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# INVENTORY MANAGEMENT IN PUSH PRODUCTION SYSTEMS IN THE PLASTIC DISPOSABLES INDUSTRY

# GESTÃO DE ESTOQUES EM SISTEMAS PRODUTIVOS EMPURRADOS NA INDÚSTRIA DE DESCARTÁVEIS PLÁSTICOS

# GESTIÓN DE INVENTARIOS EN SISTEMAS DE PRODUCCIÓN POR EMPUJE EN LA INDUSTRIA DE PRODUCTOS PLÁSTICOS DESECHABLES

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## Abstract

Inventory management plays a strategic role in production management because it influences material availability, service levels, operating costs, and tied-up capital. In push production systems (make-to-stock), where production is based on demand forecasts, defining control parameters and monitoring performance indicators are essential for balancing availability and operational efficiency. This article aims to analyze, based on the literature, how control parameters and performance indicators contribute to structuring inventory management in push production systems, with a focus on the disposable plastics industry. This is a literature review conducted in three stages: (i) A bibliographic search in the Scopus, Web of Science, ScienceDirect, and Google Scholar databases via the CAPES Journal Portal, using search terms in Portuguese and English related to inventory management, push production, and plastic disposables; (ii) application of inclusion and exclusion criteria, considering full-text, peer-reviewed articles published in the last ten years; and (iii) analysis and synthesis of the selected studies. The results demonstrate that integrating control parameters-such as minimum and maximum stock levels, reorder points, and lead times-with performance indicators-such as inventory turnover, coverage, fill rate, and OTIF-helps increase the reliability of replenishment decisions, reduce costs, minimize stockouts, and improve service levels. It is concluded that the integrated use of these tools strengthens inventory management in "push" production systems, particularly in sectors characterized by high product variety, large-scale production, and the need for prompt delivery, such as the plastic disposables industry.

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**Keywords:** inventory management; push production; performance indicators; control parameters; plastic disposables.

## Resumo

A gestão de estoques desempenha papel estratégico na administração da produção por influenciar a disponibilidade de materiais, o nível de serviço, os custos operacionais e o capital imobilizado. Em sistemas produtivos empurrados (*make-to-stock*), nos quais a produção é ancorada em previsões de demanda, a definição de parâmetros de controle e o monitoramento por indicadores de desempenho tornam-se essenciais para equilibrar disponibilidade e eficiência operacional. Este artigo tem como objetivo analisar, com base na literatura, como os parâmetros de controle e os indicadores de desempenho contribuem para a estruturação da gestão de estoques em sistemas produtivos empurrados, com foco na indústria de descartáveis plásticos. Trata-se de uma revisão de literatura desenvolvida em três etapas: (i) levantamento bibliográfico nas bases *Scopus*, *Web of Science*, *ScienceDirect*, *Google Scholar,* a partir do Portal de Periódicos da CAPES, utilizando descritores em português e inglês relacionados à gestão de estoques, produção empurrada e descartáveis plásticos; (ii) aplicação de critérios de inclusão e exclusão, considerando artigos completos, revisados por pares e publicados nos últimos dez anos; e (iii) análise e síntese dos estudos selecionados. Os resultados evidenciam que a integração entre parâmetros de controle, como estoque mínimo, máximo, ponto de pedido e *lead time*, e indicadores de desempenho, como giro de estoque, cobertura, *fill rate* e OTIF, contribui para aumentar a confiabilidade das decisões de reposição, reduzir custos, minimizar rupturas e elevar o nível de serviço. Conclui-se que a utilização integrada desses instrumentos fortalece a gestão de estoques em sistemas produtivos empurrados, especialmente em setores caracterizados por elevada variedade de produtos, produção em larga escala e necessidade de pronta entrega, como a indústria de descartáveis plásticos.
**Palavras-chave:** gestão de estoques; produção empurrada; indicadores de desempenho; parâmetros de controle; descartáveis plásticos.

