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INTERNATIONAL LOGISTICS AND THE OPTIMIZATION OF INVENTORIES: THE CASE OF CERVEJAS DE MOÇAMBIQUE

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Abstract: This study entitled International Logistics and Inventory Optimization: A Case Study of Cervejas de Moçambique, has become one of the most critical logistics functions in the context of international trade. This article analyzes the main inventory management models with a focus on practical application in the Mozambican context, using the company Cervejas de Moçambique (CDM) as a case study. Using an exploratory and explanatory methodological approach, it makes use of a literature review and document analysis, including interviews with employees. The results show that Just in Time (JIT) and Just in Sequence (JIS) - The company adopts the Just in Time (JIT) concept, with the aim of ensuring that essential raw materials, such as malt, hops and packaging, are delivered exactly when needed, minimizing storage costs. It is concluded that the adoption of technologies such as *Just in Time* (JIT), Artificial Intelligence and models such as *Milk Run* have enabled CDM to overcome structural, logistical and seasonal challenges, ensuring operational efficiency.
Keywords: Inventory, International Logistics, Just in Time, Supply Chain, Mozambique

INTRODUCTION

BACKGROUND

Inventory management has faced continuous challenges due to the development, quality, *design* and manufacture of new products. Since the 1990s, with the advance of globalization and technology, the demand for new products has fluctuated rapidly and in recent years, consumers have become even more demanding, especially in relation to the quality and durability of products, factors which increase the demand for items and products with longer life cycles (Shah, Mittal and Cárdenas-Barrón, 2021:1-4).

However, many products suffer from loss of usefulness, degradation and devaluation due to technological innovation and seasonality. This phenomenon was analyzed in 1993 by Fujiwara and Perera, who developed an EOQ (Economic Order Quantity) model for perishable products. Later, in 1997, they further developed this study, which considered the negative effects of the age of stored products (*ibid*).

From the 2000s onwards, the need to optimize stock management became even more relevant with the growth of e-commerce and the demand for fast and efficient deliveries. In 2006, they introduced an inventory model, which took into account the expiry dates of perishable products, while in 2008, they explored the impact of product display on sales volume (*ibid*).

In the 2010s, new approaches began to integrate pricing strategies and order volume. In 2016, a model was developed in which demand was directly influenced by the freshness of products and the level of display. In the same period, authors such as Chen[1] studied the influence of prices on purchasing decisions and stock replenishment (*ibid*).

More recently, between 2020 and 2021, researchers such as Agi and Soni[2] developed models to optimize the supply chain, which take into account the dependence of demand on the age, available stock and price of products.

According to Shah, Mittal and Cárdenas-Barrón (2021:1-4), efficient stock management thus requires a balance between replenishment strategies, pricing and control of product freshness in order to meet consumer expectations and maximize company profits.

[1] Chen K, Xiao T, Wang S, Lei D (2020) Inventory strategies for perishable products with two-period shelf-life and lost sales.
[2] Agi MA, Soni HN (2020) Joint pricing and inventory decisions for perishable products with age-, stock-, and price-dependent demand rate. J Oper Res Soc 71(1):85-99

PROBLEM TIZATION

According to Chirstopher (2016:14-16), inventory management is considered a pillar of international logistics, which directly influences supply chain efficiency and consumer satisfaction. However, there is a paradox between maintaining high inventories to guarantee availability and minimize stock-outs, *versus* the need to reduce inventories to avoid excessive costs and losses due to obsolescence.

On the one hand, there is a group of authors, led by Ballou (2016:19-20), who consider the traditional theory of inventory management, such as Wilson's model (EOQ - Economic Order Quantity), emphasizes that high inventories guarantee the continuity of operations and reduce the risk of shortages. However, on the other hand, given the argument presented above, authors such as Chopra and Meindl (2019:33) argue that keeping high stocks increases operating costs, ties up capital and can result in huge losses, especially when it comes to perishable products such as food and medicines.

