments at INDTRAV (production, maintenance, logistics, quality, sourcing, commercial) and used to calculate cycle times, changeover times, inventory levels, and performance indicators such as OEE. A fishbone (Ishikawa) diagram was also developed to investigate root causes of waste across the 5M categories: Methods, Machines, Materials, Manpower, and Environment.

- **Structure of the dissertation**

the dissertation structure is divided on three chapters.

The first chapter is a theoretical chapter which is broken into two main sections, the first one is a literature review where we have mentioned some previous searches about the value stream mapping topic in different sectors defining its importance and the benefits of the value stream mapping implementation in deferent organizations. In the second section we have defined the main topic concepts such as value stream mapping as a lean management tool also supply chain main key elements and challenges.

The second chapter is broken into two main sections. The first one presents INDTRAV as an organization chosen as a case study for the VSM implementation. in the second chapter we have described our research methodology and the data collection and treatment for better VSM application.

The third chapter is concerned with the VSM field implementation in INDRAV company based on a structured methodology in order to reach supply chain efficiency through the implementation results and discussion recommendations.

CHAPTER 01: THEORETICAL FRAMEWORK

In this chapter we explore the core ideas of lean management and Value Stream Mapping as they apply specifically to supply chains. We start with foundational work by Womack & Jones and Rother & Shook, then move through to today's Industry 4.0 tools. You'll see how organisations have used these methods to spot waste and add value for their customers and discover exactly where our research will bring something fresh.

Section 01: Literature review.

In order to make more sufficient research it is required to have a general overview of different searches that have treated the same topic to acquire the main terms and base concepts and also to define the research gap.

Thus, the reason why some scientific resources that address lean management especially value stream mapping in supply chain will be reviewed

According to womack and jones (1996) a value stream is « the set of all the specific actions required to bring a specific product through the three critical management tasks of any business: …problem solving, information management, physical transformation »

According to (Rother & Shook, 1999) VSM can be a tool of communication, business planning, or process changement tool.

According to (Helmold, 2020) Lean management is a modern approach to optimizing processes by the value chain. It is more about identifying and eliminating inefficiencies, on the other side, maximizing the value added from the main tasks. This value chain starts from upstream the suppliers through the operations to downstream customers.

Inefficiencies can involve with any task, activity, process, or product. The customer is central in lean management. Its primary objectives are to bring customer value by optimizing the organisations resources and establish a consistent workflow driven by customer demand. This englobes the eliminating of any waste of time, effort, or resources by analysing all the steps in a process and revising or editing or removing non-value-added steps.

The approach was generated initially in Japanese operations, but now lean management is one of the most common approaches in the worlds industries it focuses on:

The client orientation, defining the value and the added value based on the customers point of view, also eliminating all types of waste in the hole value chain, continues improvements for everything that might have an influence on the customer opinion.

1.1. The study of (L. King et al., 2019) titled: Supply Chain Optimization with High-Level Value Stream Mapping

The study examines the application of High-Level Value Stream Mapping (HLVSM) as a significant strategic tool for optimizing the supply chain operations. Value Stream Mapping (VSM), traditionally used in Lean manufacturing management, It is used to address broader supply chain challenges, such as reducing the lead time, minimizing costs, and improving distribution performance. The research presents how HLVSM provides a macro-level perspective, enabling organizations to visualize and analyse end-to-end supply chain processes, to identify inefficiencies, and implement destined improvements.

The study conveys a case study approach, focusing on real-world applications of HLVSM. Meanwhile, W.L. Gore & Associates wanted to utilize HLVSM to map four of their global supply chains through several workshops separated. This process is combined by cross-functional teams and aimed to identify opportunities for the cost reduction, lead time optimization, and regional assembly strategies.

The findings indicates that HLVSM is an effective tool for visualizing and optimizing supply chain processes. In the case of W.L. Gore & Associates, the implementation of HLVSM led to initiatives such as regional final assembly, supplier consolidation, and development of their inventory strategy, resulting in an annual benefit of $5 million.

1.2. The doctoral dissertation of (bin Ali, 2021) titled Operationalization of Lean Thinking Through Value Stream Mapping with Simulation and Flow

Value Stream Mapping (VSM) has been widely applied to visualise and optimise processes. However, as Lean principles are extended into other fields like software engineering, the limitations in the traditional application of VSM have surfaced.

This dissertation reviews the theoretical and practical foundations of VSM, identifies its challenges in dynamic environments and the simulates it in the software engineering filed by a qualitative approach using a several case studies on different samples such as practitioners from software development roles and students enrolled in a software engineering project management course.

Firstly, it starts by defining the lean thinking principles which are specifying value, mapping value streams, establishing flow, implementing pull systems, and pursuing perfection and states how VSM inter relate with lean thinking by designing a current-state map, identifying waste, and proposing a future-state process aligned with customer needs.

Later, Ben Ali have mentioned the challenges in adapting VSM into Software Engineering firstly it started with Static Modelling it is suitable for manufacturing however it is insufficient for software engineering because it involves uncertainty and variability. Secondly the challenge of Lack of Information Flow Analysis hence traditional VSM methods do not adequately fully map the intangible flows which cause difficulties in the optimisation of knowledge-intensive activities. A third Idealistic Assessments due to the complexity of the software engineering field it is impractical or fail to address real-world constraints, because that will be limiting the methods.

The study suggests two key solutions to enhance VSM application in software engineering field:

- The first solution is the Simulation Assistance for VSM which is Software Process Simulation Modelling (SPSM) to implement a dynamic modelling capability. By allowing conception executers to simulate processes changes and predict the outcome out of them, SPSM overcomes the limitations of static VSM models. The study results that SPSM supports VSM identifying inefficiencies and deriving a realistic improvement which is likely impossible to reach by traditional methods.
- The second solution proposed was FLOW which is a lightweight, systematic method introduced in the study to address a significant gap in traditional VSM concerning its inability to effectively capture and analyse information flows in processes. Moreover, it is more frequently applied for information flows therefore modern workflows especially in software engineering are extremely dependent on communication, decision making, and knowledge sharing. In the industrial application, FLOW permitted VSM to discover critical bottlenecks in information flows, leading to actual improvements in process efficiency based on reality.

As a result, those two-solutions impact was benefiting in terms of process understanding, the feasibility of the enhancements which lead to a realistic improvements.

1.3.The study of (Riad, 2024) titled Lean Management Approach as an Application Tool for Cost Reduction

It is an article that was written for the Journal of Contemporary economic research. This paper analyses the lean management application in healthcare sector. The study has discussed the cost reduction using key lean management concepts such as value stream mapping and Kaizen approach also Toyota production system and total quality management.

Concerning the study methodology, it was based on mainly on observation by analysing papers, reports and previously published articles using a comparative study on 3 health care organisations each on belong to a deferent level of economic growth specifically high-income countries compared to low-income countries.

The study derives that the application of lean management approach in deferent healthcare settings in deferent organisations reflect commonly a significant improvement in operational efficiency such as the notable reduction in patients waiting time.

1.4.The study of (EL Kihel et al., 2022) titled Optimization of the Sustainable Distribution Supply Chain Using the Lean Value Stream Mapping 4.0 Tool

Kihel and all. (2022) have presented an innovative study on the optimization of sustainable distribution supply chains through the integration of Lean Value Stream Mapping (VSM) 4.0 in the automotive wiring industry. The study defines how Industry 4.0 technologies, such like IoT, RFID, AGVs, augmented reality, and AI-driven analytics, can improve the efficiency, the visibility, and the sustainability of global supply chains in multinational logistics operations.

The research made an empirical case study conducted in an automotive equipment manufacturing company with a supply line that starts from Morocco to Austria. By applying VSM 4.0, the study consequently identifies inefficiencies such as excessive lead times, redundant processes, and wasted resources. By implementing digital and automation solutions, the authors found a significant performance improvements, including a 41%

reduction in lead time, a 52% decrease in workforce requirements, and optimised real-time tracking of logistics.

Moreover, Kihel and all. contribute to the ongoing discourse on sustainable supply chain management by addressing the economic, social, and environmental impact of digital lean logistics.

Overall, this study offers valuable insights into the intersection of Lean methodologies and Industry 4.0 technologies, making it a significant reference for scholars and practitioners aiming to enhance efficiency and sustainability in modern supply chains.

Table 1: general review of the studies.

Author(s) & Year	**Title**	**Key Focus**	**Methodology**	**Findings & Contributions**
Womack & Jones (1996)	Lean Thinking	Conceptual definition of Value Stream Mapping (VSM)	Theoretical study	Defines VSM as the set of actions required to manage problem-solving, information, and physical transformation.
Rother & Shook (2003)	Learning to See	VSM's role in business planning and change management	Theoretical study	Highlights the role of VSM in visualising processes and supporting business improvements.
Helmold (2020)	Lean Management and Kaizen	Lean management as a process optimisation approach	Theoretical study	Emphasises customer-centric value creation, waste elimination, and continuous improvement across the value chain.

King, Rurak, & Liberatore (2019)	Supply Chain Optimization with High-Level VSM	Application of High-Level Value Stream Mapping (HLVSM) in supply chains	Case study (W.L. Gore & Associates)	HLVSM enables end-to-end supply chain visualisation, reducing lead time and improving cost efficiency, resulting in $5M in annual benefits.
Bin Ali (2021)	Operationalization of Lean Thinking Through VSM with Simulation and Flow	Extending VSM to software engineering	Qualitative study with case studies	Identifies challenges of traditional VSM in dynamic environments and proposes simulation-based solutions (SPSM & FLOW) for process optimisation.
Riad (2024)	Lean Management as a Tool for Cost Reduction	Application of Lean in healthcare for cost reduction	Comparative analysis of three healthcare organisations	Demonstrates efficiency gains, particularly in reducing patient waiting times, through lean principles like VSM and Kaizen.
Kihel et al. (2022)	Optimisation of the Sustainable Distribution Supply Chain Using VSM 4.0	Integration of VSM 4.0 and Industry 4.0 in supply chain management	Empirical case study in the automotive sector	Implements IoT, RFID, and automation to reduce lead time (41%) and workforce requirements (52%), enhancing efficiency and sustainability.

Source: created by the author

Section 02: Conceptual framework

2.1.Introduction to Lean management

According to the lean enterprise institute “Lean is a way of thinking about creating needed value with fewer resources and less waste, and lean is a practice consisting of continuous experimentation to achieve the perfect value with zero waste. Lean thinking and practice occur together.”

According to Womack and Jones the pillars of this approach “lean provides a way to do more and more with less and less human effort, less equipment, less time, and less space while coming closer and closer to providing customers with exactly what they want.”

Also, they mentioned in their revised version of their book” Lean Thinking” lean thinking as a provider for the more satisfying work using immediate feedback on effort to remake muda(wastes) into value.

2.1.1 Historical development

Lean Management has evolved from a production-centric approach into a comprehensive management philosophy, emphasizing efficiency, waste reduction, and continuous improvement. Initially rooted in manufacturing, Lean principles have expanded into various sectors, including healthcare (Gil-Vilda et al., 2021), software development, and service industries (Gil-Vilda et al., 2021). This paper explores the historical development of Lean Management, tracing its origins in the Toyota Production System (TPS), its formalization into Lean Manufacturing, and its subsequent evolution into Lean Management and modern adaptations.

- The Toyota Production System (TPS), developed by Sakichi Toyoda, Kiichiro Toyoda, and Taiichi Ohno in the mid-20th century, serves as the foundation of Lean Management (Dekier Łukasz, 2012). TPS is based on two core principles:
  - Just-in-Time (JIT): Producing only what is needed, when it is needed, and in the exact quantity required, thus reducing waste and excess inventory (Dekier Łukasz, 2012)
  - Jidoka (automation with human oversight): Allowing machines to detect defects and stop production autonomously, ensuring high-quality standards and eliminating defective products early in the production process (Dekier Łukasz, 2012).

Toyota’s leaders were inspired by Henry Ford’s assembly line techniques and American supermarket inventory systems, adapting these concepts into a pull-flow production system, where production is driven by customer demand rather than (Dekier Łukasz, 2012). Although TPS proved highly effective, it gained international recognition only after the 1973 oil crisis, when organizations began seeking resource-efficient production methods (Gil-Vilda et al., 2021).

- The term "Lean Manufacturing" was introduced by James P. Womack, Daniel T. Jones, and Daniel Roos in their 1990 book *The Machine That Changed the World* (Womack et al., 1990). Their research at MIT's International Motor Vehicle Program (IMVP) demonstrated that Toyota's lean methodologies outperformed traditional mass production in efficiency, cost reduction, and quality improvement (Dekier Łukasz, 2012).

Lean Manufacturing is built upon five key principles (Womack et al., The Machine That Changed the World, 1990):

- Define Value: Understanding what customers perceive as valuable.
- Map the Value Stream: Identifying every step in the production process and eliminating waste.
- Create Flow: Ensuring smooth workflows without bottlenecks.
- Establish Pull: Producing only in response to customer demand.
- Pursue Perfection: Continuously improving processes to achieve operational excellence.

The widespread adoption of Lean principles extended beyond automotive manufacturing, leading to global implementation in multiple industries (LEAN enterprise institute, 2025).

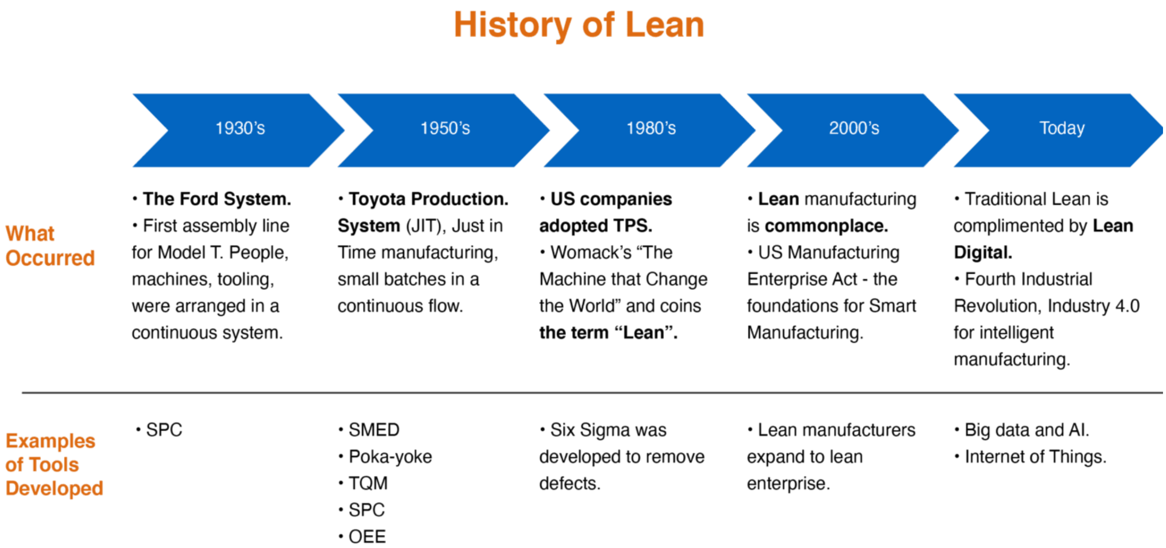
- Over time, Lean principles evolved into Lean Management, a broader business philosophy that applies Lean thinking to organizational culture and leadership rather than just production efficiency (Dekier Łukasz, 2012). Unlike Lean Manufacturing, which focuses on factory-floor optimization, Lean Management emphasizes:
  - Employee Engagement: Encouraging employees to participate in continuous improvement initiatives.
  - Leadership Development: Training managers to foster a Lean culture.
  - Effective Communication: Enhancing transparency and collaboration across departments.
  - Process Optimization: Extending Lean principles to service industries, healthcare, and financial sectors (NHS England, 2011).