## Resumen

La gestión de inventarios juega un papel estratégico en la gestión de la producción al influir en la disponibilidad de materiales, los niveles de servicio, los costos operativos y el capital inmovilizado. En los sistemas de producción para inventario, donde la producción se basa en pronósticos de demanda, definir parámetros de control y monitorear a través de indicadores de desempeño se vuelve esencial para equilibrar la disponibilidad y la eficiencia operativa. Este artículo tiene como objetivo analizar, con base en la literatura, cómo los parámetros de control y los indicadores de desempeño contribuyen a la estructuración de la gestión de inventarios en sistemas de producción para inventario, centrándose en la industria de plásticos desechables. Esta es una revisión de la literatura desarrollada en tres etapas: (i) búsqueda bibliográfica en las bases de datos Scopus, Web of Science, ScienceDirect y Google Scholar, utilizando el Portal de Publicaciones Periódicas de CAPES, con descriptores en portugués e inglés relacionados con la gestión de inventarios, la producción para inventario y los plásticos desechables; (ii) aplicación de criterios de inclusión y exclusión, considerando artículos completos, revisados por pares y publicados en los últimos diez años; y (iii) análisis y síntesis de los estudios seleccionados. Los resultados muestran que la integración entre parámetros de control, como niveles mínimos y máximos de existencias, punto de reorden y plazo de entrega, e indicadores de desempeño, como rotación de inventario, cobertura, tasa de cumplimiento y OTIF (entrega a tiempo y completa), contribuye a aumentar la confiabilidad de las decisiones de reabastecimiento, reducir costos, minimizar desabastecimientos y elevar el nivel de servicio. Se concluye que el uso integrado de estos instrumentos fortalece la gestión de inventarios en sistemas de producción push, especialmente en sectores caracterizados por una alta variedad de productos, producción a gran escala y la necesidad de entregas rápidas, como la industria de plásticos desechables.
**Palabras clave:** Gestión de inventarios; producción por impulso; indicadores de rendimiento; parámetros de control; plásticos desechables.

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## 1. Introduction

Inventory management is a central issue in production management, as it influences material availability, service levels, fixed capital, storage costs, and operational continuity. In industrial settings, this issue becomes even more relevant when production and replenishment decisions are made before actual demand is confirmed—a characteristic observed in push production systems. In these contexts, the company relies on forecasts, replenishment parameters, and control mechanisms capable of reducing exposure to stockouts, excess inventory, and underutilization of production resources. (Bortolini et al., 2021).

The disposable plastics industry presents unique challenges for inventory management. Large production volumes, extensive product variety, rapid delivery requirements, competitive pressure, and the need for continuous replenishment all increase the complexity of inventory planning. In addition, growing environmental regulations and material innovations require companies to balance operational efficiency with regulatory compliance and sustainability objectives. (Chen, 2025; Martins, 2023; Salwa, 2023). Despite this progress, striking a balance between availability and cost remains a recurring challenge, especially when volumes are high and demand fluctuates.

Inventory management in the disposable plastics sector is particularly complex due to the industry's large-scale production, broad product portfolio, demand for rapid delivery, intense competitive pressure, and the logistical challenges of maintaining a continuous market supply. Products such as cups, plates, lids, containers, and packaging are widely used in everyday life and require regular availability, while at the same time being subject to growing environmental concerns, material innovation, and regulatory compliance. (Prado Cabezas, 2024; Zapata Martinez; Civit; Arena, 2022). Therefore, inventory management must address both operational needs and the economic and environmental pressures facing the industry.

Although the literature contains numerous studies on inventory management, reorder points, and performance indicators, this knowledge is scattered across different theoretical approaches. Furthermore, there is a need to integrate these elements into a systematic framework focused on push-type production systems and the characteristics of the disposable plastics sector.

Push production, or make-to-stock, is well-suited to high-volume sectors with continuous replenishment, as it allows for manufacturing in advance and building inventory to ensure rapid fulfillment-a model that relies on well-defined forecasts and parameters. When forecasts deviate from actual consumption, this can lead to excess inventory, unnecessary use of space, increased costs, and obsolescence; conversely, it can also result in stockouts that compromise customer service. This trade-off between availability and efficiency is cited as one of the main challenges of push production (Bortolini et al., 2021).

Defining control parameters-such as minimum inventory, optimal inventory, maximum inventory, lead time, production batch size, and service level—is essential for guiding replenishment and manufacturing decisions. These parameters transform historical data and operational guidelines into practical management rules, reducing

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reliance solely on empirical decisions. The literature also highlights the importance of performance indicators-such as inventory turnover, safety stock, stockouts, adherence to the plan, and service level-for monitoring the effectiveness of the adopted policy and sustaining cycles of continuous improvement. (Costa et al., 2025; Demiray Kırmızı; Ceylan; Bulkan, 2024; Pereira et al., 2023; Yanovsky; Graf, 2024).

The purpose of this article is to analyze, based on the literature, how control parameters and performance indicators contribute to the structuring of inventory management in push-type production systems, with a focus on the disposable plastics industry.

## 2. Materials and Methods

This study is a narrative literature review. Relevant publications were identified through searches of scientific databases focusing on inventory management, push production systems, and the disposable plastics industry. Because the review was developed to support the theoretical framework of a master's thesis, it did not follow a formal systematic review protocol. Instead, the search strategy is presented to ensure transparency in the identification and selection of the literature.

