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Cooperation between Artificial Intelligence and Lateral Transshipment: Qualitative Study

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Abstract

Artificial intelligence (AI) is transforming inventory management by leveraging advanced algorithms and machine learning techniques to analyze large data sets quickly and accurately. AI-powered systems can process data at unprecedented scale and speed, unlike traditional methods that rely on manual data entry and analysis. But, to be more competitive in a complex market, the supply chain can improve its performance by applying coordination between its different retailers, called "Transshipment-Lateral", which organizes stock transfers between sites of the same level, either according to a preventive policy to reduce the risks of stock shortages in the face of anticipated customer demands, or according to an emergency policy to resolve the problem of actual stock shortages.

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Introduction

The use of artificial intelligence for the automation of inventory management firstly brings a gain in precision by producing predictions linked to each point of sale separately. This is possible thanks to the volumes and continuous flows of data that these data science tools can ingest.

This qualitative study explores the cooperative dynamics between artificial intelligence (AI) systems and lateral transshipment processes in logistics management. With the rise of complex supply chains requiring efficient and adaptable operations, understanding how AI can enhance transshipment strategies is essential for modern logistics.

The ever-evolving landscape of logistics and supply chain management necessitates innovative approaches to meet the increasing demands for efficiency and responsiveness. Lateral transshipment, which involves transferring cargo between two or more points in a network, offers a flexible solution for inventory management and resource allocation. This study investigates the collaboration between AI technologies and lateral

transshipment, aiming to uncover qualitative insights into their synergistic potential.

Supply chain management is an efficient approach to managing the flow of information, goods, and services in fulfillment of customer demand.

With information technology, peer retailers have easily adjusted forecasts to adjust inventories as the sales season approaches.

Thumbelina, this paper focuses on lateral transshipment as an alternative and studies transshipment policies at a supplier with two symmetrical retailers.

According to Sayed and Muhammad integrating artificial intelligence (AI) into your warehouse management could be the innovation you have been waiting for to improve your operational efficiency [1].

Landwehr shows that AI, a cutting-edge technology that has the potential to learn and analyze data in real time, is now an indispensable tool for inventory management and the operation of an efficient supply chain [2]. The positive impact of AI is undeniable, going even beyond automation and robotization to increase time savings, profitability and even customer satisfaction.

Justin and Mizuko approve that, in the context of inventory management, AI offers undeniable added value, particularly in terms of time savings and profitability [3]. Drawing on a multitude of data, it can, for example, predict the company's future needs based on historical sales data, orders and stock levels.

It can also optimize decisions regarding procurement and storage, even going so far as to recommend adjustments in the physical layout of stocks in the warehouse.

However, none of this research has taken into account the support of the same level in a supply chain, in particular that of competitors [4].

Nakandala et al, indicates that the role of artificial intelligence in optimizing inventory management by applying Transshipment-Lateral is multifaceted and complex [5]. For example,

AI can analyze the sales rate of products and create an inventory management model based on this. It is thus possible to precisely adjust stock levels at retailers to avoid shortages or excess products, this corresponds to Transshipment-Preventive. This contributes not only to better inventory management, but also to a significant reduction in costs.

The research work of Rainie et al, shows that artificial intelligence also plays a crucial role in the automation of order picking [6]. With it, robots can intelligently organize the preparation of products in the warehouse and follow an optimized route to the order pickers. AI can even suggest efficient scenarios for arranging the packages on the pallet. This results in reduced costs, time savings, increased productivity, and greater overall efficiency.

According to the research work of Petousi and Sifaki the Artificial-Intelligence has quickly become an essential pillar in supply chain management and optimization [7]. Whether by accelerating the decision-making process, optimizing production, storage or transport capacities, or updating multiple action scenarios and crisis prevention, AI is capable of improving almost all facets of supply chain management.

This is, for example, the case in an omnichannel warehouse that manages inventory. Located at the heart of all operations, from delivery to online sales, including in-store pickup, an omnichannel warehouse must deal with a delicate mix of different channels and actors, and a multitude of different locations and preparation methods.