- Lean Management integrates human-centric methodologies, such as Kaizen (continuous improvement), competency matrices, and suggestion systems, to optimize both organizational and employee performance (Bozdogan, 2010).

- With the rise of Industry 4.0, Lean principles have evolved further, integrating digital technologies to enhance Lean methodologies. Lean 4.0 combines Lean practices with Industry 4.0 tools such as automation, artificial intelligence (AI), and the Internet of Things (IoT) to improve efficiency, reduce variability, and enhance decision-making ((Gil-Vilda et al., 2021).
- Hybrid approaches like Lean Six Sigma have also emerged, merging Lean's waste-reduction focus with Six Sigma's quality control methodology (Dekier Łukasz, 2012). This transition demonstrates that Lean Management continues to evolve, adapting to modern business challenges and technological advancements (Bozdogan, 2010).

In the end its obvious that the historical development of Lean Management reflects its transformation from a manufacturing-focused system into a versatile management philosophy applicable across industries. Toyota's innovations laid the foundation for Lean Manufacturing, which was later formalized and expanded into Lean Management. Today, Lean continues to evolve, integrating digital transformation and hybrid methodologies. As businesses navigate increasing complexity and global competition, Lean remains a relevant and highly effective management approach.

Figure 1 lean historical development



source: (VIMANA, 2025)

2.1.2 Lean Management principals

Lean Management, rooted in the Toyota Production System (TPS), encompasses 14 foundational principles designed to enhance efficiency, eliminate waste, and promote continuous improvement.

- Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals: This principle emphasizes aligning decisions with the organization's core values and long-term objectives. A comprehensive literature review indicates that Lean Management has evolved into an interdisciplinary subject, linking Operations Management, Organizational Behaviour, and Strategic Management, underscoring the importance of a long-term philosophical approach (Sinha & Matharu, 2019).
- Create continuous process flow to bring problems to the surface: Implementing a seamless workflow helps in promptly identifying and addressing issues. A study on Lean manufacturing techniques highlights that continuous process flow leads to increased productivity and product quality (Naveen et al., 2022).
- Use 'pull' systems to avoid overproduction: A pull-based approach ensures that production aligns with actual demand, minimizing waste. Research indicates that Lean manufacturing tools focus on continuous removal of wastes in manufacturing processes, aligning with the pull system methodology (Naveen et al., 2022).
- Level out the workload (heijunka): Balancing workloads prevents overburdening resources and maintains a steady production rhythm. The evolution of Lean Management into an interdisciplinary subject suggests the importance of workload levelling to ensure sustainable performance (Sinha & Matharu, 2019).
- Build a culture of stopping to fix problems, to get quality right the first time: Encouraging immediate problem resolution ensures quality is maintained throughout the production process. Lean manufacturing emphasizes the continuous removal of wastes, which includes addressing quality issues promptly (Naveen et al., 2022).
- Standardized tasks and processes are the foundation for continuous improvement and employee empowerment: Consistency in tasks lays the groundwork for ongoing enhancements and empowers employees. The comprehensive literature review on Lean Management highlights the role of standardized processes in facilitating continuous improvement (Sinha & Matharu, 2019).

- Use visual control so no problems are hidden: Visual tools and indicators make it easier to detect anomalies, promoting transparency. The Lean Management approach emphasizes performing effectively, which includes using visual controls to increase customer satisfaction (Liker, 2004).
- Use only reliable, thoroughly tested technology that serves your people and processes:
  Adopting proven technologies ensures they complement and enhance existing workflows. The Lean Management approach focuses on performing effectively, which includes utilizing reliable technologies to support processes (Liker, 2004).
- Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others: Developing leaders from within who embody the organization's principles ensures the perpetuation of its culture and values. The evolution of Lean Management into an interdisciplinary subject highlights the need for leaders who understand and teach Lean principles (Sinha & Matharu, 2019).
- Develop exceptional people and teams who follow your company's philosophy: Investing in talent development fosters cohesive teams aligned with the organization's mission and goals. The Lean Management approach emphasizes performing effectively, which includes developing exceptional people and teams (Liker, 2004).
- Respect your extended network of partners and suppliers by challenging them and helping them improve: Collaborative relationships with partners and suppliers, focused on mutual growth and improvement, strengthen the entire value chain. The Lean Management approach includes respecting and improving the extended network of partners and suppliers (Liker, 2004).
- Go and see for yourself to thoroughly understand the situation (Genchi Genbutsu): Firsthand observation provides accurate insights, enabling informed decision-making. The Lean Management approach encourages leaders to thoroughly understand situations by direct observation (Liker, 2004).
- Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly (nemawashi): Deliberate decision-making ensures comprehensive evaluation, while swift implementation facilitates prompt action. The Lean Management approach supports making decisions slowly by consensus and implementing them rapidly (Liker, 2004).

- Become a learning organization through relentless reflection (hansei) and continuous improvement (kaizen): Fostering a culture of reflection and continuous improvement drives innovation and maintains competitiveness. The comprehensive literature review on Lean Management emphasizes the importance of continuous improvement and learning within organizations (Sinha & Matharu, 2019).

These 14 principles collectively form a robust framework guiding organizations toward operational excellence, adaptability, and sustained success in today's dynamic business environment.

2.1.3 The seven wastes “MUDA”

Muda, a Japanese term meaning "waste," is a fundamental concept in Lean management. It refers to any activity or process that consumes resources without adding value to the final product or service. Originating from the Toyota Production System (TPS), Muda is one of the three key inefficiencies identified by Taiichi Ohno.

- In Lean management, Muda represents inefficiencies that hinder productivity and profitability. Taiichi Ohno categorized waste into seven types, which were later expanded to include an eighth category: unused employee talent (Wevalgo, 2025). These wastes are widely known as TIMWOODS:

Figure 2: Lean Management wastes "MUDA"

source: (VIMANA, 2025).

1. **Transportation**: Unnecessary movement of materials or products.
2. **Inventory**: Excess stock beyond immediate needs.
3. **Motion**: Inefficient movement of people or equipment.
4. **Waiting**: Idle time caused by delays in workflows.
5. **Overproduction**: Producing more than required or too early.
6. **Overprocessing**: Performing extra work that does not add value.
7. **Defects**: Errors requiring rework or disposal.
8. **Unused Talent**: Failing to utilize employees' skills and creativity effectively.

Muda is distinct from necessary non-value-adding activities, such as regulatory compliance, which are essential for operations but do not directly contribute to customer value (safetyculture team, 2024).

Muda negatively affects operational efficiency by increasing costs and reducing resource utilization. For example, overproduction ties up capital in unsold inventory, while defects lead to wasted materials and labour due to rework (Kaizen institute, 2024). In service industries like healthcare, waiting times and redundant administrative processes can delay service delivery and reduce customer satisfaction (Hartanti et al., 2022).

A study by Hartanti et al. (2022) demonstrated that identifying and eliminating Muda in higher education institutions improved operational performance by streamlining processes and reducing non-value-adding activities.

Lean management provides several tools and methodologies for identifying and eliminating Muda:

1. **Kaizen**: A continuous improvement approach that involves small, incremental changes to processes (safetyculture team, 2024).
2. **Value Stream Mapping (VSM)**: A visualization tool used to identify wasteful activities within workflows (Yanthan , 2024).
3. **5S Methodology**: A workplace organization system comprising five steps—Sort, Set in Order, Shine, Standardize, and Sustain—to improve efficiency and reduce waste (Kaizen institute, 2024)
4. **Kanban System**: A visual scheduling tool that aligns production with demand to minimize overproduction and inventory waste (Yanthan , 2024).

5. **Just-in-Time (JIT) Production**: A strategy that synchronizes production with demand to eliminate excess inventory and reduce lead times (Wevalgo, 2025).

These strategies not only address the seven types of waste but also foster a culture of continuous improvement within organizations.

2.2. Supply Chain Management “SCM”

Supply Chain Management (SCM) is a critical component of modern business operations, encompassing the coordination and integration of processes that guide the flow of goods, services, information, and finances from raw material sourcing to the delivery of finished products to customers. In this part various definitions of SCM will be explored and highlight its importance in achieving operational efficiency, customer satisfaction, and competitive advantage will be highlighted.

2.2.1 Definitions and importance of Supply Chain Management

SCM has been defined in various ways by experts and organizations, reflecting its multifaceted nature:

1. **Scott Robinson from techtarget team (2025):** SCM is described as “the optimization of a product's creation and flow from raw material sourcing to production, logistics, and delivery to the final customer.” It emphasizes collaboration among supply chain partners to create efficiencies, manage risks, and adapt to changes.
2. **IBM (2022):** SCM is "the coordination of a business’s entire production flow," involving suppliers, manufacturers, distributors, retailers, and customers. It integrates supply and demand management across companies to minimize costs, waste, and time in the production cycle.
3. **Seattle University MBA Program (2024):** SCM refers to managing every stage involved in getting a product from raw materials to the customer. This includes sourcing, manufacturing, shipping, storage, distribution, and delivery.

These definitions collectively underline that SCM is not just about logistics but involves strategic planning, execution, and collaboration across all stages of the supply chain.

The Importance of Supply Chain Management

SCM is vital for businesses due to its profound impact on operational performance, customer satisfaction, resilience against disruptions, and overall competitiveness: **Operational Efficiency:** Effective SCM optimizes resource utilization by reducing waste, minimizing delays, and improving inventory management. For instance, IBM (2022) notes that advanced SCM systems allow businesses to streamline their production cycles while ensuring timely delivery.

1. **Customer Satisfaction:** A well-managed supply chain ensures that products are delivered promptly and in good condition. This enhances customer loyalty and retention by meeting or exceeding expectations (Seattle University , 2024).
2. **Cost Reduction:** By integrating processes such as demand forecasting and real-time tracking, SCM minimizes operational costs associated with overproduction or excess inventory (Robinson, 2025).
3. **Risk Mitigation:** SCM helps businesses anticipate potential disruptions—such as geopolitical tensions or natural disasters—and develop contingency plans. IBM (2022) highlights how SCM systems improve resilience by enabling proactive responses to risks.
4. **Sustainability:** Modern SCM incorporates sustainable practices such as optimizing transportation routes to reduce emissions or sourcing materials ethically. This aligns with growing environmental concerns while enhancing brand reputation (Robinson, 2025).
5. **Competitive Advantage:** Companies with robust SCM capabilities can respond more quickly to market changes. A study cited by IBM (2022) found that organizations with advanced SCM systems were 23% more profitable than their peers.

2.2.2 Key Components of Supply Chain Management

SCM consists of several essential components that work together to create a seamless flow of materials, information, and products. These components are foundational to the success of any supply chain and include:

1. **Planning:** It is the strategic foundation of SCM. It involves demand forecasting, inventory management, and production scheduling to align supply with customer demand while minimizing waste. Tavana et al. (2022) highlight that effective planning integrates predictive analytics and risk management strategies to address uncertainties in global supply chains. Furthermore, planning includes setting

performance metrics to evaluate supply chain efficiency and effectiveness (Aamer et al., 2021)

2. **Sourcing**: It focuses on selecting suppliers and managing relationships to ensure the timely delivery of high-quality raw materials or components. Sustainable sourcing practices are increasingly emphasized in modern SCM to address environmental and ethical concerns (Batista et al., 2021). For instance, Kannan et al. (2020) discuss how green supplier selection methods can minimize environmental impact while maintaining cost-effectiveness.
3. **Production**: It involves transforming raw materials into finished goods through manufacturing or assembly processes. This component includes quality assurance, process optimization, and waste reduction strategies (Bechtsis et al., 2018).
4. **Delivery**: It encompasses logistics and distribution activities aimed at transporting finished products to customers efficiently. This component includes warehousing, order fulfillment, and transportation management. Wang et al. (2020) emphasize the role of real-time tracking technologies such as IoT in improving delivery accuracy and customer satisfaction.
5. **Returns (Reverse Logistics)**: management handles defective or excess products through reverse logistics processes. This component is essential for addressing customer complaints, conducting product recalls when necessary, and recycling or disposing of returned items responsibly (Batista et al., 2021). Reverse logistics also provides valuable feedback for improving product design and reducing future returns.

2.2.3 Supply Chian Challenges

supply chain management faces numerous challenges that directly impact operational efficiency, profitability, and customer satisfaction. Among these, cost reduction, lead time minimization, and maintaining high levels of customer satisfaction are critical. This section explores these challenges and strategies to address them using insights from recent academic and industry sources.

- **Cost Reduction:** is a fundamental challenge in SCM as companies strive to improve profitability while maintaining competitive pricing. Rising raw material costs, labor shortages, and fluctuating transportation expenses exacerbate this challenge (Johns, 2024). Effective cost management involves optimizing processes across the supply chain to eliminate waste and inefficiencies.

1. **Process Optimization**
   Lean manufacturing techniques such as Kaizen and value stream mapping can help identify non-value-adding activities and reduce costs (Wrike team, 2023). For example, implementing just-in-time (JIT) systems minimizes inventory holding costs by aligning production with real-time demand (Kenton, 2024).
2. **Technology Integration**
   Advanced technologies like artificial intelligence (AI) and data analytics enable companies to forecast demand more accurately and optimize resource allocation. According to Global Trade Magazine (2024), supply chains equipped with AI are over 67% more effective in reducing costs compared to traditional systems.
3. **Supplier Collaboration**
   Building strong relationships with suppliers allows companies to negotiate better pricing and improve procurement efficiency. Collaborative forecasting with suppliers also helps in reducing excess inventory and associated costs (ANVYL, 2023).

- **Lead Time Minimization:** Lead time is the time between placing an order and delivering the final product—is a critical factor in SCM. Long lead times can result in higher inventory costs, delayed deliveries, and decreased customer satisfaction (Wrike team, 2023).
  1. **Streamlining Processes:** Companies can reduce lead times by automating order processing and production workflows. Tools like enterprise resource planning (ERP) systems improve coordination across supply chain functions, enabling faster response times (Kenton, 2024).
  2. **Local Sourcing**: Sourcing materials from domestic or nearby suppliers reduces transit times compared to international sourcing. Anvyl (2025) highlights that prioritizing local suppliers not only shortens lead times but also mitigates risks associated with customs delays and geopolitical disruptions.
  3. **Collaborative Forecasting**: Including suppliers in demand forecasting processes ensures better alignment between production schedules and customer needs. This reduces delays caused by supply-demand mismatches (Wrike team, 2023).
  4. **Technology Adoption**: Technologies like IoT provide real-time visibility into inventory levels and shipment statuses, helping companies identify bottlenecks and address them proactively (Johns, 2024).

- **Customer Satisfaction:** Customer satisfaction is a key driver of business success but remains a persistent challenge for supply chains due to rising expectations for faster deliveries, higher product quality, and seamless service experiences.
  1. **On-Time Delivery**: Meeting promised delivery dates is critical for maintaining customer trust. Measuring key performance indicators (KPIs) such as on-time delivery rates help organizations monitor performance and identify areas for improvement (Wrike team, 2023).
  2. **Personalized Service**: Advanced analytics enable companies to understand customer preferences better and tailor their offerings accordingly. For instance, predictive analytics can help anticipate demand spikes during peak seasons, ensuring adequate stock levels (Johns, 2024).
  3. **Sustainability Initiatives**: Modern customers increasingly value environmentally responsible practices in supply chains. Companies adopting sustainable sourcing methods or optimizing transportation routes to reduce emissions enhance their brand reputation while satisfying customer expectations (ANVYL, 2023).
  4. **Proactive Communication**: Clear communication about order statuses or potential delays builds transparency and trust with customers. Wrike team (2023) emphasizes the importance of using automated tracking systems to keep customers informed throughout the delivery process.