Literature searches were conducted in the Scopus, Web of Science, ScienceDirect, and Google Scholar databases via the CAPES Journal Portal, using combinations of the terms “inventory management,” “stock control,” “inventory indicators,” “make-to-stock,” “push production,” and “plastic disposable products,” as well as their Portuguese equivalents. For the selection of references, priority was given to full-text scientific articles, preferably published within the last ten years, peer-reviewed, and relevant to the research topic. Duplicate studies and publications not directly related to the subject of study were excluded. The selected references were organized into a library using Mendeley® software, which was used to manage, read, and explore the bibliographic material.

## 3 Results of the Literature Review

This section presents the main findings of the review, organized by the evolution of inventory management, types of inventory, control parameters, performance indicators, the disposable plastics sector, and push production. In addition, the chapter characterizes the disposable plastics sector, highlighting its unique production and logistics characteristics, and then discusses the principles and implications of push production in industrial settings.

### 3.1 The Evolution of Inventory Management

Inventory management has existed since ancient civilizations, where rudimentary control systems were used to ensure the availability of food and other essential resources. Although these early practices relied on simple records, they established the foundations of modern inventory control by introducing the concepts of stock monitoring and replenishment planning. (Shirinzade; Özkaral, 2024; Souza et al., 2025).

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The Industrial Revolution significantly increased the complexity of production systems, requiring more structured methods for inventory planning and control. Later, during the two world wars, the need to manage large volumes of supplies drove the development of quantitative models, optimization techniques, and control systems capable of supporting decision-making in environments characterized by high uncertainty (Moorthy et al., 2024; Nayyar; Nayyar, 2025; Taleghani, 2024).

The advances made during this period established inventory management as a strategic function of industrial operations, laying the groundwork for the development of modern methods of planning, demand forecasting, and logistics optimization (Sindhuja et al., 2024; Tang; Thelkar, 2023).

In the postwar period, the Toyota Production System redefined inventory management by introducing principles such as Just-in-Time, Kanban, and continuous improvement, prioritizing the reduction of waste and the synchronization of production with demand. This approach established inventory as a strategic element, with inventory levels now designed to strike a balance between operational efficiency and service levels. (Chiarini; Baccarani; Mascherpa, 2018; Luz; Araújo; Barreto, 2021).

In recent decades, the adoption of ERP systems, automatic identification technologies, the Internet of Things (IoT), and real-time data analytics has significantly expanded the ability to monitor and plan inventory. These technologies enable more accurate forecasts, integration across the supply chain, and data-driven decision-making, thereby increasing operational efficiency and reducing uncertainty (Chen, 2025; Martins, 2023; Salwa, 2023).

### 3.2 Types of Inventory

Raw materials are the basic inputs purchased from external sources that are essential for manufacturing a product or providing a service. These materials undergo transformations during the production process across its various stages, and their proper procurement and storage are critical factors in avoiding surpluses or shortages that directly or indirectly impact costs and operational efficiency. (Chaves; Feroni, 2025; Rodrigues Neves; Ribeiro Ramos Spairani; Valadares, 2025).

Raw material management requires rigorous monitoring of inventory levels, forecasting consumption based on production plans, and ongoing evaluations of supplier quality and delivery times. Packaging materials include all supplies used to protect, preserve, transport, and present the product to the end consumer. This category encompasses boxes, labels, plastics, and others. Proper management of this inventory must take into account both product demand forecasts and replenishment strategies aligned with the production flow to prevent process interruptions and material waste. (Brito; Oliveira, 2024).

Properly managing inventory of packaging materials is essential to ensuring product integrity throughout the supply chain and adding value to the end consumer's experience. In addition, innovative approaches, such as reusing cardboard boxes, demonstrate not only economic gains through reduced packaging costs but also environmental benefits by minimizing waste, thereby reinforcing a commitment to sustainability in supply chains. (Silva et al., 2024).

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Work-in-progress, also known as semi-finished goods, refers to materials that have already undergone some stage of processing but have not yet reached the stage of being ready for sale. They require special attention in the production chain, since proper management can reduce waste and rework, as well as optimize production flow and minimize delivery delays, as noted in recent analyses of the food and industrial sectors. (Rodrigues Neves; Ribeiro Ramos Spairani; Valadares, 2025; Vitória et al., 2025).

Inventory control for work-in-process products is challenging because it involves batch traceability, process time management, and the assessment of potential production bottlenecks. In this context, the implementation of tools such as tracking codes and automated controls, as suggested in studies on warehousing and materials management, enhances the efficiency of monitoring internal flows, reducing operational errors and costs associated with managing these intermediate inventories. (Gonçalves et al., 2024; Vitória et al., 2025).

Finished products are fully manufactured items, ready for sale or distribution to customers. Having completed all stages of the production process, they offer high added value and require rigorous control and traceability methods to ensure availability and quality. Automation and data integration are key to optimizing storage and mitigating losses, as recent case studies in an industrial context demonstrate (Souza et al., 2021; Vitória et al., 2025).