In addition, according to Simchi-Levi *et al* (2021:21), globalization has intensified the complexity of the supply chain, which has made demand forecasting more uncertain. To meet this challenge, according to Ivanov *et al* (2019), they advocate the use of predictive models based on *big data*[3] and artificial intelligence to optimize stocks, while other authors, such as Tang and Musa (2011:47), warn that over-reliance on these modern technologies can lead to systemic failures if external variables are not correctly interpreted.

Another contradictory point, in line with Paul and Chowdhury (2020:57), is considered to be the impact of sustainability on inventory management, while strategies such as **Just--in-Time (JIT)** promise to reduce waste and improve efficiency, these strategies also make companies vulnerable to interruptions in the supply chain, as evidenced during the Sars Cov - 2 pandemic.

Given the arguments presented above, this research seeks to answer: **How can inventory management balance availability, costs and sustainability in the context of international logistics?**

OBJECTIVES

GENERAL OBJECTIVE

To analyze the impact of international logistics on inventory management;

SPECIFIC OBJECTIVES

- To assess the challenges and opportunities of international logistics in inventory management and the global distribution of goods;
- Investigate how digitalization and new technologies, such as blockchain and artificial intelligence, can contribute to efficiency and security in inventory management;
- Analyze the impact of trade policies and logistics barriers on inventory management in international trade.

BASIC THEORIES

LITERATURE REVIEW

STOCK

Stock[4] is defined as a certain amount of raw material or finished product that has not yet been consumed or purchased/delivered to the organization's customer. Inventory reflects an imbalance between supply and demand that can generate three situations: intentional in-

[3] **Big Data** - refers to large volumes of data that are generated at a very high speed and in a variety of formats. This is high-volume, complex data that cannot be processed in a conventional way using traditional data management methods - consulted at https://www.sas.com/en_us/insights/big-data/what-is-big-data.html

[4] Stock - in English.

ventory, inventory caused by a lack of planning and inventory caused by a failure to plan.[5]

Stock is the composition of materials - raw materials, materials in process, semi-finished materials, finished materials, finished products - which is not used at any given time in the company, but which needs to exist in view of future needs. Stock is therefore the entire assortment of materials that the company owns and uses in the process of producing its products or services. From an accounting point of view, stock is an asset (something that represents money for the company) .[6]

According to Chiavenato (2005:34), stock is the composition of materials (raw materials, materials in process, semi-finished materials, finished materials, finished products), which at a given moment are not used in the company but will be used in the future. In this way, the concept of stock includes all the variety of materials that the company has and uses in the production process of its products and/or services.

After evaluating the concepts of various authors presented above, the concept that should be considered throughout this scientific article, stock is the composition of materials, including raw materials, in-process, semi-finished and finished products, which have not yet been consumed or delivered to customers. Stock represents a company asset and reflects the balance or imbalance between supply and demand, which can arise intentionally, through lack of planning or through failure to plan.

INVENTORY MANAGEMENT THEORY

Inventory management theory is based on quantitative and qualitative models to determine optimum storage levels, which ensure that the company has sufficient supplies without incurring unnecessary excesses. One of the most widely used models is the Economic Order Quantity (EOQ) Model, developed by Wilson in 1913, which calculates the ideal purchase volume to minimize the total costs of acquiring and maintaining stocks (Slack, Chambers & Johnston, 2009:78).

JUST IN TIME (JIT)

Ensuring that a product is available at the time and in the quantity required is one of the main objectives of inventory management. The *Just-in-time* replenishment model is based on the premise of guaranteeing exactly that, by replenishing the required items only at the time and in the quantity needed, without generating stock for the customer, whether this is internal, supplying production or distribution centers, or external. Any wait due to lack of material or any excess of items generates costs and waste .[7]

DEMAND-BASED INVENTORY MANAGEMENT

Demand-based inventory management is a strategic approach that focuses on aligning inventory levels with actual market fluctuations and needs. Unlike traditional approaches that maintain inventories based on fixed forecasts or past history, demand-based inventory management uses real-time data to adjust product replenishment on an ongoing basis.