2.3. Value Stream Mapping "VSM"

Value Stream Mapping is a methodological tool used to analyse and improve processes by identifying and eliminating waste, thereby enhancing efficiency and customer value. This part will explore different definitions of VSM.

2.3.1 Definition and Purpose

Value Stream Mapping is defined as a visual representation of the material and information flow within a process, aiming to identify and eliminate waste while enhancing value-added activities (Shook & Rother, 1999). It is a systematic approach to analyse and improve the efficiency of processes by mapping out the current state and designing a future state that minimizes waste and maximizes value.

Applications and Benefits: VSM is applied in various sectors such as manufacturing, healthcare, and construction. In manufacturing, it helps reduce production lead times and enhance operational flexibility (Womack & Jones, 2010). In healthcare, VSM has been used to improve patient care by reducing waiting times and enhancing the quality of service (Dickson et al., 2008).

2.3.2 VSM Historical Development

Value Stream Mapping (VSM) has evolved significantly since its inception, transforming from a tool primarily used in manufacturing to a versatile method applied across various industries. This will explore the historical development of VSM, drawing on reliable sources and books.

1. Early Beginnings: Toyota Production System

The concept of VSM originated within the Toyota Production System (TPS), where it was used to visualize and optimize material and information flows. TPS, developed by Taiichi Ohno and Shigeo Shingo, emphasized continuous improvement (Kaizen) and the elimination of waste (Muda) to enhance productivity and efficiency (Womack & Jones, 2010). The early application of VSM in TPS focused on improving manufacturing processes by identifying and eliminating non-value-added activities.

The formalization and popularization of VSM as a distinct tool are often attributed to researchers James Womack and Daniel Jones. Their work in the 1990s helped expand VSM beyond manufacturing, applying its principles to other industries (Womack & Jones, 2010). The publication of « Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA » by Mike Rother and John Shook in 1998 further solidified VSM's place in Lean management (Shook & Rother, 1999).

2. Expansion Across Industries

By the 21st century, VSM had spread to various sectors such as healthcare, software development, and construction. In healthcare, VSM has been used to improve patient care by reducing waiting times and enhancing the quality of service (Dickson et al., 2008). In construction, VSM helps identify and reduce waste, improving project efficiency (Kunyoria, 2022)

3. Modern Developments

Today, VSM is integrated with digital technologies to enhance sustainability and efficiency, aligning with Industry 4.0 principles. Hybrid approaches combining VSM with simulation tools are used to improve environmental performance in construction (Issa et al., 2018).

2.3.3 VSM Key Elements

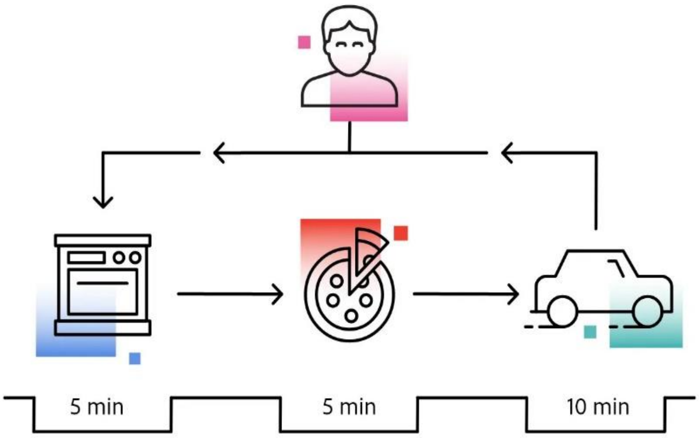
By identifying value-adding and non-value-adding steps, VSM helps organizations optimize operations, reduce waste, and improve efficiency. This text explores the key elements of VSM—current state mapping, future state mapping, and action plans

- Current State Mapping

Current state mapping is the first step in the VSM process. It involves creating a detailed visual representation of the existing workflows, including material flow, information flow, and lead times. The goal is to identify inefficiencies and areas of waste within the current process.

1. **Purpose**
   Current state mapping provides a baseline for understanding how processes operate in their present form. It highlights bottlenecks, delays, excess inventory, and other inefficiencies that hinder performance (Rother & Shook, 1999). According to Marin-Garcia et al. (2021), this step is critical for establishing a shared understanding among stakeholders of the current value stream.
2. **Key Features**
   A current state map typically includes:
   - **Information flow:** Details how data moves between stakeholders.
   - **Material flow:** Tracks how resources progress through production stages.
   - **Lead-time ladder:** Quantifies the time taken at each stage of the process (BRAGLIA et al., 2006).

Figure 3: Example of VSM time ladder



source: (Team Adobe Communications, 2022)

3. **Benefits**

   By visualizing the current state, organizations can pinpoint specific areas for improvement. For example, a study by Marin-Garcia et al. (2021) demonstrated that current state mapping in healthcare reduced patient waiting times by identifying redundant administrative processes.

- Future State Mapping

Future state mapping builds on insights from the current state map to design an optimized workflow that eliminates inefficiencies and maximizes value creation.

1. **Purpose**

   The future state map represents the ideal version of a process after improvements have been implemented. It serves as a blueprint for achieving operational excellence by focusing on customer needs and reducing waste (Rother & Shook, 1999).

2. **Key Features**

   A future state map includes:

   - Improved material and information flows.
   - Reduced lead times.
   - Enhanced alignment with customer requirements.

3. **Benefits**

   Future state mapping enables organizations to set realistic goals for process improvement. For instance, Toyota's use of future state maps allowed it to streamline production workflows while maintaining quality standards (Liker, 2004).

- Action Plans

The final step in VSM is creating actionable strategies to transition from the current state to the future state.

1. **Purpose**
   Action plans outline specific tasks required to implement changes identified during future state mapping. These plans ensure accountability among stakeholders and provide a structured approach to achieving improvements (Marin-Garcia et al., 2021).
2. **Key Features**
   Effective action plans include:
   - Clear objectives tied to measurable outcomes.
   - Defined roles and responsibilities for team members.
   - Timelines for implementation.
   - Monitoring mechanisms to track progress.
3. **Benefits**
   Action plans facilitate continuous improvement by ensuring that changes are systematically implemented and evaluated. In healthcare settings, Marin-Garcia et al. (2021) found that action plans based on VSM reduced operational costs by 15% while improving patient satisfaction.

2.3.4 VSM overall Benefits

Value Stream Mapping has emerged as a critical tool for organizational improvement, offering measurable advantages in efficiency, cost reduction, and process optimization. Recent studies highlight its effectiveness across multiple industries, demonstrating its versatility and impact.

➢ Improving Operational Efficiency

Research indicates that VSM significantly enhances workflow efficiency by identifying and eliminating non-essential steps in processes. In healthcare settings, its application has led to substantial reductions in patient waiting times by streamlining administrative and clinical procedures (Marin-Garcia et al., 2021). Similarly, manufacturing firms have reported shorter production cycles and better resource utilization after implementing VSM-based interventions (Braglia et al., 2019).

- Strengthening Cross-Functional Collaboration

  One of the notable advantages of VSM is its ability to foster teamwork across different departments. Studies have shown that organizations using VSM experience improved communication between teams, leading to fewer errors and more coordinated efforts (Henrique et al., 2016). Additionally, employee engagement tends to increase when staff members are actively involved in mapping and refining workflows (Tortorella et al., 2016).

- Reducing Costs While Maintaining Quality

  Organizations adopting VSM frequently report cost savings without compromising service or product quality. For instance, hospitals integrating VSM with Lean Six Sigma methodologies have achieved significant budget reductions while sustaining high standards of patient care (Antony et al., 2019).

- Supporting Sustainable Practices

  While traditionally focused on operational improvements, VSM is increasingly being adapted to address environmental concerns. Some studies propose modified versions of VSM, such as Green VSM, which incorporate sustainability metrics into process evaluations (Muñoz-Villamizar et al., 2019). However, gaps remain in applying these principles consistently, particularly in service-oriented sectors like healthcare (Marin-Garcia et al., 2021).

- Broad Applicability Across Sectors

  The adaptability of VSM makes it valuable in diverse fields. Healthcare institutions use it to enhance patient flow, manufacturers apply it to refine production lines, and service providers leverage it to improve customer interactions. This flexibility ensures that VSM remains relevant regardless of industry-specific challenges.

Conclusion of the chapter

We've walked through lean's story starting on Toyota's factory floor, moving through classic Value Stream Mapping, and arriving at today's digital tools. Along the way, we've seen how these ideas help uncover hidden waste and create real value for customers.

CHAPTER 02: DATA AND METHODS

In this chapter theory will meet the factory floor of SARL INDTRAV. Here, we introduce you to El Kantara's spring, the company's role in its local community and economy, and the qualitative toolkit interviews, Gemba walks and field observations, that we deployed to capture real world insights. This chapter lays out the who, what and how of our study, setting the stage for a data-driven exploration of Value stream map as a lean implementation in action.

Section 01: Organizational Context

1.1.Historical Overview of the El Kantara Region and Its Water Source

The El Kantara spring water represents a natural marvel, originating at the foot of Mount Djebel Metlili. Renowned for its refreshing and sparkling qualities, El Kantara water is synonymous with vitality, effervescence, and well-being.

El Kantara, formerly known as Calceus Herculis, is a municipality in the wilaya of Biskra, Algeria. This oasis is located in the southwestern part of the Aurès, 52 kilometers north of Biskra and 62 kilometers southwest of Batna. The natural site of El Kantara and its Roman heritage have been classified and protected since 1923.

The town of El Kantara is the result of Mio-Pliocene and Quaternary sedimentation processes. The Ain Skhoun Spring is the most significant in the region. The El Kantara wadi, or Oued El Haï, is composed of small dams that are sequentially arranged into four irrigation channels to ensure a reliable water supply for the community. The climate is cold in winter and hot in summer. The municipality is traversed by Algeria's national road No. 3 and by the railway line connecting Batna and Biskra.

1.2.Company Overview

SARL INDTRAV is a limited liability company specializing in the production of mineral water under the commercial name "El Kantara." Established in March 2017 by a group of partners, the company is headquartered in El Kantara, an oasis located in the southwestern Aurès region, 52 km north of Biskra and 62 km southwest of Batna. The company is managed by Mr. Saleh Saker and operates from Lot 8 Mai 1945, El Kantara, Biskra.

The El Kantara mineral water primary mission is to meet societal needs and contribute to fulfilling the demands of the local community. The company is also committed to the rationalization of production processes, aiming for efficiency and sustainability.

- Facilities and Capacity
  - Total area: 15,000 m²
  - Covered area: 7,000 m²
- Production lines:
  - Bottles (1.5L): Capacity of 24,000 bottles per hour
  - Bottles (0.5L): Capacity of 10,000 bottles per hour
  - Large containers (5.5L): Capacity of 600 containers per hour
- Workforce Structure
  - Executives: 11
  - Supervisors: 11
  - Operational staff: 112
- **Raw Materials and Production Inputs**: The production process utilizes a variety of raw materials and consumables, including preforms, stretch films, adhesive handles, neutral films, bottle caps, and cleaning/disinfection chemicals (CIP products).
- **Product Range and Quality Assurance** The company offers a range of products that comply with HACCP standards, including 1.5L, 0.5L, and 5.5L formats of spring water.

1.3.Strategic Objectives

The translation and analysis of SARL INDTRAV's organizational objectives reveals three primary strategic dimensions:

- Human Capital Development: "Contribute to the improvement of employees' standard of living", These objective positions the organization within contemporary human resource management theory that recognizes employee well-being as instrumental to organizational performance. The enterprise acknowledges its role in enhancing socioeconomic conditions for its workforce, suggesting a stakeholder-oriented approach to organizational success.
- Market Positioning and Consumer Influence: "Establish specific consumption models by influencing public preferences through the introduction of new products", This objective reflects a market-shaping strategy rather than merely responding to existing demand. The organization aims to exercise agency in consumer preference formation, suggesting an innovative approach to product development and marketing that aligns with proactive market orientation theories.

- Stakeholder Integration with the Workplace Climate: Ensuring cohesion, This dual-focused objective connects external stakeholder relations with internal organizational climate, suggesting recognition of the interdependence between customer satisfaction and employee engagement. This approach reflects contemporary organizational theory on stakeholder integration and its impact on operational effectiveness.

1.4.The company's Main missions

While INDTRAV LLC does not present a formally articulated mission, the analysis of its operational characteristics and stated objectives reveals implicit mission elements that can be interpreted.

- Resource Stewardship: The enterprise's operations center around a natural spring water resource with historical and ecological significance. This suggests an implicit mission element focused on responsible resource management and environmental stewardship, particularly considering the protected status of the El Kantara natural site since 1923.
- Community Development: With a substantial workforce of 128 employees in a relatively small municipality, the enterprise serves as a significant regional employer. This workforce structure, established in 2017, indicates a mission element oriented toward regional economic development and community support.
- Quality and Consumer Welfare: The implementation of HACCP standards and production of various water formats demonstrates a mission orientation toward health promotion and quality assurance. This aligns with the company's implicit positioning of its products as contributors to consumer well-being through natural mineral water.
- Operational Excellence: The infrastructure investment and production capacity suggest a mission element focused on efficiency and operational optimization. This is further supported by the explicitly stated objective of "rationalization of production" in the company documentation.
- Cultural Heritage Integration Mission: The enterprise's identity incorporation of the rich historical context of El Kantara represents a mission element focused on cultural heritage preservation and regional identity maintenance within commercial operations.

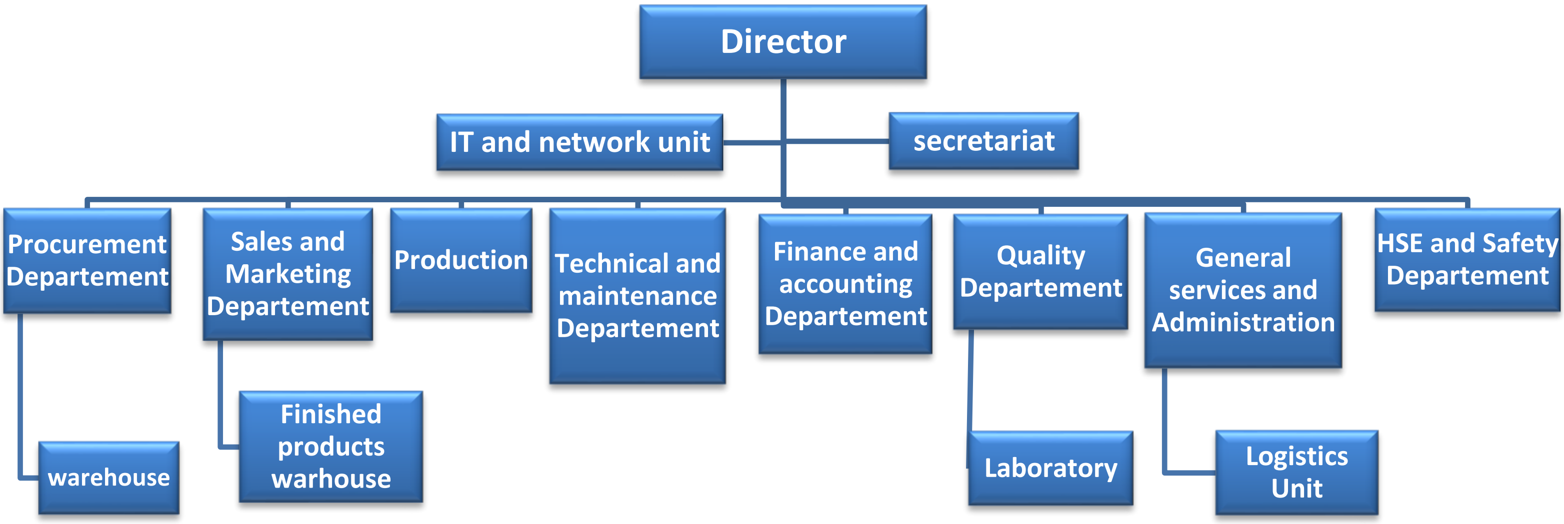
- Market Responsiveness: The stated objective of influencing consumer preferences indicates a mission orientation toward market leadership and innovation rather than passive market response, suggesting proactive strategic positioning within the beverage industry.

table 2: **Identification sheet**

Corporate Name:	INDTRAV
Trade Name:	EL Kantara Water
Logo	
Legal Status:	LLC (Limited Liability Company)
Address:	Lot 8 May 1945, El Kantara, Biskra
Share Capital:	/
Website:	www.elkantarawater.com
Email:	contact@elkantarawater.com
Phone:	+(213) 561 76 94 81
Fax:	033 631 002

Source: Created by the author

Figure 4: INDTRAV organizational chart



Source: (INDTRAV, 2025)

Section 02: Methodological framework (Qualitative Approach)

In this section we will be presenting the methodological approach used to treat the study effectively firstly we will be starting by defining the methodological terms that has been used secondly a furthermore explanation to clarify why and how this approach was treated in the case study of VSM implementation in INDTRAV company.