As a result of these developments, inventory management has come to play a strategic role in organizations' competitiveness, requiring increasingly sophisticated mechanisms to control inventory levels, ensure product availability, and reduce operating costs. Table 1 summarizes the types of inventory that serve specific functions throughout the production flow, requiring management policies consistent with their operational purpose.

**Table 1:** Characteristics and Implications of the Main Types of Inventory in Production Systems

| Type of inventory | Role in the production system | Key management aspects | Operational impact |
|---|---|---|---|
| **Raw material** | Ensure the supply of production operations. | Monitoring of consumption, supplier management, lead time and replenishment levels | Reduced risk of production interruptions and greater process stability (Chaves; Feroni, 2025; Rodrigues Neves; Ribeiro Ramos Spairani; Valadares, 2025). |
| **Packaging Materials** | Ensure the protection, conservation and availability of products. | Demand planning, synchronization with production and waste reduction. | Improved logistics efficiency and reduced operating costs (Brito; Oliveira, 2024; Silva et al., 2024). |
| **Work in Progress (WIP)** | Maintain the continuity of the production flow between the manufacturing stages. | Traceability, bottleneck control, and processing time monitoring. | Reduction of rework, losses and waiting times (Gonçalves et al., 2024; Vitória et al., 2025). |
| **Finished products** | Make products available to meet demand. | Inventory turnover, coverage, minimum and maximum levels, and demand forecasting. | Balance between service level, fixed assets, and storage costs (De Freitas, 2024; Souza et al., 2021; Vitória et al., 2025). |

Source: prepared by the authors (2026).

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Although they have distinct characteristics, they all depend on the definition of control parameters that guide decisions regarding replenishment, sizing, and performance monitoring. Thus, the integrated management of these inventories is a key element in balancing material availability, operational efficiency, and customer service levels (Demiray Kırmızı; Ceylan; Bulkan, 2024).

Therefore, the management of these inventories seeks to balance two objectives: preventing stockouts that compromise service levels and, at the same time, avoiding excessive volumes that increase storage costs and the risk of obsolescence. Practices such as demand forecasting, inventory turnover analysis, and the adoption of minimum and maximum inventory management are widely recommended for the effective management of finished goods. The incorporation of automation, artificial intelligence, and quantitative tools, including data-driven predictive systems and real-time monitoring, enhances operational efficiency, reduces losses, and increases reliability in inventory control. (De Freitas, 2024).

### 3.3 Inventory Control Parameters

Setting minimum, optimal, and maximum inventory levels is a governance mechanism for balancing availability and tied-up capital. Minimum inventory reduces the risk of stockouts in the face of uncertainties regarding demand and lead times. Optimal inventory establishes the operational target that guides when and how much to replenish under normal conditions. Maximum inventory limits accumulation beyond what is necessary, avoiding costs associated with maintenance, obsolescence, and logistical bottlenecks. Together, these parameters anchor replenishment decisions in push-based production environments, enabling service levels agreed upon with sales and production, with less variability and lower total cost. (Demiray Kırmızı; Ceylan; Bulkan, 2024).

The behavior resulting from these parameters can be visualized in the classic sawtooth pattern: available inventory declines almost linearly at the average consumption rate until it reaches the reorder point, at which point replenishment is triggered; after the lead time, the arrival of the batch restores the level to near the maximum. The minimum inventory acts as a buffer to absorb variations in demand and lead time, reducing the risk of stockouts. The amplitude of this “sawtooth” is determined by the production lot size.

Reorder point: This is the inventory level that triggers a new purchase or production order, taking into account expected consumption during the lead time and a safety margin to account for fluctuations in demand or replenishment delays. This parameter helps reduce stockouts, avoid excess inventory, and provide greater predictability for supply decisions in push-based production systems. (Demiray Kırmızı; Ceylan; Bulkan, 2024).

### 3.4 Key Performance Indicators (KPIs)

To address challenges such as demand volatility, pressure for fast delivery, and resource optimization, industrial organizations have turned to the rigorous use of KPIs (Key Performance Indicators). These tools not only monitor performance

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across various aspects of inventory but also support agile, evidence-based decisions aimed at the continuous improvement of processes (Costa et al., 2025; Pereira et al., 2023).

In an industrial context, poorly managed inventory exacerbates a variety of problems: high working capital, a buildup of obsolete items, supply shortages, and delays in the production chain. Furthermore, it compromises the ability to serve customers, negatively impacting the company's image and customer loyalty. (Costa et al., 2025; Yanovsky; Graf, 2024).

KPIs are quantifiable metrics that make it possible to measure, monitor, and analyze the performance of inventory management processes. In industry, they guide everything from production planning to the establishment of purchasing management, including materials control and loss management (Yanovsky; Graf, 2024).