According to Chopra and Meindl (2017:34), demand-based inventory management involves the use of information systems that allow visibility of customer demand and control over the flow of materials. This tool makes it possible to avoid overstocking and, at the same time, ensure that products are available when needed. The use of technologies

[5] https://cesad.ufs.br/ORBI/public/uploadCatalago/09223404102012Gestao_de_Operacoes_e_Logistica_I_aula_4.pdf - consulted on March 10, 2025

[6] https://vali.qconcursos.com/odin/topics/76fa1c70-ccad-47de-bcf5-61e6125df970.pdf - consulted on March 11, 2025

[7] https://www.maxwell.vrac.puc-rio.br/24604/24604_3.PDF consulted on March 11, 2025

such as ERP (*Enterprise Resource Planning*) and EDI (*Electronic Data Interchange*) systems has become essential for companies to be able to operate based on real demand.

One of the main benefits of this approach is the reduction of costs related to storage and product obsolescence. As Ballou (2004) explains, companies that adopt demand-based stock management can avoid holding large volumes of stock, which frees up financial resources and reduces the risk of losing products due to deterioration or changes in consumer preferences. In addition, stock is replenished more efficiently, based on the immediate needs of the market.

In line with the above argument, Hugos (2018:89), presents another important advantage of demand-based inventory management is increased customer satisfaction. By better aligning stock levels with actual demand, companies can improve product availability, which results in lower out-of-stock rates and faster delivery times. This will contribute to building a positive reputation and loyalty on the part of consumers.

However, implementing demand-based inventory management also presents challenges, mainly related to the need for integration between different systems and parts of the supply chain. For the strategy to be effective, there needs to be a continuous and accurate flow of information between suppliers, distributors and retailers, which requires investment in technology and processes. According to Ballou (2004:134), organizations seeking to adopt this model must be prepared to deal with the complexity of managing *real-time* data and ensure that communication between the various links in the supply chain is efficient.

CROSS-DOCKING AND SUPPLY CHAIN INTEGRATION

According to Ballou (2004:155), ***cross-docking*** can be implemented in various ways, which can depend on the specific needs of the company and the nature of the products to be handled. The most common system involves the use of distribution centers or *cross-docking* terminals, where goods are received from suppliers and immediately organized for direct delivery to customers.

The main benefit of ***cross-docking*** is the reduction of cycle time in the distribution process. By minimizing storage time and facilitating the direct movement of goods to distribution channels, the model increases the speed of the logistics process. In addition, the reduction in storage costs is one of the main attractions, since inventory does not remain in stock for long periods. This type of operation can be particularly advantageous in industries that deal with products with high turnover or limited shelf life, such as food and medicines Ballou (2004:155).

In addition to its operational efficiency, **cross-docking** has implications for **supply chain integration**. Supply chain integration refers to the coordination of all the logistics and information processes that connect suppliers, distributors and customers. For **cross--docking** to work effectively, it is essential that there is continuous collaboration between all the partners in the chain, including suppliers, carriers and distribution points (*ibid*).

ADVANCED INVENTORY MANAGEMENT MODELS

- **Vendor Managed Inventory (VMI)** - Advances in the availability of information have made it possible to implement alternatives for managing goods in organizations. Vendor Managed Inventory (VMI) is one such system, in which information is shared via EDI,

guaranteeing constant updating. Several companies have achieved success in MRO inventory management through VMI, benefiting from the supplier's broad view of demand and obtaining discounts based on the volumes purchased. In addition, VMI reduces inventory transactions, as payment only occurs when the item is used. Although the supplier often bears the transportation costs, these costs are offset by the increase in sales provided by the use of this system .[8]