Samtani et al, explains that in such a complex environment, AI can act as a catalyst to make the system smoother and more efficient [8]. By making better use of every available resource, AI makes the supply chain more connected, leading to better product traceability and increased performance. The result is added value not only for the company, but also for consumers. With AI's ability to provide more accurate information, customer trust can only increase. Ultimately, whether it's improving inventory management efficiency or increasing customer satisfaction, AI is an asset for any company looking to optimize its supply chain.

Tahiru analyzed the spoilage of perishable products and proposed a lateral shift option to meet demand while simultaneously minimizing transportation and distribution costs and random accidental losses [9]. According to Ayling and Chapman the future of AI in inventory management is here, and it is transforming the way retailers operate [10]. As AI improves at lightning speed and takes over more and more business tasks, its impact is being felt across the retail industry. At the same time, retail itself is reinventing itself in the wake of digital transformation, omnichannel expectations, and changing customer demands post-COVID.

Today, technology is becoming a critical part of business. Artificial intelligence and machine learning are widely expected to reshape businesses. By enabling organizations to automate repetitive tasks and analyze vast data sets, AI will drive faster, more efficient performance across the enterprise, and in nearly every industry).

Supply chain is no exception. In fact, AI has already begun to transform manufacturing, from how we build our products to how we source, schedule, manage, and distribute the raw materials that go into them. Particular and firms are taking advantage from AI. In the next decade.

Danahershow that more and more companies with very large supply chains and a large number of orders are now using AI to automate these processes [11]. Indeed, with the amount of data generated by the different links in the supply chain, AI makes it possible to avoid sources of errors and save time and money.

First, we must differentiate between process automation (RPA) and Artificial Intelligence. RPA makes it possible to execute data processes without many possible options by reproducing the mechanical gestures of humans. Artificial Intelligence is capable of analyzing and structuring information (machine learning) and thus reproducing thought processes that humans might have. Of course, these concepts can be used at the same time within a structure.

Process automation is a field where artificial intelligence will use machine learning to learn to identify phenomena or analyze data using algorithms. In this way, the machine will identify patterns and associate answers with questions to understand how certain given situations work.

The research of Jarrahifocuses on the study of e-commerce where customers want to be able to get their products everywhere, all the time and at the best price cooperated with AI [12]. This can be extremely useful. Indeed, artificial intelligence has never been as mature and accessible as it is today, especially in logistics, because its environment and its operation allow us to imagine many applications of AI to optimize processes.

Qualitative Study

A qualitative research design was employed, focusing on interviews with industry experts and stakeholders involved in logistics and supply chain management. The participants were selected based on their experience with AI integration and lateral transshipment processes. Thematic analysis was utilized to identify patterns and insights from the data collected. According to the state of the literature, it is similar, that the research works that deal with the problem of Lateral-Transshipment combined with Artificial Intelligence, are too rare. For that, in this paper, we study a qualitative study based on this concept.

This collaboration between different retailers at the same level generally takes the form of a “lateral transshipment”, presented in (Figure 1).