**Table 2:** Key Performance Indicators (KPIs)

| KPI | What it measures | Purpose | Decision supported by |
|---|---|---|---|
| **Turnover** | inventory turnover | reduce capital | lot |
| **Coverage** | autonomy | preventing disruption | replacement |
| **Fill Rate** | Kundenservice | Verfügbarkeit | Sicherheitsbestand |
| **OTIF** | perfekte Lieferung | Servicelevel | Logistik |

Source: Prepared by the authors (2026).

Inventory Turnover: Inventory turnover measures how efficiently a company converts inventory into sales over a given period. It is one of the most widely used indicators of inventory performance because it reflects both inventory utilization and replenishment efficiency. (Consuelo; Chavez; Cabrera, 2023). A high inventory turnover rate is associated with greater profitability, as costs can be reduced, while a slow turnover rate can reduce profits. Studies show a positive correlation between inventory turnover and return on assets and return on equity. (Srour, 2022).

The usefulness of inventory turnover extends across various areas of business management, where it is used to evaluate the logistical and economic performance of the supply chain. Improvements in logistics processes, such as the implementation of integrated management systems (ERP), can be measured using indicators such as order fulfillment time and inventory turnover itself, which reflects the success in converting inventory into sales, thereby boosting operational efficiency (Nasiri; Moradi; Khodayari, 2025; Prabha; Malini; Jyothi, 2024).

Stock Coverage: Stock coverage, also known as days of supply, is a key performance indicator (KPI) that measures an operation's self-sufficiency by quantifying how long available inventory can meet average demand without the need for replenishment. Its fundamental calculation, the ratio of available inventory to average daily consumption, provides an instant snapshot of inventory health and is crucial for balancing customer service levels with the efficiency of capital employed. Furthermore, accurately measuring inventory coverage has direct implications for the financial cost of holding inventory, highlighting, for example, how products with higher inventory volumes can incur significant costs even during short storage periods. (Ferrari; Wernke, 2025).

Setting appropriate inventory coverage levels is a strategic decision that directly impacts the resilience of the supply chain. Excessively high levels result in

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tied-up capital, high storage costs, and a greater risk of obsolescence, especially in industries with short product lifecycles. The accuracy of inventory coverage is enhanced by the integration of Industry 4.0 technologies, such as the Internet of Things (IoT) and big data analytics. The use of real-time data on sales, production, and logistics movements allows for a more precise and adaptive calculation of average consumption, overcoming the limitations of moving averages or static projections. Forecasting models based on machine learning, for example, have been used to capture complex consumption patterns and anticipate sudden fluctuations, substantially increasing the reliability of inventory replenishment decisions (Machado et al., 2023; Pasinato; Campana, 2020).

Fill Rate: The fill rate is a key metric for evaluating the effectiveness of inventory management and outbound logistics, measuring the percentage of customer demand that is met directly from available inventory, without delays or backorders. This indicator can be measured in different ways, such as the line fill rate or the order fill rate, and serves as a direct reflection of the level of customer service. A high fill rate is often the result of advanced demand forecasting and inventory optimization strategies based on machine learning, which can reduce stockouts, minimize excess inventory, and respond quickly to market fluctuations. (Pasupuleti et al., 2024).

Fill rate performance is an indicator of the health and internal alignment of the supply chain. Low fill rates can be caused by a variety of interrelated factors, such as inaccurate demand forecasts, inadequate inventory management, a lack of real-time visibility into inventory levels, or coordination failures between sales, planning, and operations. Analyzing the root causes of order fulfillment failures is essential for identifying process bottlenecks and implementing continuous improvements in the forecasting and replenishment process. (Guijarro; Babiloni; Cardós, 2022).

In increasingly volatile business environments, maintaining a high and consistent fill rate requires an integrated, technology-driven approach. Leading companies use advanced supply chain planning systems (Advanced Planning and Scheduling - APS) and real-time visibility platforms to align supply with demand. Setting fill rate targets in Service Level Agreements (SLAs) with customers and using them as a KPI for internal performance evaluation fosters an organizational culture focused on operational excellence and the intelligent use of inventory (Guijarro; Babiloni; Cardós, 2022).

On-Time In-Full (OTIF): The OTIF (On-Time In-Full) indicator represents an evolution in the measurement of logistics performance, as it combines two critical dimensions from the customer's perspective into a single metric: the timeliness (On-Time) and completeness (In-Full) of the delivery. For an order to be considered "perfect" from an OTIF perspective, it must be delivered on the agreed-upon date and to the agreed-upon location, with all requested items and quantities, and without damage. This binary and rigorous nature provides a holistic and uncompromising view of the supply chain's ability to fulfill its promise to the customer. (Tian et al., 2024).