2.1.Presentation of the search methodology

In order to address the main topic of the search which is the implementation of the value stream map as a lean management tool we have decided to use a qualitative approach.

Meaning of search According to (western Sydney University, 2024), research is defined as "the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts". Kumar (2011) describes research as a careful and systematic investigation aimed at discovering and interpreting new facts. He emphasises the importance of using structured methods to ensure the results are reliable, replicable, and applicable beyond the immediate study.

Qualitative approach Qualitative research is a systematic, flexible, and interpretive approach aimed at exploring and understanding complex phenomena through the collection and analysis of non-numerical data such as text, audio, or video. It seeks to provide rich, detailed insights into people's experiences, perceptions, behaviours, and social contexts, focusing on the "why" and "how" questions rather than quantifying variables or testing hypotheses. Unlike quantitative research, which emphasizes measurement and statistical analysis, qualitative research prioritizes depth of understanding and the meaning that participants assign to their experiences (Oranga & Matere, 2023).

The reason we deemed the qualitative approach appropriate in our case lies in the complexity of our topic and its significance in creating value for the host organisation. This approach requires a sustained presence in the field to enable interpretation and the collection of a maximum amount of information. It calls upon a certain degree of observational skill, as well as close interaction with staff members and senior management, in order to diagnose the existing context. Various data collection tools were employed throughout our immersion in the organisation.

2.2.Data collection

To carry out our study, we opted for a *qualitative approach* in the form of interviews with the managers of INDTRAV, complemented by field observation, after consulting several publications on the subject to gain a comprehensive understanding. The information was obtained through face-to-face interviews conducted in the offices of INDTRAV managers, based on an interview guide.

Thus, qualitative research through interviews, supported by observation and documentation, represents the most appropriate method for our study. This approach allowed us to gather as much information and data as possible to identify sources of waste and to select the Lean Manufacturing tools best suited to each issue in order to ensure the success of our implementation.

2.2.1 Observation

Observation is a foundational qualitative research method in lean management, particularly crucial for the effective implementation of Value Stream Mapping (VSM). In lean practice, observation is an intentional and structured activity aimed at gaining a deep understanding of actual processes, identifying inefficiencies, and supporting continuous improvement efforts. By directly observing workflows and interactions on the shop floor, researchers and practitioners can accurately capture the current state of operations, which is essential for creating valid and actionable VSMs (Danese et al., 2018).

Observation and Lean Management, rooted in the Toyota Production System, prioritizes the elimination of waste (*muda*) and the continuous enhancement of value delivered to customers. Central to this philosophy is the principle of *genchi genbutsu* or "go and see," which emphasizes firsthand observation of the real work environment. This principle underlines the importance of observation in lean, as it allows for the discovery of issues that may not be apparent through reports or assumptions alone (Sinha & Matharu, 2019).

Key Related Terms used in Lean Observation:

- **Gemba Walk:** A Gemba walk is a structured observational practice where managers and improvement teams visit the actual place where value is created—the gemba—to observe processes, engage with employees, and identify problems and opportunities for improvement. This practice fosters a culture of continuous improvement by grounding decisions in real-world observations (Danese et al., 2018).
- **Muda Walk:** A Muda walk is a focused observation specifically aimed at identifying the seven types of waste (*muda*) defined in lean: overproduction, waiting, transport, extra processing, inventory, motion, and defects. Conducting a Muda walk during VSM implementation provides empirical evidence necessary for designing waste elimination strategies and improving process flow (Sinha & Matharu, 2019).

2.2.2 Interviews

A semi-structured interview is a qualitative research method that combines a set of predetermined open-ended questions with the flexibility to explore emerging topics during the conversation. This approach allows the interviewer to adapt the phrasing and sequence of questions based on the flow of the discussion, enabling deeper exploration of participants' experiences and perspectives while maintaining a consistent thematic framework (Coccolini et al., 2023).

Semi-structured interviews are particularly valuable in lean management research because they provide both structure and adaptability, making it possible to gather detailed and comparable data from different stakeholders while also probing for unique insights relevant to each participant's context. In this format, the interviewer can clarify responses and follow up on interesting points, which enhances the depth and quality of the information collected (Tortorella et al., 2017).

In our case we have made a several interviews with all the heads of the concerned departments in INDTRAV enterprise in order to have a full vision of the process and easy and fast issues identifications throughout their experience, we have based the sample on all the steps that the value stream have to pass on from the raw materials coming from the suppliers into the shipping to clients, the interviews where not decisively programmed in matter of date or period, but the periods was around 15min into 1 hour based on our interviewees available time.

Also, the questions were based on an interview guide (appendix A) in order to define the main topic and letting the interviewees speak freely so we can gain their own opinion or analytics about the topic, sources of waste (MUDA) and their observations.

Table 3: INDTRAV interviewes

N	Interviewee	Durance
1	Procurement responsible	50 min
2	Warehouse manager	20 min
3	Production manager	01h
4	Quality responsible	30 min
5	Commercial manager	49 min
6	Maintenance engineer	01h
7	HSE responsible	40 min

Source: Created by the author

Conclusion of the chapter

We've introduced SARL INDTRAV, taken Gemba walks, and sat down with the people who run the show. By blending field observations with in-depth interviews, we've built a toolkit that will let us dive deep into how lean really works on the ground.

CHAPTER 03: VSM implementation in INDTRAV company

In this chapter we will be presenting the Value stream mapping realisation in INDTRAV company and its role in defining different MODA based on our data collection methods which are real time and place observations such like Gemba walk and moda walk and, also arranging some interviews with concerned people in the supply chain process gaining their preview and opinions.

Section 01: VSM implementation steps

We are going to base our work on a well-organized methodology that was mentioned in the main source of the founders of the VSM concepts which are rother and shook and it follows the following steps you can see the presented in the following figure.

Figure 5 : VSM Implémentation phases.

Source: (Rother & Shook, 1999)

1.1.Product choice

INDTRAV company have 3 main products and each one is produced in a separated production line thus why we have to choose the most important product among these 3 products in order to give our study a valuable result for us and also for the company.

Using ABC classification method in order to detect which product is the chosen for our VSM implementation and here we are going to use the products Inventory movements value for last year from 01 January 2024 till 31 December 2024.

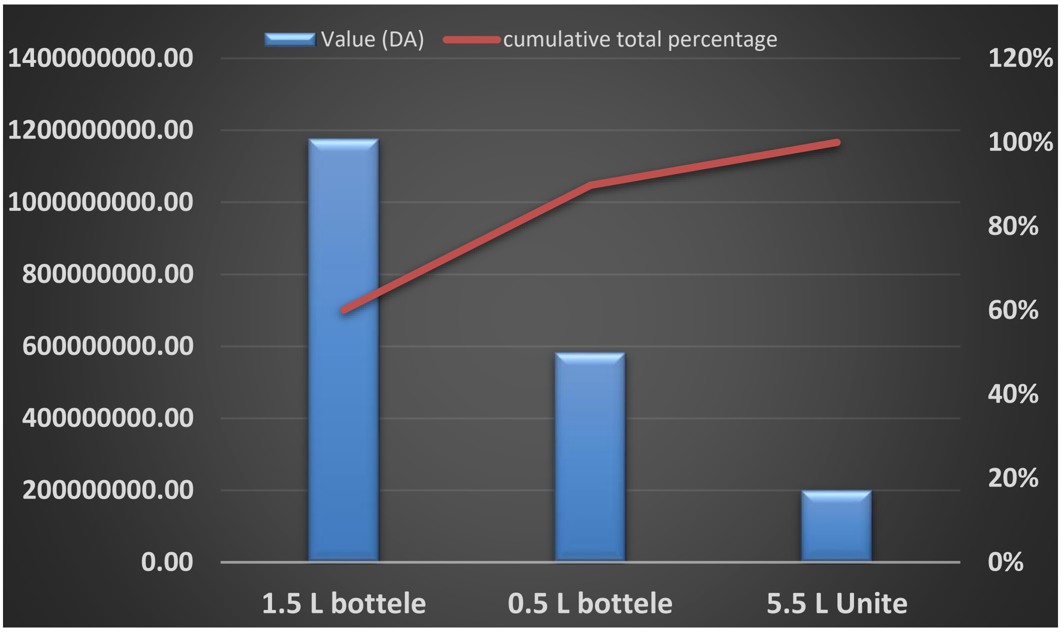
table 4: INDTRAV Product value classification

Product	Volume	Value percentage
1.5 L bottle	57540372	60,09%
0.5 L bottle	51600768	29.7%
5.5 L Unite	3300341	10%

Source: created by the author

Based on the past table it's obvious that the 1.5 litre bottels are the most important product based on volume and also as an inventory value and in order to make it much clearer we will present in the following figure the pareto chart that indicates the importance of products which means 20% of the products presents 80% of the total products value.

Figure 6: Pareto Product classification



Source: created by the author (excel)

The chart presents 1.5 litre bottles as the most valuable product in indtrav company so our study will be based on this product.

1.2.Pre-VSM realisation

Before the realisation we have to explore the hole process in order to understand the key related functions and to gain a general overview that could assist our analyse thus why we are going to explain these principal functions.

1.2.1 Water pumping

At INDTRAV, water pumping process starts by drawing water from EL KANTARA borehole with 24 turbine pumps. It first passes through a coarse sand filter, then collects in our 100K litres reservoir. From there, the water is sent to holding tanks and given a finer 5-micron filtration. Next, it moves into the production reservoir for a 1-micron polish. Finally, it's split across each production line, each one with its own 0.2-micron filter, just before it reaches the filling machine.

This multi-stage process ensures we remove every last impurity and deliver perfectly clean water for bottling.

1.2.2 Logistic management

In terms of logistic in Indtrav company its about heavy trucks and as resources there is trucks and truck drivers who belong to the company and those are all tracked using a geographic information system 'SIG' which uses a GPS tracking system on trucks.

Also, the transportation costs are one of the important tasks that are laid on the logistic responsibility such as gas consumption using a gas receipts that are given to drivers also the forklifts gas is calculated in order to make a sufficient function for the hole in and out transportations.

1.2.3 Quality management

The Quality Department, primarily centred around the laboratory, plays a pivotal role in the day-to-day assurance of water quality and material integrity.

Among its principal functions:

- **Physical and Bacteriological Analysis**: Routine testing is conducted on raw materials, such as preforms, and finished products to verify physical properties and ensure bacteriological safety before any product reaches the market.
- **External Verification through Accredited Institutions**: Water samples are periodically dispatched to leading institutions the Pasteur Institute and the National Water Resources Agency (ANRH) particularly during periods of hydrological fluctuation (high levels between September and October, low levels between April and May). This external validation reinforces the robustness of our internal controls.

- **Regulatory Compliance and Standards Enforcement**: The department oversees the application of all conditions laid out in the specification documents jointly prepared with the Ministry of Water Resources. It also ensures strict adherence to internationally recognised standards such as HACCP, focusing on risk management throughout production.

- **Batch Validation and Documentation**: Every production series is subject to thorough analysis, and the laboratory results serve as formal documentation to meet regulatory requirements and provide traceability for every unit produced.

- **Hygiene Management: The Clean-In-Place (CIP) System**

At INDTRAV, maintaining the highest standards of water purity is critical, not just for production quality, but for consumer safety as well.
To achieve this, INDTRAV use a highly efficient **CIP (Clean-In-Place)** system to clean the pumping reservoirs, pipelines, and filters without the need to dismantle the equipment. This method allows to perform deep cleaning quickly, safely, and consistently, ensuring that every drop of water meets strict hygiene standards.

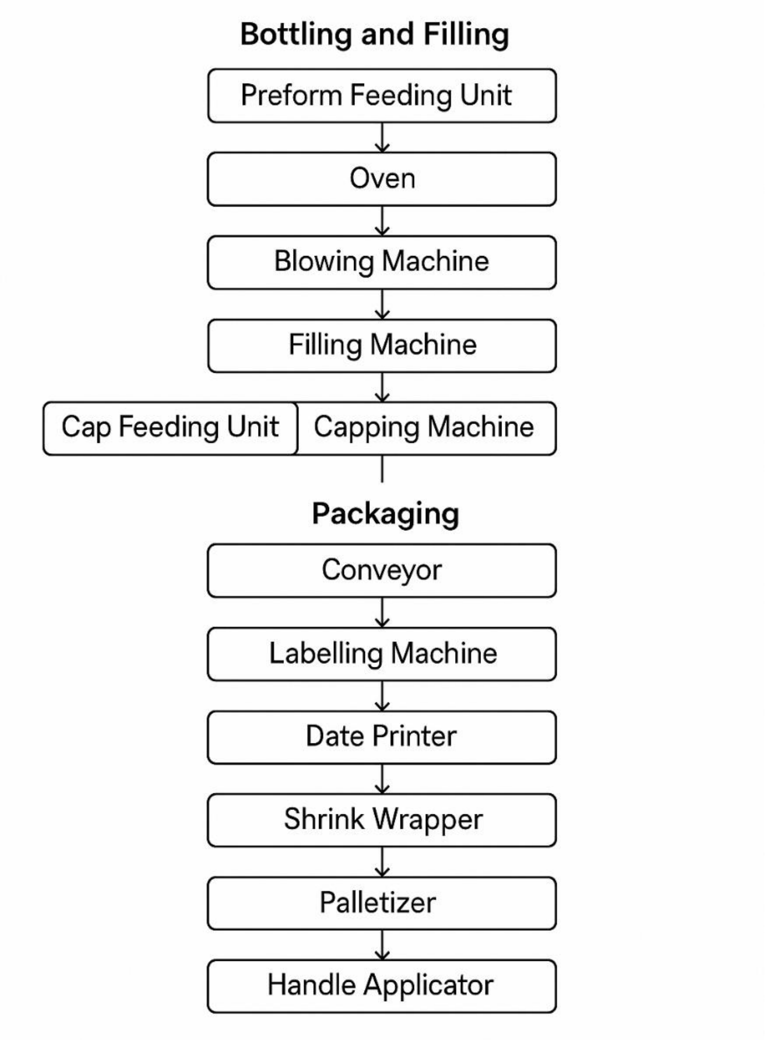
Throughout the CIP cycle, careful monitoring through pH testing, visual inspection, and microbiological sampling ensures that every step meets stringent standards before resuming production.