- **Just in Sequence (JIS)** is an evolution of **Just in Time (JIT)** and has been widely applied in automated assembly lines, especially in the automotive industry. While JIT aims to deliver components exactly when they are needed, JIS adds the requirement that these components be delivered in the exact sequence in which they will be assembled. This reduces handling time and the need for storage space, improving production efficiency (Santos and Almeida, 2019:79).
- **Modular Consortium** - is a partnership model between suppliers for the assembly of complete modules within the supply chain. Unlike traditional models, in which the manufacturing company takes full responsibility for production, in the Modular Consortium suppliers participate directly in the assembly line, where they take on specific stages of the production process (Christopher, 2016:45). This allows each partner to focus on its *core business, a* strategy that helps reduce costs and improves specialization.
- **Milk Run** - is a logistics strategy used to consolidate collections and reduce transportation costs. Inspired by the milk delivery model in the United States, this system optimizes the collection of raw materials and components from various suppliers, reducing travel and logistics costs (Novaes, 2007:15). According to Chopra and Meindl (2019:45), this approach reduces intermediate stocks and improves predictability in production supply.
- **Kanban system** - is a visual method for controlling production and replenishing stock, developed in Japan and widely used in industries that apply the ***Lean Manufacturing*** system. Through the use of cards or visual signals, Kanban tells you when a particular item needs to be replenished, which avoids excess stock and waste (Ohno, 1997:43).
- **Transit Point** - is a distribution strategy based on keeping stocks at transition points to optimize logistics and reduce delivery times. Instead of storing large volumes of products in fixed distribution centers, companies use intermediate *hubs* to redirect goods according to demand (Ballou, 2006:132).

CASE STUDY: INVENTORY MANAGEMENT AT CERVEJAS DE MOÇAMBIQUE

COMPANY HISTORY

Cervejas de Moçambique (CDM), SARL was founded in 1995 as a result of the privatization of the MachMahon and Manica breweries, located in Maputo and Beira respectively. The company belongs to the multinational group AB InBev and was the first company to be listed on the Mozambique Stock Exchange. With factories located in **Maputo, Beira and Nampula**, the company is one of the largest producers and distributors of beverages in the

[8] https://www.maxwell.vrac.puc-rio.br/24604/24604_3.PDF consulted on March 11, 2025

country. CDM is responsible for brands such as **2M, Laurentina, Manica, Stela Artois, Flying Fish, Budweiser, Imapala, Castle and others**, supplying the domestic market and exporting to neighboring countries .[9]

The growing demand for their products has required major investments in **supply chain management**, with the aim of ensuring that raw materials such as malt and hops are delivered at the right time for production. The adoption of modern technologies in **stock management** has made it possible to optimize the process, reduce waste and minimize logistics costs (*ibid*).

MISSION, VISION AND VALUES

- **Mission: To** produce and distribute high quality drinks, promoting moments of joy and conviviality for Mozambican consumers.
- **Vision:** To be the benchmark in the drinks sector in Mozambique, operating with excellence and sustainability.
- **Values:** Innovation, Quality, Sustainability, Customer Commitment and Business Ethics.

CDM constantly strives to improve its production and logistics processes to **guarantee the availability of products on the market**, without excess stock or disruptions in the supply chain (*ibid*).

INVENTORY MANAGEMENT STRATEGIES

- **Just in Time (JIT) and Just in Sequence (JIS**) - The company adopts the Just in Time (JIT) concept, with the aim of ensuring that essential raw materials such as malt, hops and packaging are delivered exactly when needed, minimizing storage costs. In addition, the Just in Sequence (JIS) system allows inputs such as bottles and labels to be delivered according to the production order.
- **Kanban System and Electronic Monitoring** - CDM uses the Kanban System, which allows visual control of production and automatic stock replenishment. Sensors and barcodes ensure real-time monitoring of available materials, with the aim of avoiding overstocking and shortages.
- **Milk Run Strategy for Distribution** - In order to reduce logistics costs, CDM adopts the Milk Run strategy, which consolidates deliveries from various suppliers into a single route. This model avoids unnecessary journeys and optimizes the use of transport trucks.
- **Use of Transit Points for National Distribution** - CDM maintains intermediate distribution centers, called *Transit Points*, in strategic locations such as Beira and Nampula. These points enable faster and more efficient distribution to different regions of the country, reducing delivery times and improving product availability.

CHALLENGES AND SOLUTIONS IMPLEMENTED

INVENTORY MANAGEMENT CHALLENGES

	Challenge	Solution Implemented
Poor Logistics Infrastructure	Mozambique has structural challenges that impact the supply chain, including roads in poor condition, congested ports (long waiting times at the bar) and limited rail systems. These factors affect the transportation of raw materials, increasing lead times and supply costs.	CDM has diversified its transport modes, using a combination of trucks, railroads and ships to minimize risks and reduce delays. In addition, the company has invested in setting up regional distribution centers (Transit Points) to decentralize stocks and speed up delivery.