The implementation of OTIF as the primary customer service indicator forces organizations to overcome functional silos, since the causes of failure are multifactorial. Delays (On-Time) can stem from problems in production planning, warehouse picking, transportation management, or customs clearance processes. In-Full failures, in turn, are often linked to stockouts, inventory errors, or order

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processing failures. Systematic analysis of the causes of OTIF non-compliance allows companies to identify and correct systemic weaknesses in their end-to-end processes (Rebollar; Zamalloa; Quiroz-Flores, 2023; Tian et al., 2024).

Real-time OTIF monitoring, made possible by logistics control towers and integrated digital platforms, has become a cornerstone of proactive supply chain management. Instead of merely measuring past performance, companies can now predict potential OTIF failures and intervene to mitigate risks before they affect the customer. This analytical capability not only improves operational efficiency and reduces contractual penalties but also strengthens the relationship of trust with customers, cementing OTIF as one of the key drivers of competitive differentiation in the modern market. (Acevedo-Aybar et al., 2024).

### 3.5 Disposable Plastic Industry

Disposable plastic products are those used for single-use items, such as cups, cutlery, plastic plates, and disposable food and beverage packaging. These items are intended to be used only once and then discarded, which contributes significantly to the generation of plastic waste in the environment, causing negative environmental impacts (Caixeta; Morais, 2022).

The convenience, low cost, and versatility of these products underpin a multibillion-dollar global supply chain, with significant impacts on public policy and industrial strategies. This progress, however, presents challenges: reducing the environmental footprint and transitioning to more sustainable production and consumption patterns, as highlighted by life-cycle assessments and regulatory initiatives that seek to limit the persistence of plastics and promote alternative and recycled materials (James et al., 2024; Valentini; Dorigato, 2023).

The development of the plastics industry was revolutionized in the 20th century, especially after World War II, when materials such as polypropylene (PP), polystyrene (PS), and polyethylene (PE), which currently form the basis of most disposable plastics, became widely established. It is estimated that more than 400 million metric tons of plastics are produced worldwide each year, and a large portion of this production is used to manufacture disposable products—such as packaging, face masks, utensils, and medical supplies—which pose significant environmental challenges due to their short lifespan and high potential to generate persistent plastic waste in the environment. (Caixeta; Morais, 2022; Sirijamorn et al., 2025).

The global market for these disposable products is characterized by a relentless pursuit of innovation in design, functionality, heat resistance, and logistical efficiency to meet the demand from the food, catering, hospitality, and food retail sectors. Developed countries, such as the United States, members of the European Union, and Japan, lead both in the consumption and production of disposable plastics, followed by major emerging markets such as China, India, and Brazil (Prado Cabezas, 2024; Zapata Martinez; Civit; Arena, 2022).

The sector's expansion has brought with it growing concerns about improper disposal and pollution caused by single-use plastics, which often end up in rivers and oceans, forming garbage patches and damaging aquatic ecosystems. Recent studies indicate that only about 9% of the plastic produced globally is recycled, with the rest sent to landfills, incinerated, or discarded into the environment. Faced with

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**Pages:** 1-19

this situation, countries such as Canada have adopted policies to encourage the transition to sustainable alternatives, supported by stricter regulations and investments in research on substitute materials. (Prado Cabezas, 2024).

Brazil plays a prominent role in the global plastics industry, combining a significant petrochemical base with a domestic market in which packaging accounts for a substantial share of polymer use. In 2017, the country generated approximately 12 million metric tons of post-consumer plastic packaging waste, with a low recycling rate, while international estimates rank it among the world's largest generators of plastic waste. This underscores the economic and environmental impact of the disposable products sector and its interconnection with industries such as food and beverages, food service, and healthcare. Globally, the packaging industry itself accounts for approximately 40% of plastic consumption, which helps explain the intensity of plastic use and disposal in Brazil (Lima; Gutierrez; Cruz, 2022; Pimentel Pincelli et al., 2021).

This significance is also evident in the production structure: in the packaging sector, plastics lead in production value, accounting for 38.85% of the total, in addition to generating significant employment and contributing to the sector's exports. Among the most widely used materials in disposable products is expanded polystyrene, whose supply chain is extensively used in packaging and accounts for about 2.4% of all plastic consumed in the country, illustrating the widespread use of these items in sectors such as agribusiness, food retail, and services (De Oliveira; Mônica; Campos, 2019).

Seeking to mitigate these impacts, Brazil has established shared responsibility mechanisms. The National Solid Waste Policy set forth principles of reverse logistics and the allocation of obligations among manufacturers, importers, distributors, retailers, and government agencies, culminating in a sector-specific agreement for packaging. Even so, the data reveal bottlenecks: in 2017, 63% of the plastic packaging stream was not monitored, informal collection exceeded formal selective collection by 24%, and only 4.5% of the volume generated was actually recycled, highlighting limitations in governance and infrastructure. (Pimentel Pincelli et al., 2021).