1.2.4 The production chain

The organisation of INDTRAV's production line is designed for efficiency and hygiene, ensuring a seamless flow from raw water extraction to final product dispatch. The production system is fully automated where possible, minimising manual handling and maintaining high standards of product integrity.

A key feature of the production facility is its ability to process several bottle formats—namely 5 litres, 1.5 litres, and 0.5 litres—on the same line. This flexibility, supported by a unified feeding system, allows the company to respond efficiently to market demands without the need for extensive equipment reconfiguration.

Figure 7 INDTRAV's production



source: created by the author

And the production process passes on a different Stages:

1. Feeding and Heating of Preforms

The production process begins with PET preforms, which are fed into the system via an automated hopper. These preforms are then conveyed through infrared heating tunnels, where they are softened without deformation, preparing them for the blow moulding phase.

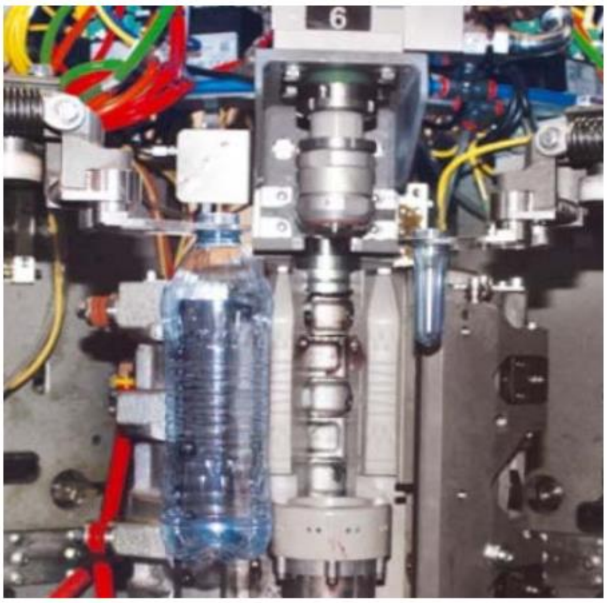
Figure 8: Preform feeding unit **Figure 9: PET preforms**

source: created by the author

2. Blow Moulding Process

In the blow moulding station, preforms are expanded into their final bottle shapes using high-pressure air within precision-designed moulds. This stage is crucial for ensuring uniform bottle strength and consistency.

Figure 10 Blowing machine



source: created by the author

3. Bottle Conveyance

Once formed, the empty bottles are transferred via a hygienic air conveyor system to the filling station. This system reduces mechanical contact and potential contamination, preserving the sanitary condition of the bottles.

4. Filling and Capping

At the filling station, bottles are filled with mineral water under controlled conditions. Immediately after filling, bottles are capped to seal the product and protect it from external contaminants.

5. Labelling and Date Marking

Filled and sealed bottles proceed to labelling machines where brand labels and essential traceability information, including production and expiry dates, are accurately applied.

6. Packaging and Palletising

Following labelling, bottles are grouped and shrink-wrapped into bundles. These bundles are conveyed towards robotic palletisers, which stack them neatly onto pallets.

Figure 11: the robotic palletiser

source: created by the author

The pallets are then securely wrapped using an automated stretch wrapper, ensuring stability during storage and transport.

1.3. Current state “VSM”

1.3.1 The first step: the client

As a first stage in the value stream mapping, we are going to present INDRAV’s clients which are diverse such as distributers in other states and its warehouses across the country (ORAN, Tipaza, Annaba) also a bulk water storage tanks for CILAS company also university dorms as contractor.

And it will be presented in the top left side using its own presentation symbol.

And their requirements are:

table 5: INDTRAVS client requirements

Clients requirements	/
Quantity distributed priorities	Company warehouses
The price	Monthly discounts
Quantity required per bottle/day	478800
Quantity required per pallet/day	700
Client’s orders	Daily orders
Contact methods	Phone, whatsApp, Viber, email

source: created by the author

The selling forecasts in IDTRAV are yearly based on historical sales data because its different from season to other (summer, winter), also some special cultural occasions could affect the demand such as the holy month of Ramadan.

1.3.2 The second step: manufacturing process

In this step the manufacturing processes are symbolled as data box and they are used to record information’s concerning a manufacturing process or department and each one contains the process name and number of operators (as a symbol inside the data box) and the process boxes must be arranged sequentially by the process occurrence.

The data box must contain some certain information's such as:

- Process cycle time
- Machine up time
- Available working time(shifts)

as it mentioned before the manufacturing process are:

1) Feeding and Heating of Preforms
2) Blow Moulding Process
3) Filling and Capping
4) Bottle Conveyance
5) Labelling and Date Marking
6) Packaging and Palletising

1.3.3 Third step: suppliers

Suppliers will be presented in the top left side of the map using a similar symbol of the clients and the objective is to present all the information's required such as communication methods order frequencies delivery means transportation.

In INDTRAV case the suppliers are diverse such like pet preforms caps and labels but the product is generally based on the PET preforms that's because it interacts with the water directly and a major changing is made on it.

The shipments are arriving daily but the orders are monthly and the delivery method is trucks

1.3.4 Fourth step: Information flow

Recently we have presented the physical flows but now we have to clarify the information flows and their channels:

- **Purchase Order (PO)**: Used to formally request goods or services from suppliers; essential for procurement tracking and cost control.
- **Transfer Order**: Internal document used to track the movement of materials or products between different departments, warehouses, or production lines.
- **Shared Network Drives**: Digital communication channels and collaborative tools used for information exchange, document sharing, and task coordination.

- **Mobile Phone**: A key tool for real-time communication, especially for coordination between departments, field staff, or in urgent operational contexts.
- **Meetings**: Organised discussions used to align teams, review performance, and make strategic or operational decisions.
- **Visual Display Boards (Communication Boards)**: On-site visual management tools used to display key performance indicators (KPIs), shift objectives, safety information, or production status.
- **Work Orders and Production Orders (from BIG ERP system)**: System-generated directives for executing specific production or maintenance tasks; they ensure traceability, planning accuracy, and resource allocation.

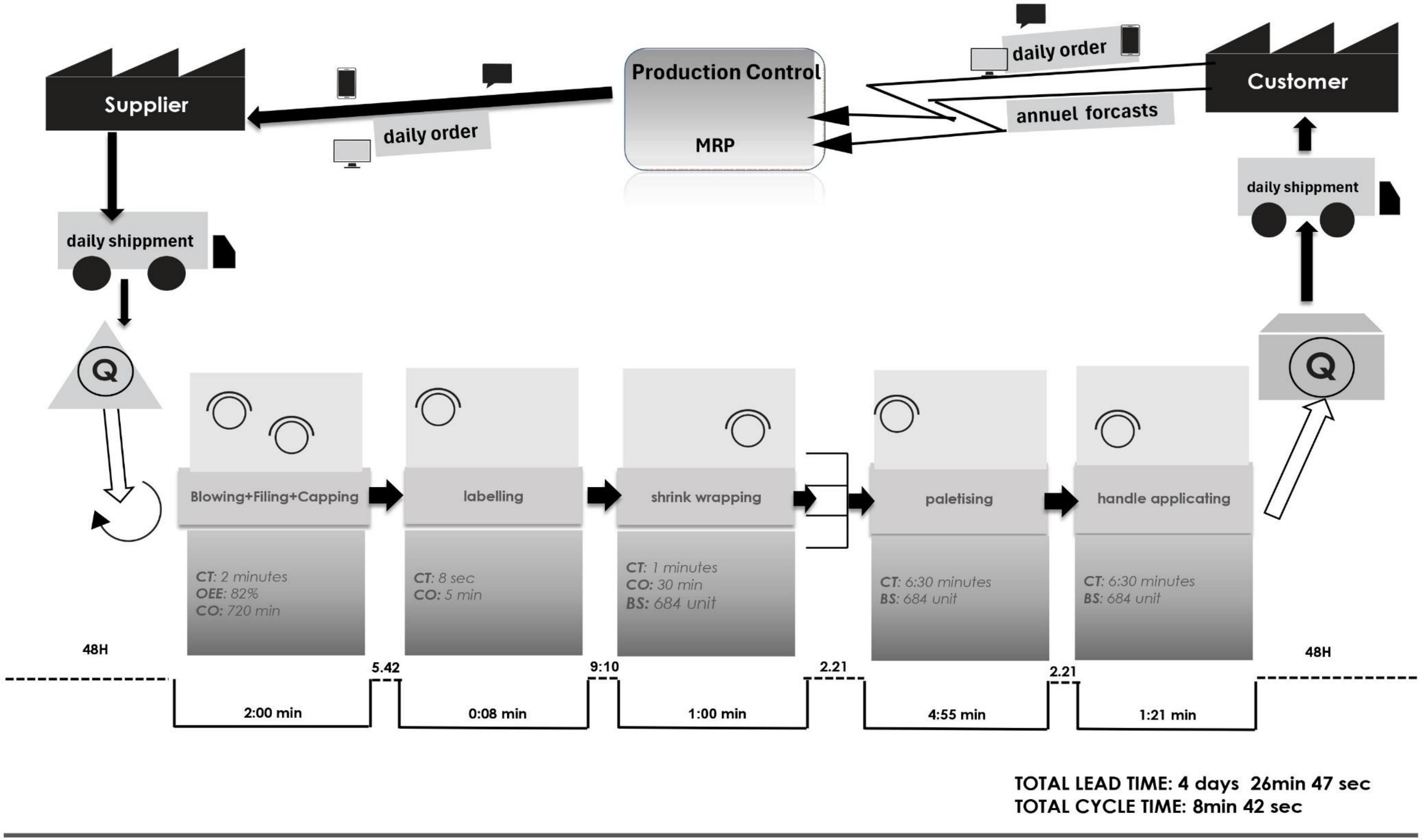
1.3.5 Fifth step: Time line

To better understand the flow of operations, we used a timeline bar placed along the bottom of the Value Stream Map (VSM). This allowed us to visually track how much time each process step actually adds value, as well as how long products remain idle between stages. Towards the end of the timeline, we were able to calculate the overall lead time by combining the time goods spend in stock with the total time they are actively being processed.

We gathered key insights about stock duration during a discussion with the deferent managers across the factory such as inventory manager, production manager… , who provided helpful details based on their operational experience. In addition to that, we made several site visits to the warehouse and production lines to observe the workflow firsthand. During these visits, we manually timed each phase of the process.

Altogether, we monitored all concerned operations, covering everything from receiving and quality checks to storage allocation, order picking, and shipping. This sample size was chosen to ensure our findings were based on a realistic and representative view of day-to-day activities. Which lead into the realisation of the actual value stream map.

Figure 12:VSM actuel state



Source: Created by the author (excel template)

1.4.Current state map analysis

In this step we are about to detect and define sources of waste “MUDA” in the hole indtrav’s process

table 6: INDTRAV Wastes

Muda types	the waste description	Location (place, machine or process)
Waiting	Machine downtime due to unanticipated breakdowns and late interventions	**Filling and capping machines**
	Equipment downtime caused by reactive maintenance. Lack of preventive maintenance schedules and delays in sourcing spare parts disrupt lab workflows and microbiological testing.	**Laboratory autoclave**
	loading and unloading trucks often taking much more time for trucks to get ready for loading which makes one of the loading docks occupied	**Loading docks**
	Waiting for external interventions or delayed maintenance on critical equipment	**Technical and maintenance Department**
Motion	Disorganized equipment/files force technicians to search for calibration certificates or tools. Frequent movement between labs and storage areas to retrieve parts or documents.	**Laboratory and inventory**
	Frequent manual travel by technicians to locate parts and tools, and purchase equipment externally	**Technical and maintenance Department**
Defects	Non-conforming equipment calibration (pH meters, autoclaves) due to incomplete documentation in "fiches de vie." This leads to unreliable test results, risking product	**Laboratory and inventory**

	quality and compliance with HACCP/ISO standards.	
	the PET preforms batches are not fully conformed for the blowing machine	**Blowing machine**
	the harmed water packs or pallets cannot be repacked again which leads to tag these for internal use or discount sales by the cause of the compromised packaging	**forklifting**
	equipment not monitored: breakdowns not prevented, such as the autoclave or pasteurizer	**Microbiological analysis station**
Overprocessing	Redundant paperwork (duplicate data entry in "fiches de vie," Excel sheets). Fragmented traceability systems require repetitive checks, wasting time and resources.	**Administrative offices**
	Maximum absorbed power (PMA) often exceeded without regulation	**Entire factory (transformers, motors)**
	restart of production cycles due to repeated stoppages	**Production line**
Inventory	Excess stock of unused spare parts (autoclave gaskets, pH electrodes) due to lack of just-in-time inventory management. Expired calibration standards occupy storage space and tie up capital.	**Storage rooms**

Unused Talent	Level 3 to 5 maintenance requires external service providers, delaying recovery	**Technical and maintenance Departement**

Source: created by the author

1.5.Inefficiencies root causes

In order to define the root MUDA causes we will be analysing their causes based on the Ishikawa diagram using the 5M categorising and those categories are based on non-conformities concerning methods, materials, labour, machines, workplace

1. Methods:

- Lack of standardised rules or procedures to identify and eliminate sources of waste.
- No preventive quality control at raw material reception.
- Delayed detection and reaction to non-conformities in the production process.

2. Materials:

- No designated or structured area to isolate and handle non-conforming products.
- High rejection rate of defective products caused by insufficient inspection and traceability.
- Stockpiling of outdated or deteriorated components due to the absence of automated inventory control.

3. Manpower (labour):

- Frequent unnecessary movement of workers, often caused by poor layout and lack of visual management.
- Lack of training, especially in preventive maintenance and technical diagnosis.
- Dependence on external contractors for high-level maintenance tasks (levels 3 to 5), leading to delays.

4. Machines (Equipment):

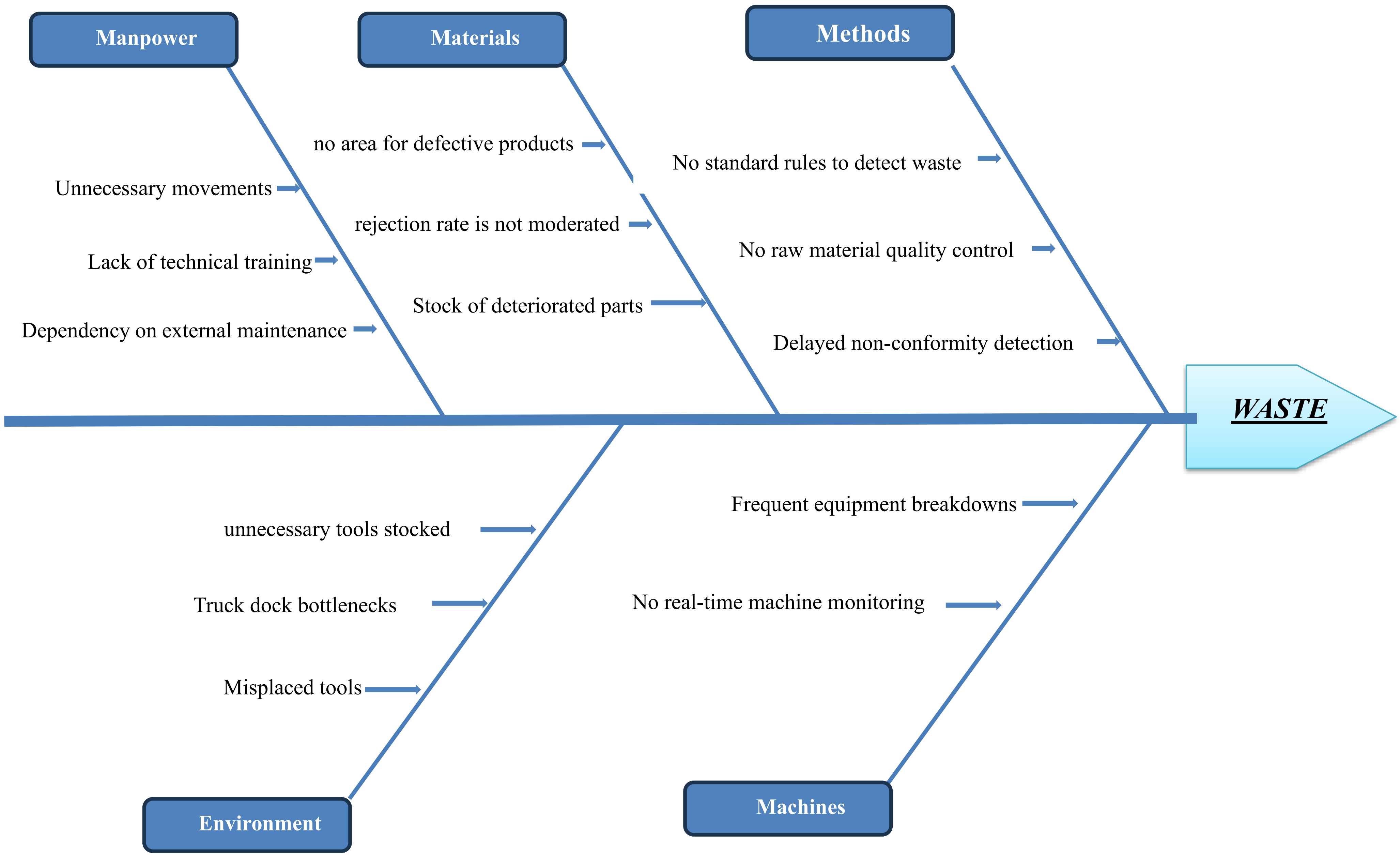
- No real-time monitoring of machine conditions or energy usage.