[9] https://cdm.co.mz/sobre-a-cdm/ consulted on March 12, 2025

Fluctuations and Seasonal Demand	Demand for beer in Mozambique fluctuates seasonally, and is higher during festive periods and national holidays, such as Christmas, New Year's Eve and Independence Day (June 25). This fluctuation can lead to overstocking in periods of low demand or product shortages at times of peak consumption.	The company has implemented demand forecasting systems based on artificial intelligence and historical data analysis. With this technology, CDM is able to adjust stocks more precisely, avoiding waste and ensuring adequate supply.
Dependence on imported raw materials	CDM imports malt and hops, essential ingredients for beer production, which makes it vulnerable to exchange rate variations and delays at ports such as Maputo and Beira.	To mitigate this dependence, the company has invested in the local production of inputs, encouraging Mozambican farmers to grow barley and corn as alternatives to reduce external dependence. In addition, CDM maintains strategic safety stocks to avoid production disruptions
High Storage and Transportation Costs	The cost of storage and transportation in Mozambique is high due to factors such as expensive energy, lack of refrigerated warehouses and limited infrastructure.	CDM has adopted the Just in Time (JIT) system to reduce idle stocks and minimize storage costs. In addition, the company has implemented the Milk Run model, consolidating deliveries from suppliers into optimized routes to reduce transport costs.

Table 2: Challenges and solutions implemented by CDM based on structural levels

Source: Research data (2025)

Technology and Demand Forecasting - CDM has implemented Artificial Intelligence (AI) and *Big Data* systems to predict fluctuations in demand. This makes it possible to adjust stocks according to expected consumption, thus avoiding overproduction or product shortages.

FINAL CONSIDERATIONS

Inventory management plays a key role in the operational efficiency of companies, especially in a globalized context where the demand for agility and cost reduction is increasing. This study covered the main concepts and strategies related to inventory management, from classic methodologies such as Just in Time (JIT) and Kanban, to modern models such as Just in Sequence (JIS) and Milk Run, which aim to improve logistics and reduce waste.

In addition, the research achieved all the specific and general objectives set out in the article and highlighted the importance of efficient stock management in the supply chain, which shows that inadequate control can result in high costs, waste, loss of competitiveness and negative impacts for consumers and companies. The implementation of advanced technologies, such as artificial intelligence and demand forecasting systems, has proved to be an effective solution for optimizing stocks and ensuring greater predictability in product replenishment.

The case study of Cervejas de Moçambique (CDM) reinforced the applicability of these strategies in the Mozambican context, which demonstrated how structural, seasonal and logistical challenges can be overcome with innovative practices. Adopting decentralized distribution centers (Transit Points), AI-based demand forecasting and optimizing logistics routes (Milk Run) were some of the solutions that enabled the company to reduce costs, avoid supply disruptions and improve operational efficiency.

Finally, the need for continued investment in innovation and professional training in the logistics area is highlighted, especially in developing countries like Mozambique, where structural challenges still represent a significant obstacle. Collaboration between companies, government and academic institutions will be key to improving logistics processes and ensuring sustainable development in the sector.

FUTURE RESEARCH

Given the challenges and opportunities identified in this study, future research could delve into various areas related to inventory management and international logistics. Some recommended directions include:

- **Impact of Digitalization and Artificial Intelligence on Inventory Management** - Analysing how the use of **Big Data, Machine Learning and the Internet of Things (IoT)** can optimize demand forecasts, reduce waste and improve logistics efficiency in Mozambican companies.
- **Sustainability in Inventory Management** - Investigating **sustainable storage and distribution practices**, including the impact of reverse logistics and the circular economy on reducing product and packaging waste.
- **Influence of Government Policies on Inventory Management** - Assess how public policies and tax incentives can **facilitate or hinder** the adoption of advanced inventory management technologies in the country.
- **Comparative Studies between Mozambican and International Companies** - Carry out a comparative study between **inventory management practices in Mozambique and in other countries**, with the aim of identifying **barriers, good practices and lessons learned** that can be applied in the local context.

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