On the regulatory front, the country is moving forward with measures regarding single-use plastics, notably bans and restrictions at the state and municipal levels. District Decree 002/2018 of Fernando de Noronha banned the import, sale, and use of a wide range of disposable items; the city of São Paulo strengthened requirements for replacing them with reusable, recyclable, or biodegradable materials and banned straws and various plastic utensils in 2019–2020; and at least 14 states have already passed laws restricting plastic straws. This movement aligns with the recent international trend, in which most government actions since 2016 have specifically targeted single-use items (Knoblauch; Mederake, 2021; Lima; Gutierrez; Cruz, 2022), as shown in Figure 1.

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**Pages:** 1-19

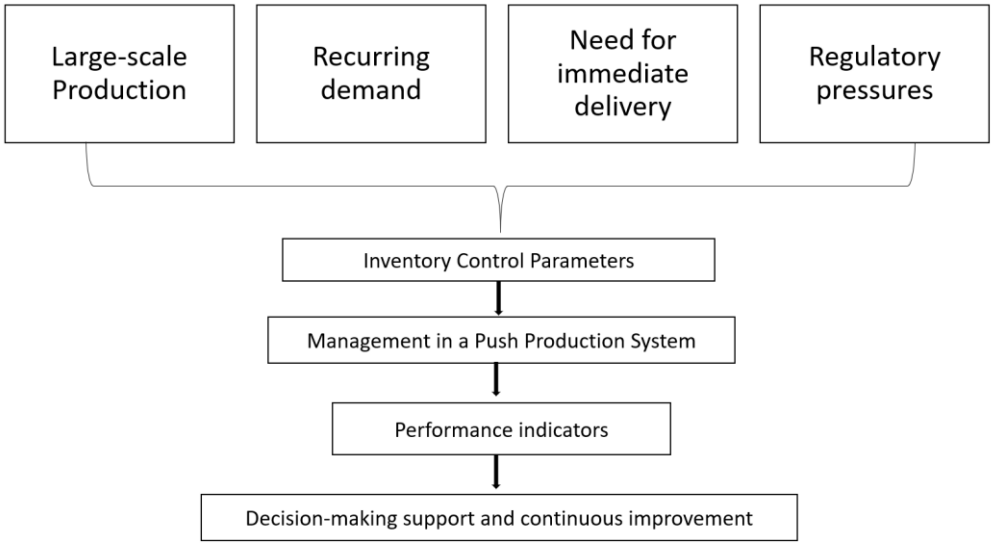



**Figure 1** - Characteristics of the disposable plastics industry. Source: authors (2026).

Companies, under pressure from consumers and new regulations, have been expanding R&D into alternatives to conventional plastics, such as bioplastics and compostable solutions. However, scalability faces technical and economic barriers already observed in real-world supply chains: the need for sorting and washing for recycling, low added value, and density that drives up logistics costs, in addition to the geographic dispersion of waste generators and limited infrastructure. This evidence helps explain why the transition to alternative materials and circular pathways requires carefully calibrated management, standardization, and investments in technology and logistics (De Oliveira; Mônica; Campos, 2019).

In Brazil, the trend is to strike a balance between advancing sustainable solutions, regulatory compliance, and international competitiveness—especially in light of markets that restrict single-use items. Recent literature indicates that effective management combines bans and fees with circular economy tools, and that, beyond the consumption phase, regulation and research are still lacking in the production sector. To sustain international competitiveness, the country needs to consolidate selective collection and reverse logistics, expand the socio-productive inclusion of waste pickers, and strengthen arrangements that move the supply chain beyond one-off recycling toward consistent circular models. (De Oliveira; Mônica; Campos, 2019; Knoblauch; Mederake, 2021).

Therefore, the link between regulatory changes and growing environmental requirements has a direct impact on inventory management in the disposable plastics industry. The need to comply with usage restrictions, substitute materials, and adopt circular economy practices increases the complexity of production planning, materials management, and the establishment of inventory policies, making efficient management a strategic factor for the sector's sustainability and competitiveness.

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**Pages:** 1-19

### 3.6 Push Production

Push production (make-to-stock) is based on demand forecasts, with production carried out in advance and inventory built up to ensure immediate product availability. This approach is widely used in the disposable plastics industry, which is characterized by high production volumes and a continuous need for replenishment. To address seasonal fluctuations in demand (Figure 2), companies often adopt production smoothing strategies, spreading manufacturing over time (Bortolini et al., 2021; Pimentel Pincelli et al., 2021).