- Recurring equipment failures due to insufficient revision and follow-up.

5. Environment (Workplace Organisation):

- Presence of unused or misplaced tools within production areas, causing clutter and risk of error.
- Loading/unloading delays caused by no instruction appeared for truck drivers.

Figure 13: Ishikawa Diagram



Source: Created by the author

1.6.Future state mapping

According to rother and shook (Rother & Shook, 1999) the future state mapping of the value stream mapping conception starts by answering 8 questions which are:

- What is the takt time?
- Will you build to a finished goods supermarket from which the customer pulls, or directly to shipping?
- Where can you use continuous flow?
- Where do you need to use pull systems? Where will you need to use a FIFO system?
- What process will be the pacemaker?
- How will you level the production mix?
- What increment of work will you consistently release and take away?
- What process improvements will be necessary?

So here we are going to implement this methodology and ask those questions concerning INDTRAVE company in order to make its future value stream map

1.6.1 What is the takt time of INDTRAV

Takt time is a German word that indicated the ability of the production line to full fill the market needs or the client's needs to be specific. Its importance comes as a way to avoid overstocks, overproduction and ensuring that the production capacities aligns with the market demand rhythm.

The calculation of the takt time follows this formula:

Takt time = Available time / Customer demand

123.4sec = 86400sec /700 pallet

0.2 sec= 86400/478800 bottle

In order to full fill the client's product demand INDTRAV have to produce one pallet every 123.4 second or a bottle every 0.2 sec

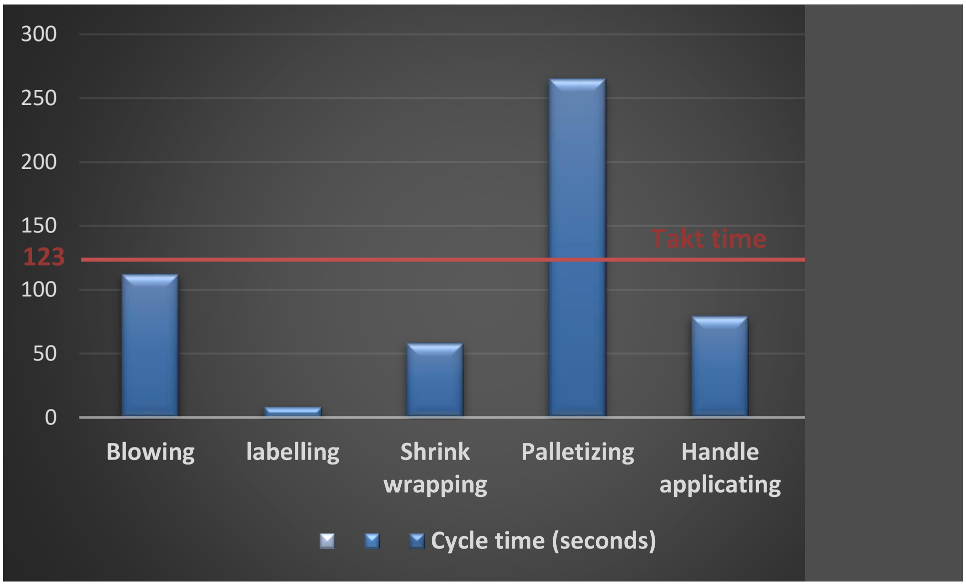
table 7: Cycle time accumulations

processes	Blowing Filling capping	Labelling	Shrink wrapping	Palletizing	Handle applicating	Total cycle time
Cycle time	112 sec	08 sec	58 sec	265 sec	79sec	522 secs

Source: created by the author

The total cycle times have to be equal or less then takt time in order to full fill the clients demand and to prevent the late deliverance which is not the case for indtrav's because the cycle time exceeds the takt time Longly.

Figure 14: global cycle time comapred



Source: created by the author (excel)

The overall cycle times of most processes are lower than the Takt Time, however, the overall cycle time of the palletization process exceeds the Takt Time. This situation indicates an imbalance in the production line, this can cause stoppages or slowdowns in the overall production flow, which can lead to accumulations of pending products, delays in the final delivery, and potentially impact the company's ability to meet deadlines and market demand efficiently. Therefore, it is important to analyse the palletization processes in detail to identify the reasons for these cycle time overruns.

1.6.2 Will you build to a finished goods supermarket from which the customer pulls, or directly to shipping?

Because INDTRAV's product follows the agri-food regulations it must be stocked for 48H waiting for the bacteriological analysis results for conformity which indicates that it is impossible for the finished goods to be directly shipped to customers.

1.6.3 Where can you use continuous flow?

A continuous flow process is the production of one product at a time, with each product passing from one operation to another in the production line without any downtime between steps. In the future state drawing, if a continuous flow is established between two processes, then their execution times will accumulate and the two process boxes will merge to form a single one.

In indtrav's case the hole production process is fully automated but initially at the first sight we had already cumulated the blowing, filling and the capping process in one box because they happen inside one machine in order to reduces mechanical contact and potential contamination, preserving the sanitary condition of the bottles.

- The palletiser machine is close to the handle applicating machine and those two processes have one similar purpose which is conditioning and packaging for better shipping also they happen in sequence.
- There is an accumulation buffer between the labelling machine and the shrink wrapper machine also between the shrink wrapper machine into the palletiser machine.
- At the beginning of the production process the PTE (preforms) feeding machine is supplied with the raw materials (preform) in batches so there is waiting time between them in order to let oven process all the preform batch.
- At the end we can see the finished goods waiting to be stocked by forklifts in the inventory.

1.6.4 Where do you need to use pull systems? Where will you need to use a FIFO system?

To answer this question, we have to analyse the waiting between processes or buffers, we had already detected where are those buffers located in the hole process and the purpose is to detect where a bottle necks could happen and prevent it also managing the overproduction.

In indtrav case we have waiting and buffers in 3 areas which are:

- Between the labelling machine and the shrink wrapper (bundler) and because it happens in a conveyor that could be manually controlled, we can implement a FIFO (first in first out) lane.
- Also, a supermarket buffer could be implemented in the beginning of the process where the raw materials wait to be interred to the oven throughout the preform feeding unit.
- In the and after the handle applicator process the pallets remain waiting for the forklift to lift them to the main warehouse in this area its better using a kanban pull signals so whenever a pallet is ready a pull signal will be sent automatically to the handle applicator process in order to accelerate and pass a new finished pallet for shipment.

1.6.5 What process will be the pacemaker (regulatory process)?

It becomes possible to control the entire production process by focusing on just one of them. The regulatory process will distribute production control information throughout the entire chain.

In indtrav case it appears that the filling machine is the closest to be the regulatory process but concerning the production process overall the retheme is controlled by the blow moulding machine as it's the main process and the Overall Equipment Effectiveness indicator is calculated based on its performance, also the quantity of products its not based on the mineral water itself in reality it is based on PTE preforms which are the main raw material for the product and it can be easily controlled either manually by controlling the feeding process or using an automative way to reduce the blowing capacity, also when we talk about changeover it is the main process that will be effected due to changeovers.

1.6.6 How will you level the production mix?

Even though INDTRAV produces only one product which is 1.5L water bottle and the production runs 24 hours a day, 7 days a week, load levelling (also known as Heijunka) still plays a very important role in improving stability and reducing waste.

Right now, the company does not produce based on live customer orders. Instead, production is driven by demand forecasts built from previous years. While that helps in preparing for high seasons like summer or Ramadan, it also means that some days the line might be working harder than others or producing more than needed, just in case. This can cause extra pressure on machines and workers, especially when the cycle time is already longer than the takt time, meaning the line is operating below the customer pace and struggling to keep up consistently.

To manage this, load levelling isn't about mixing different products (since there is only one) but rather about finding a way to spread production more evenly across shifts and days. The goal is to create a smooth and steady flow not just produce huge batches during busy periods and then slow down later. Instead of reacting to forecast spikes, the idea is to calculate a daily average need based on total demand, and then plan production around that number, adjusting only when needed.

the monthly demand is 21000 pallets, the production schedule should aim for 700 pallet per day, evenly split across two shifts. Even with a 24/7 schedule, setting a fixed pace for each shift (even if it is below capacity) helps avoid stress on the machines, prevents overproduction, and gives the team a predictable, sustainable rhythm.

Also, since INDTRAV's line includes multiple downstream processes like labelling, palletising, and shipping having a visual planning system like a Heijunka box at the pacemaker process (blow moulding) can help maintain that steady rhythm. Each shift or hourly block could be assigned a consistent production target. This gives the team clarity on what to produce and when, without relying on guesswork or responding to demand spikes with urgent overproduction.

In short, the load levelling in a 24/7, single-product environment like INDTRAV isn't about producing more it's about producing smarter. By sticking to a consistent pace, avoiding last-minute surges, and using visual planning tools, INDTRAV can run more efficiently, protect its equipment, and ensure customer needs are met without extra cost or chaos.

1.6.7 What increment of work will you consistently release and take away?

this question is about defining the Production Pitch (batch size) in which work will be released into the system (from planning) and taken away (from the pacemaker process, like blow moulding or packaging).

It's not about big batches or random timings. It's about creating rhythm and stability in production, so every shift, machine, or operator knows:

- How much to produce
- How often to produce it
- And when to move it forward

- Firstly, we have to calculate the pitch, it follows the following formula:

Pitch = Takt Time × Pack Size

Takt time = 0.2 sec

Pack size (the pack here is counted as pallets) : 1 pallet = 684 bottle

Pitch= 684 × 0.2= 136.8 sec per pallet

This calculation supports Heijunka (load levelling) and Kanban pull systems by assigning clear “work slots” to each time block

So instead of producing continuously without a clear rhythm, the pacemaker process (blow moulding) would aim to release a pallet of bottles every 136.8 seconds.

- Number of Pitches per Day

Total available time per day = 86,400 seconds

Pitch = 136.8 seconds

Number of available pitch slots per day = 86,400 ÷ 136.8 ≈ 631 slots

But the daily demand is 700 pallets, which is higher than the available pitch slots.

This indicates that:

The current capacity is not sufficient to meet 700 pallets/day at that takt time and pack size.

To achieve 700 pallets/day, either Takt time must decrease (production must be faster), or Additional machines must be added or upgrading the current one if possible.

1.6.8 What process improvements will be necessary?

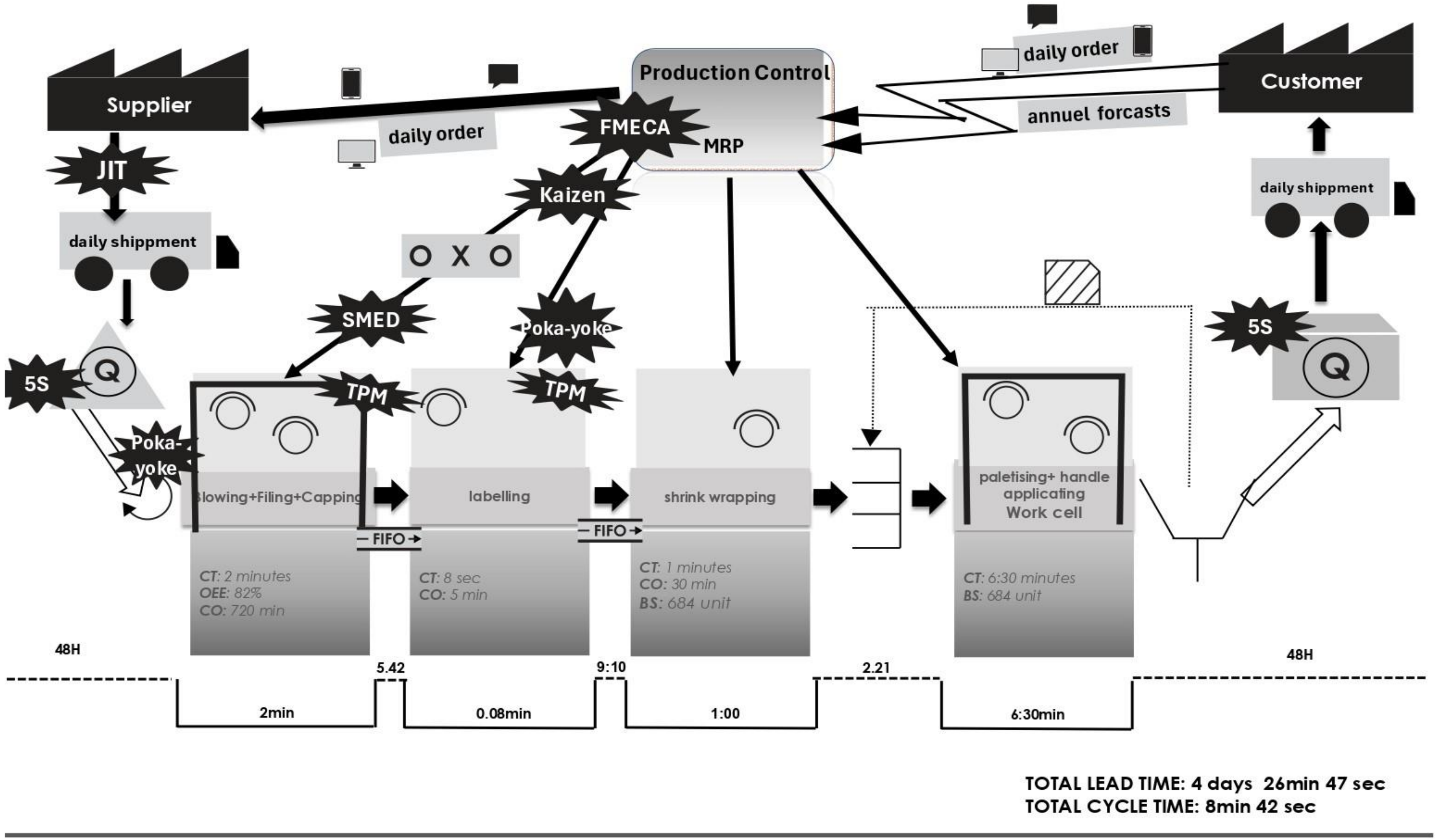
other improvements we can conduct are:

- Apply Just-In-Time (JIT) inventory principles in preforms orders.

- Investing in a new unit to repack the harmed units and palletize them it could be also useful to release the stress of the main palletizer
- Apply Total Productive Maintenance (TPM) principles
- Use 5S in the lab, storage, and workstations
- Poka-yoke style must be implemented in order to avoid errors and defects before happening.
- Launch basic Lean and TPM training for all production and maintenance staff, involving them in Kaizen (continuous improvement) projects
- Create standard work procedures with visual aids
- Kanban cards from shipping

Based on all the eight question we have answered the future state map is concepted like the following:

Figure 15: future state VSM



Source: created by the author

1.7. Action plan

After defining the muda and their sources throughout a deep analyse of the VSM from the current state into the future state, we have determined the most important improvement to make and out of these improvements we are going to propose the following action plan:

Table 8: Action plan

Type of Waste	concerning problem	solving Tool or method	Description
Waiting	Machines are often idle because breakdowns catch everyone off guard	**Total Productive Maintenance (TPM)**	TPM builds a habit of taking care of machines before they fail. By involving operators in routine checks and planning downtime ahead of time, it stops those surprise breakdowns that eat up production time.
	Delays due to reliance on external experts for high-level repairs	**Skills Matrix and Cross-Training**	By mapping out who knows what and cross-training the team, you can upskill your internal crew. This way, fewer issues need outside help, and critical machines get back on track faster.
	Loading docks often blocked due to poor truck readiness	**Standard Work for Logistics**	Setting a clear loading/unloading process (with time slots and prep stages) makes sure docks stay free and trucks don't cause backups. It turns the whole thing into a predictable, smooth routine.
Motion	Staff wastes time walking around for tools and papers	**5S Method (Sort, Set in Order, etc.)**	5S helps bring order to chaos. When tools, files, and parts all have a proper place and people get used to that, time isn't lost searching. It makes work areas quicker to use and easier to navigate.

Defects	Calibration tools aren't properly documented, leading to test failures	**Standardised Work + Visual Controls**	With clear checklists and visible cues (like colour tags or dashboards), calibration becomes something you can track and verify quickly. It keeps mistakes from slipping through.
	PET preforms don't always match spec	**Incoming Quality Control (IQC) + Supplier Scorecards**	Checking batches before they enter production catches bad parts early. When paired with feedback to suppliers, it raises the bar over time and reduces the chance of repeat problems. Also using supplier scorecards could help evaluating the suppliers in order to classify them and make priorities based on thier perfromance.
	Damaged packs are lost revenue	**Rework Cell**	Creating a small station to handle slightly damaged goods and using clear guidelines helps recover some value. Not everything has to be written off when there's a chance to salvage it.
Overprocessing	Duplicated data entry and paper work drains time and energy	**Digital Lean / Process Mapping**	Replacing repetitive manual entries with smart, digital workflows makes life easier. Mapping out processes first helps identify where paper use is just a habit, not a necessity.
	Energy spikes from unregulated power use	**Real-Time Monitoring**	Setting up a live dashboard or alerts when usage goes too high lets teams take action quickly. it gives

			energy a voice so you can listen and react.
	Frequent line stoppages lead to restarts	**5 Whys + SMED Methode**	Investigating each stoppage with simple questions (Why did this happen?) and working to cut setup times keeps the line running more smoothly. It's all about getting smarter after every issue. Also, SMED could be used as a solution for demand saturation reduction in order to reduce the changeover time when a certain product of the 3 is highly demanded in the market it will be faster and easier to add another production line work on that product
Inventory	Spare parts pile up and tie up space	**ABC Inventory Management + Kanban**	Sorting parts by importance and setting visual reorder points (like Kanban cards) keeps stock lean without risking shortages. It also helps manage budget better.
Unused Talent	High-level maintenance waits on external help	**Kaizen Events + Job Enrichment**	Hosting focused improvement sessions lets technicians pitch ideas and take on more complex challenges. It brings hidden talent to the surface and gives workers a stronger role in problem-solving.

Source: created by the author

Other procedures and methods that could improve the hole INDTRAV process

- Creating a FMECA (Failure Modes, Effects and Criticality Analysis) table in order to define all risks and prioritise them and make a well structured and planned procedures in order to conduct a corrective act or avoid the risk occurrence.
- Implement the Poka-Yoke method before executing a process or operation to ensure the right conditions thus avoid errors, defects and poor handling because it's a way to prevent them before occurring either by indicating the error before happening and avoiding it or using special measurement or procedures to eliminate the root cause of the problem.

Section 02: Results Discussion

As part of our study, we applied the methodology of Value Stream Mapping (VSM) to the production line of 1.5L bottled water at INDTRAV. The goal was to manage to understand the actual state of the production flow, then the identification of waste (Muda) sources, and explore opportunities of improvements through Lean Manufacturing tools. Our mapping conception covered the entire value chain, from the upstream reception of raw materials to the final shipment to customers.

By observing the shop floor using Gemba Walk, also conducting semi-structured interviews in addition, and analysing maintenance procedures, energy consumption, and quality records, we identified several inefficiencies scattered across the hole line. These includes excessive waiting times, inventory build-ups, overprocessing in paperwork, and recurring equipment breakdowns that often halted the production cycle. These findings were consistent with our Ishikawa root cause analysis, which linked the issues to five categories which are Methods, Machines, Materials, Manpower, and Environment.

The current state map revealed that despite full automation and a single-product focus, the cycle time of 8 minutes and 42 seconds exceeded the takt time of 0.2 seconds per bottle or 2min and 6 seconds per pallet, which reflects a clear misalignment between production capability and customer demand. Additionally, the lead time across the line was 4 days, 26 minutes, and 47 seconds most of it spent in inventory waiting for conformity results, not in value-adding activities.

Our process walkthrough showed that the pacemaker process, Blowing–Filling–Capping, was heavily impacted by machine stoppages and unregulated energy loads. Equipment such as autoclaves and capping machines often experienced downtime due to the absence of preventive maintenance and reliance on external contractors for advanced technical interventions. Furthermore, the accumulation of outdated spare parts and fragmented calibration records were signs of poor inventory control and overprocessing.

As reflex, we proposed a future state VSM guided by Rother and Shook's eight steps methodology, it included the integration of Heijunka scheduling at the pacemaker to level production volume over 24/7 of up time operating, supported by a Pitch interval of 136.8 seconds per pallet. We also recommended the implementation of a pull system using Kanban loops between shrink wrapping, palletising, and handle application, with FIFO lanes introduced to manage flow without excess inventory. A Supermarket was positioned before shipping to allow demand-driven replenishment.

To tackle the core waste issues, a set of Lean tools were matched to each Muda category: TPM for downtimes, 5S and visual management for motion wastes, Kanban for inventory control, and digitalisation of traceability systems for overprocessing reduction. We also proposed cross-training programs to develop internal technical capabilities and skills in order to reduce the dependency on external maintenance providers.

This study confirms the relevance and adaptability of VSM in an automated, high-volume industry such as bottled water production. Even that we are not dealing with a mixed-model line, the principles of takt time, pacemaker flow and load levelling proved that they are applicable.

Our recommendations, if it is implemented it would reduce waiting time, limit inventory, and increase the overall responsiveness of INDTRAV's hole supply chain.

To ensure the sustainability of these improvements, it is essential for INDTRAV to support them with a structured performance management system that continuously monitors the OEEs for all the processes, energy usage, and production lead time. By aligning Lean strategy with daily operational routines, the company can move from a reactive, forecast-based production model to a dynamic, customer-driven pull system.

GENERAL CONCLUSION

This study aimed to analyse and optimise the supply chain processes of INDTRAV, an Algerian company specialising in bottled water, through the application of the Value Stream Mapping (VSM) approach. In line with the initial research objectives, our goal was to identify the sources of waste throughout the 1.5L bottle production line, formulate targeted recommendations for improvement, and assess the broader impact of these actions on the company's operational performance.

The commitment and collaboration of the INDTRAV team played a crucial role in the success of this study. The company granted access to its production line, some technical documentations, and key staff, while also demonstrating a willingness to embrace continuous improvement. Through direct observations throughout site visits, semi-structured interviews, and the collection of operational data, several improvement opportunities were identified.

This research offers several contributions to operational management practices at INDTRAV:

- **Identification of waste sources**: The VSM allowed us to detect major forms of waste including downtime, redundant manual documentation, excessive in-process inventory, and maintenance delays.
- **Concrete action plan**: The study resulted in the development of a future state map supported by practical lean tools such as Kanban systems, FIFO lanes, Heijunka scheduling, and pacemaker identification to streamline flow and reduce inefficiencies.
- **Improved supply chain performance outlook**: The application of these lean recommendations is expected to significantly enhance productivity, reduce lead times, and improve the responsiveness of the supply chain.
- **Promotion of a continuous improvement culture**: By involving operators, technicians, and managers, the project helped raising awareness about the operational performance and established a mindset geared toward ongoing process optimisation.

However, certain limitations must be acknowledged. Although the study followed a rigorous reliable methodology combining qualitative and quantitative data, the depth of the analysis was partly constrained by several factors:

- Limited access to historical digital production data hindered real-time performance tracking.
- The time available for interviews and process observation was restricted to specific shifts.
- The study durations was conducted in two months period which is insufficient for a key lean management tool like VSM because it requires a long time analyses to be able to visualise the hole supply chain in the map identifying simultaneously the detailed wastes and proposing an action plan for improvement.
- The technical details of the supporting different processus such as maintenance and laboratory were hard to grasp for us knowing that we do not acquire any familiarity with those fields

Despite these limitations, the obtained results through VSM offer a strong foundation for more improvement and open up promising avenues for future development both for INDTRAV and the Algerian beverage sector more broadly:

- **Integration with other Lean tools**: While VSM is effective, its combination with methods such as TPM, 5S, or SMED could enable a more holistic transformation.
- **Comparative studies**: Exploring VSM implementation across other Algerian manufacturers could help identify best practices and common barriers to Lean adoption.
- **Environmental footprint**: VSM can also serve as a basis for reducing energy waste, packaging losses, and carbon emissions contributing to more sustainable operations.

Looking ahead, several suggestions may guide future research and practice:

- **Financial impact evaluation**: A detailed cost-benefit analysis of waste elimination efforts would help clarify the return on investment of Lean implementation at INDTRAV.
- **Cross-functional collaboration**: Engaging with external consultants especially with lean management experts or peer companies could accelerate the improvement through shared expertise and benchmarking.

In summary, this research has highlighted the tangible benefits of applying VSM in a supply chain. By offering a clear roadmap for the redesign of its processes, this project gives INDTRAV a strategic opportunity to enhance its competitiveness, optimise resource utilisation, and lay the groundwork for a culture of continuous improvement in the Algerian industrial landscape.

Bibliography

1. L. King, P., Rurak, D., & Liberatore, S. (2019, 01 02). *Association for supply chain management*. Retrieved from Supply Chain Optimization with High-Level Value Stream Mapping: https://www.ascm.org/ascm-insights/supply-chain-optimization-with-high-level-value-stream-mapping/?utm_source=chatgpt.com

2. Womack, J., Jones, D. T., & Roos, D. (1990). *The Machine That Changed the World.* Massachusetts Institute of Technology.

3. Aamer, A. M., Yani, E. L., & Priyatna, A. I. (2021). Data Analytics in the Supply Chain Management: Review of Machine Learning Applications in Demand Forecasting. *OPERATIONS AND SUPPLY CHAIN MANAGEMENT, 14*(1), 1-13.

4. Antony, J., Sunder M, V., Sreedharan, R., Chakraborty, A., & Gunasekaran, A. (2019). A systematic review of Lean in healthcare: a global prospective. *International Journal of Quality and Reliability Management, 36*(8), 1370-1391. Retrieved from https://researchportal.hw.ac.uk/en/publications/a-systematic-review-of-lean-in-healthcare-a-global-prospective

5. ANVYL. (2023, september 26). *10 Strategies To Reduce Lead Time and Manage Your Supply Chain*. Récupéré sur ANVYL: https://anvyl.com/blog/reduce-lead-time/

6. Batista, L., Dora, M., Garza-Reyes, J. A., & Kumar, V. (2021). Improving the sustainability of food supply chains through circular economy practices – a qualitative mapping approach. *Management of Environmental Quality, 32*(4), 752-767. https://doi.org/ https://doi.org/10.1108/MEQ-09-2020-0211

7. Bechtsis, D., Tsolakis , N., Vlachos, D., & Srai, J. S. (2018). Intelligent Autonomous Vehicles in digital supply chains: A framework for integrating innovations towards sustainable value networks. *Journal of Cleaner Production, 181*, 60-71. https://doi.org/10.1016/j.jclepro.2018.01.173

8. bin Ali, N. (2021). *OPERATIONALIZATION OF LEAN THINKING THROUGH VALUE STREAM MAPPING WITH SIMULATION AND FLOW(Doctoral dessertation).* Kalmar: Blekinge Institute of Technology.

9. Bozdogan, K. (2010). EVOLUTION OF THE LEAN ENTERPRISE SYSTEM: A CRITICAL SYNTHESIS AND AGENDA FOR THE FUTURE+. (R. blockley, W. Shyy, J. Wiley, & Sons, Éds.) *Encyclopedia of Aerospace Engineering, 6*(02139).

10. BRAGLIA, M., CARMIGNANI, G., & ZAMMORI, F. (2006). A NEW VALUE STREAM MAPPING APPROACH FOR COMPLEX PRODUCTION SYSTEMS. *International Journal of Production Research, 18*(19), 1-45. Retrieved from https://www.researchgate.net/publication/232840579_A_new_value_stream_mapping_approach_for_complex_production_systems

11. Braglia, M., Frosolini, M., Gallo, M., & Marrazzini, L. (2019). Lean manufacturing tool in engineer-to-order environment: Project cost deployment. *International*

Journal of Production Research, 57(6), 1825–1839. Retrieved from https://www.researchgate.net/publication/327106278_Lean_manufacturing_tool_in_engineer-to-order_environment_Project_cost_deployment

12. Coccolini, D., Bragadin, M., & Kähkönen, K. (2023, 07 10). Implementation of lean construction in Finland. *2023 European Conference on Computing in Construction and the 40th International CIB W78 Conference.* Heraklion: European Council on Computing in Construction (EC3). https://doi.org/10.35490/EC3.2023.224

13. Danese, P., Valeria, M., & Pietro, R. (2018). A Systematic Literature Review on Recent Lean Research: State-of-the-art and Future Directions. *International Journal of Management Reviews, 20*(2), 579-605. https://doi.org/10.1111/ijmr.12156

14. Dekier Łukasz. (2012). The Origins and Evolution of Lean Management System. *Journal of International Studies, 5*(1), 46-51.

15. Dickson, E., Singh, S., Cheung, D., Wyatt, C., & Nugent, A. (2008). APPLICATION OF LEAN MANUFACTURING TECHNIQUES IN THE EMERGENCY DEPARTMENT. *Journal of Emergency Medicin, 37*(2), 177–182.

16. EL Kihel, A., El kihel, Y., & Embarki, S. (2022). Optimization of the Sustainable Distribution Supply Chain Using the Lean Value Stream Mapping 4.0 Tool: A Case Study of the Automotive Wiring Industry. *Processes, 10*(9), 1671. https://doi.org/10.3390/pr10091671

17. Gil-Vilda, F., Yagüe-Fabra, J., & Sunyer, A. (2021). From Lean Production to Lean 4.0: A Systematic Literature. *Applied Sciences, 11*(10318), 1-20.