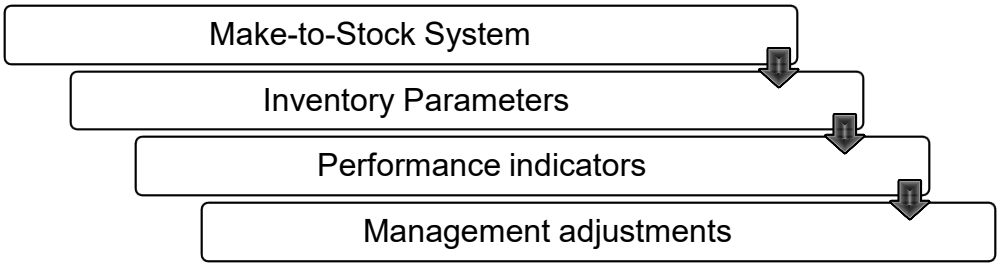



Figure 2 - Characteristics of the sector. Source: authors (2026).

As for the pros and cons, the push production system reduces the risk of shortages and improves responsiveness, but it tends to put pressure on inventory costs, space utilization, and even capacity, especially when demand is uncertain; therefore, the efficiency gains must be weighed against the loss of responsiveness (Bortolini et al., 2021; Lin et al., 2022).

On the shop floor, a typical lever of push production is the deliberate use of strategic work-in-process inventory and optimal lot sizes to “buffer” variability and shorten lead times. Adjusting lot size aims to find the point that balances the cost of maintaining work-in-process inventory with the reduction of the order-to-shipment cycle, improving the service level without inflating inventories beyond what is necessary. (Lin et al., 2022).

At the dynamic level, forecast-based inventories can amplify variability throughout the supply chain—a phenomenon known as the bullwhip effect. The bullwhip effect is the amplification of demand fluctuations as information moves up the supply chain: small fluctuations in retail sales become larger fluctuations in distributor orders and even larger ones in the manufacturer’s production. This happens because each link in the chain reacts with a delay and uncertainty, relies on forecasts to replenish inventory, aggregates orders into batches, uses management models, responds to promotions and rationing, and operates with non-negligible lead times. (Lin et al., 2022).

Empirical results reinforce the role of push production as an “availability buffer,” but at the cost of inventory: In an ATO case study, shifting just 7% of parts from push to pull reduced the number of pallets in stock by about 27%, at the cost of a modest 3.5% increase in total setup time, illustrating the classic trade-off between inventory and flexibility (Bortolini et al., 2021).

Taken together, the studies indicate that OTIF goes beyond its role as a logistics indicator, serving as a mechanism for integrating planning, production, inventory, and

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**Pages:** 1-19

distribution. Thus, its use in push-based production systems makes it possible to simultaneously assess product availability and the reliability of customer service—aspects that are particularly relevant to the disposable plastics industry.

## 4. Conclusions

The literature review showed that inventory management is a strategic element for organizations, especially when they operate within push production systems. Properly defining replenishment parameters, combined with monitoring through performance indicators, helps strike a balance between product availability, resource utilization, and customer service levels. In the plastic disposables sector, characterized by high production volumes and a continuous need for supply, such practices play an even more critical role.

The studies analyzed demonstrate that the efficiency of inventory management depends on the proper definition of replenishment parameters, the systematic monitoring of performance indicators, and the ability to adjust inventory levels to the operational characteristics of production. However, the literature indicates that many organizations still employ poorly structured controls, limiting the effectiveness of decisions regarding replenishment, storage, and customer service.

As an implication for future research, the formalization of control parameters and the systematic use of performance indicators have the potential to support more consistent decisions regarding replenishment, production, and storage. The use of metrics such as inventory turnover, coverage, stockouts, service level, and adherence to planning can help reduce excess inventory, prevent shortages, and improve operational efficiency in push-based production systems.

As a future research agenda, we recommend the development and application of material classification models linked to the inventory control parameters and performance indicators discussed in this study, evaluating their impacts on coverage, inventory turnover, service level, tied-up capital, and operational efficiency in companies in the plastic disposables sector.

The results of this review lead to the conclusion that efficient inventory management in push-type production systems depends on the integration of replenishment parameters, performance indicators, and the sector's operational characteristics. In the disposable plastics industry, this integration becomes even more relevant given the large scale of production, the need for prompt delivery, and growing regulatory and environmental pressures.

## Statement on the Use of Artificial Intelligence:

I hereby declare that artificial intelligence tools were used to assist in the preparation of this manuscript. ChatGPT_4 (OpenAI), Grammarly, and DeepL were used for linguistic review, grammatical correction, improvement of scientific writing, textual organization, and translation of the manuscript into English, while fully preserving the scientific content produced by the authors. All changes suggested by these tools were reviewed, validated, and approved by the authors, who assume full responsibility for the final content of the manuscript.

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