18. Hartanti, L. S., Gunawan, I., Jaka, M., & Herwinarso, H. (2022). Identification of Waste Based on Lean Principles as the Way towards Sustainability of a Higher Education Institution: A Case Study from Indonesia. *Sustainability, 14*(4384), 1-18. https://doi.org/https://doi.org/10.3390/su14074348

19. Helmold, M. (2020). *Lean Management and Kaizen.* Berlin: Springer International Publishing.

20. Henrique, D. B., Rentes, A. F., Filho, M. G., & Esposto, K. F. (2016). A new value stream mapping approach for healthcare environments. *Production Planning & Control: The Management of operations, 27*(1), 24-48. Retrieved from http://dx.doi.org/10.1080/09537287.2015.1051159

21. Issa, A., Hatiboglu, B., Bildstein, A., & Bauernhansl, T. (2018). Industrie 4.0 roadmap: Framework for digital transformation based on the concepts of capability maturity and alignment. *Procedia CIRP, 72*, 973-978. https://doi.org/https://www.sciencedirect.com/science/article/pii/S2212827118303081?via%3Dihub

22. Johns, S. (2024, october 17). Supply Chain Management in 2025: Trends, Challenges, and Key Statistics. *Global Trade Magazine*. Récupéré sur https://www.globaltrademag.com/supply-chain-management-in-2025-trends-challenges-and-key-statistics/

23. Kaizen institute. (2024, Mar 23). *Muda, Mura, Muri*. Retrieved from Kaizen institute: https://kaizen.com/insights/muda-mura-muri/

24. Kenton, W. (2024, jun 05). Lead Time: Definition, How It Works, and Example. (E. Rasure, & V. Velasquez, Éds.) *Investopedia*. Retrieved from https://www.investopedia.com/terms/l/leadtime.asp

25. Kunyoria, O. J. (2022). A Literature Review And Research Agenda Of Value Stream Mapping Addressing Study Population And Sample Design. *International Journal of Progressive Sciences and Technologies (IJPSAT), 34*(2), 102-125. https://doi.org/https://doi.org/10.1016/j.jemermed.2007.11.035

26. LEAN enterprise institute. (2025, march 20). *A Brief History of Lean*. Retrieved from LEAN enterprise institute: https://www.lean.org/explore-lean/a-brief-history-of-lean/

27. Liker, J. K. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer* (Vol. 5). McGraw-Hill. https://doi.org/https://doi.org/10.56293/IJMSSSR.2022.4547

28. Marin-Garcia, J., Vidal-Carreras, P., & Garcia-Sabater, J. (2021). The Role of Value Stream Mapping in Healthcare Services: A Scoping Review. *Int. J. Environ. Res. Public Health, 18*(3), 1-25. https://doi.org/https://www.mdpi.com/1660-4601/18/3/951

29. Muñoz-Villamizar, A., Santos, J., Garcia-Sabater, J., Lleo, A., & Grau, P. (2019). Green value stream mapping approach to improving productivity and environmental performance. *International Journal of Productivity and Performance Management, 68*(3), 608-625. https://doi.org/10.1108/IJPPM-06-2018-0216

30. Naveen, K., Syed, S. H., Kunal, S., Rayhan, A., Rakesh, K. Y., & Vikas , K. C. (2022). Lean manufacturing techniques and its implementation: A review,. *64*(3), 1188-1192.

31. NHS England. (2011, october 2011). An Overview of Lean. Retrieved from NHS England: https://www.england.nhs.uk/improvement-hub/wp-content/uploads/sites/44/2018/06/An-Overview-of-Lean.pdf

32. Oranga, J., & Matere, A. (2023). Qualitative Research: Essence, Types and. *Open Access Library Journal, 10*(e11001), 1-9. https://doi.org/https://doi.org/10.4236/oalib.1111001

33. Riad, L. (2024). Lean Management Approach As An Application Tool For Cost Reduction. *Journal of contemporary economic research, 07*(02), 91-112.

34. Robinson, S. (2025, march 25). *supply chain management (SCM)*. (Diann Daniel, Éd.) Retrieved from techtarget: https://www.techtarget.com/searcherp/definition/supply-chain-management-SCM

35. Romero, L., & Arce, A. (2017). Applying Value Stream Mapping in Manufacturing: A Systematic Literature Review. *IFAC-PapersOnLine, 50*(1), 1075-1086. https://doi.org/10.1016/j.ifacol.2017.08.385

36. Rother, M., & Shook, J. (1999). *Learning to See: Value Stream Mapping to Add Value and Eliminate Muda.* Lean Enterprise Institute.

37. safetyculture team. (2024, mar 13). *An overview on the lean management concept for wastefulness and how to detect it at work*. Retrieved from safetyculture: https://safetyculture.com/topics/muda/

38. Seattle University . (2024, april 23). *What Is Supply Chain Management? Defining SCM and Its Role in Business Operations*. Retrieved from Seattle University MBA Program: https://www.seattleu.edu/business/online/albers/blog/what-is-supply-chain-management-and-why-is-it-important

39. Shook, J., & Rother, M. (1999). *Learning to See: Value Stream Mapping to Add Value and Eliminate Muda.* Brookline,Massachusetts,USA: The Lean Enterprise Institute.

40. Sinha, N., & Matharu, M. (2019). A comprehensive insight into Lean management: Literature review and trends. *Journal of Industrial Engineering and Management, 12*(2), 302-317.

41. Sinha, N., & Matharu, M. (2019). A comprehensive insight into Lean management: Literature review and trends. *Journal of Industrial Engineering and Management (JIEM), 12*(2), 302-317. Retrieved from https://hdl.handle.net/10419/261693

42. Sinha, N., & Matharu, M. (2019). A comprehensive insight into Lean management: Literature review and trends. *Journal of Industrial Engineering and Management, 12*(2), 302-317. https://doi.org/doi.org/10.3926/jiem.2885

43. Tavana, M., Shaabani, A., Raeesi Vanani, I., & Kumar Gangadhari, R. (2022). A Review of Digital Transformation on Supply Chain Process Management Using Text Mining. *Processes, 10*(5), 842. https://doi.org/10.3390/pr10050842

44. Team Adobe Communications. (2022, 11 22). *What is value stream mapping and why is it important?* Retrieved from Adobe for Bussines: https://business.adobe.com/uk/blog/basics/value-stream-mapping

45. Tortorella, G. L., Fogliatto, F. S., Michello, l., Marodin, G. A., Garcia, M., & Esteves, R. R. (2016). Making the value flow: application of value stream mapping in a Brazilian public healthcare organisation. *Total Quality Management & Business Excellence, 28*(14), 1-15. Retrieved from

https://www.researchgate.net/publication/297609729_Making_the_value_flow_application_of_value_stream_mapping_in_a_Brazilian_public_healthcare_organisation

46. Tortorella, G., Fettermann, D., Anzanello, M., & Sawhney, R. (2017). Lean manufacturing implementation, context and behaviors of multi-level leadership: A mixed-methods exploratory research. *Journal of Manufacturing Technology Management, 28*(7), 867-891. https://doi.org/10.1108/JMTM-06-2017-0128

47. VIMANA. (2025, 04 22). *What are Lean Manufacturing Tools?* Retrieved from VIMANA: https://govimana.com/lean-manufacturing-tools/

48. western Sydney University. (2024, sep 11). *RESEARCH*. Récupéré sur western Sydney University website: https://www.westernsydney.edu.au/research/researchers/preparing_a_grant_application/dest_definition_of_research

49. Wevalgo. (2025, March 23). *The 8 Wastes or "Muda" of Lean with Examples in Production and Maintenance*. Retrieved from Wevalgo: https://www.wevalgo.com/know-how/lean-management/lean-wastes

50. Womack, J., & Jones, D. (2010). *LEAN THINKING: Banish Waste and Create Wealth in Your Corporation.* New York: Free Press.

51. Wrike team. (2023, may 22). *The Importance of Lead Times in Supply Chain Management*. Retrieved from Wrike: https://www.wrike.com/blog/lead-times-supply-chain-management

52. Yanthan , N. (2024, Jan 10). *Lean Waste Reduction Strategies: Boost Efficiency and Cut Costs*. Retrieved from sprintzeal: https://www.sprintzeal.com/blog/lean-waste-reduction-strategies

Appendices

Appendix A – Interview Guide

GUIDE D'ENTRETIEN (VERSION FRANÇAISE)

Thème de recherche : Application du Lean Management à travers la cartographie des flux de valeur (VSM) pour l'optimisation de la performance de la chaîne d'approvisionnement – Cas de la société INDTRAV

Informations personnelles :

Nom	______________________________
Prénom	______________________________
Poste	______________________________

Dans le cadre de la réalisation de notre mémoire de fin d'études en Master, nous vous sollicitons pour répondre aux questions suivantes relatives à l'efficacité des processus internes au sein de votre entreprise. Vos réponses seront traitées de façon strictement confidentielle à des fins académiques uniquement.

I. Directeur de production

N°	Question
1	Comment se déroule le processus de production ?
2	Comment organisez-vous la production ?
3	Quels sont les produits que vous fabriquez ?
4	Quel est votre produit le plus stratégique ?
5	Comment est organisé votre atelier de production ?
6	Connaissez-vous le concept du Lean Manufacturing ?
7	Quels outils Lean utilisez-vous ou envisagez-vous d'utiliser ?
8	Comment communiquez-vous les informations entre services ?

II. resposable logistique

N°	Question
1	Comment gérez-vous les commandes clients ?
2	Quel est le délai moyen de réception des matières premières ?
3	Quel est le délai de livraison moyen vers les clients ?
4	Quel média utilisez-vous pour transmettre les informations logistiques ?

III. Responsable approvisionnement

N°	Question
1	Qui sont vos fournisseurs principaux et comment communiquez-vous avec eux ?
2	Quel produit est le plus critique dans l'approvisionnement ?
3	À quelle fréquence passez-vous vos commandes ?
4	Le niveau actuel de stock est-il suffisant ?

IV. Opérateurs logistiques

N°	Question
1	Quels sont les problèmes que vous rencontrez le plus souvent ?
2	Quelles solutions envisagez-vous pour les résoudre ?

VI. Responsable maintenance

N°	Question
1	Comment gérez-vous l’entretien des machines et équipements ?
2	Comment faites-vous face aux pannes imprévues ?
3	Connaissez-vous la méthode TPM ?

Merci pour votre participation

INTERVIEW GUIDE (THE ENGLISH VERSION)

Research Topic: Application of Lean Management through Value Stream Mapping (VSM) for optimising supply chain performance Case of INDTRAV

Personal Information:

Name	______________________________
First Name	______________________________
Position	______________________________

As part of our Master's thesis, we kindly invite you to answer the following questions related to the internal efficiency of your organisation. Your answers will remain strictly confidential and used only for academic purposes.

I. Production Manager

No.	Question
1	How does the production process work?
2	How is the production scheduled and organised?
3	What are the main products you produce?
4	Which product is considered most strategic?
5	How is the production workshop structured?
6	Are you familiar with Lean Manufacturing?
7	What Lean tools do you use or plan to apply?
8	What communication methods are used across departments?

II. Logistics Resposible

No.	Question
1	How do you manage customer orders?
2	What is the average reception time for raw materials?
3	What is the average delivery time to customers?
4	What tools do you use to share logistics information?

III. Procurement Officer

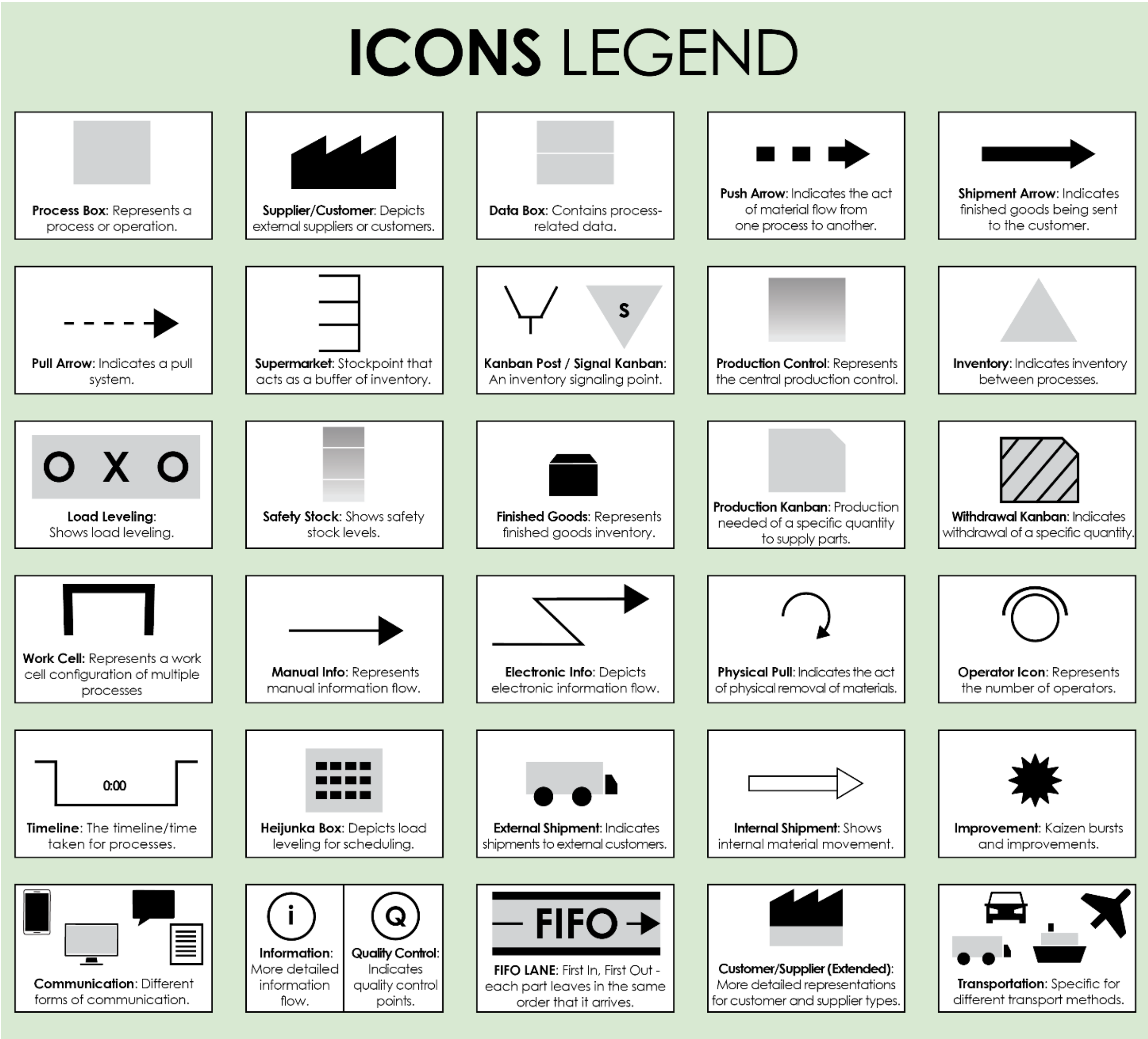
No.	Question
1	Who are your key suppliers and how do you communicate with them?
2	Which product is most critical to your supply chain?
3	How frequently do you place your orders?
4	Is the current stock level adequate?

IV. Logistics Operators

No.	Question
1	What problems do you frequently face in your role?
2	What possible solutions do you suggest?

Thank you for your contribution

Appendix B – VSM symbols



source: Smartsheet