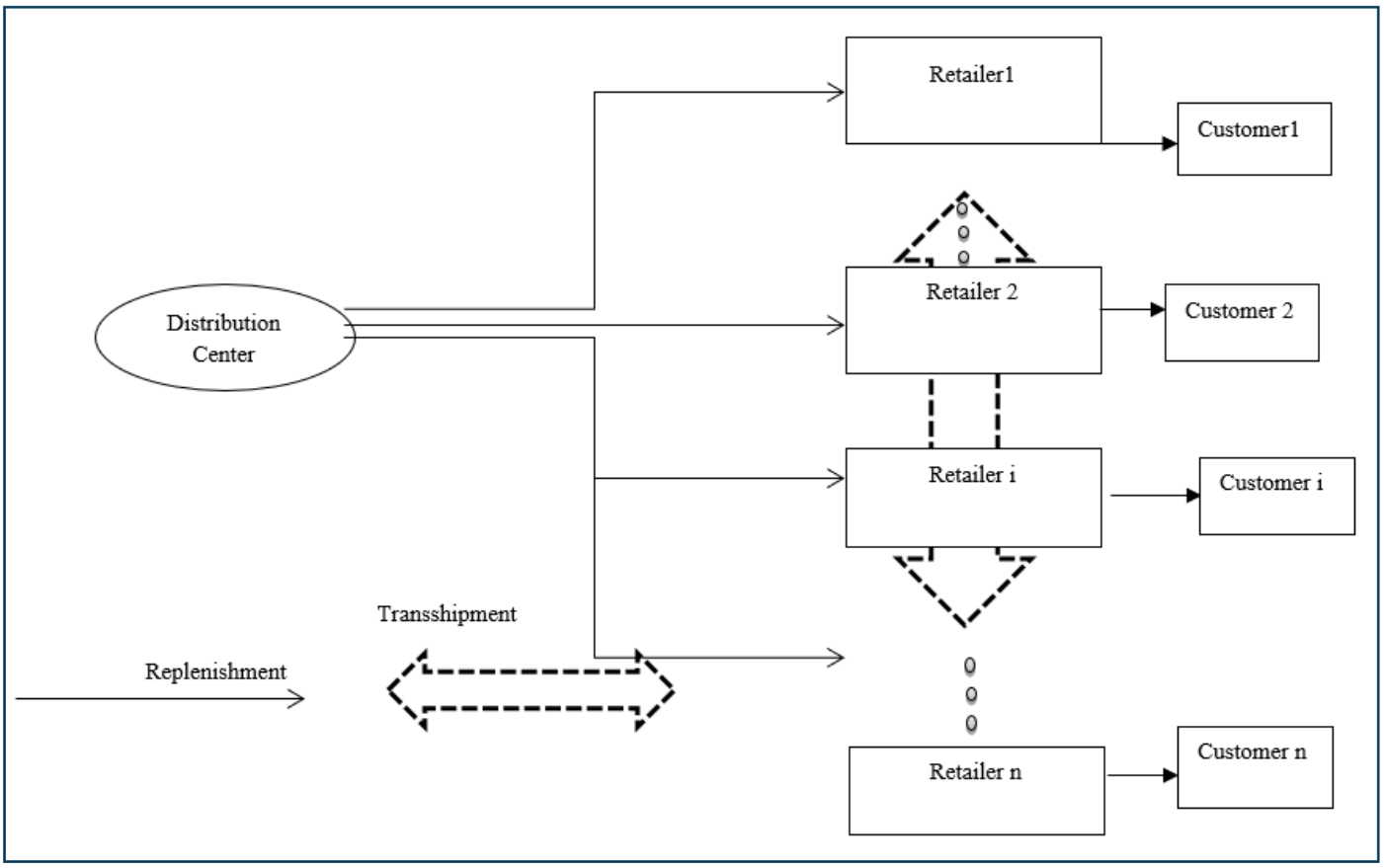

Figure 1. Representation of Transshipment in a logistics chain

There are two Lateral Transshipment policies, which are:

- Complete - Pooling: The retailer agrees to transfer all of its available stock when needed; that is, to pool all of its stock with another site, without any restriction.
- Partial - Pooling: Transshipment is performed by preserving a targeted stock level.

We then find the following variants:

- A retailer accepts transshipment up to the surplus stock at a transshipment threshold equal to the estimated demand for the next period.
- The decision to integrate a transshipment at the level of a retailer depends on the current stock level and the time remaining before the next supply.
- A retailer accepts transshipment up to the excess stock of a threshold equal to its reorder point [7]. The retailer applies transshipment up to the excess stock of a threshold equal to its safety stock [13].

Research Design

In our paper, we seek to study the impact of "Artificial Intelligence" on "Lateral Transshipment".

For this, we studied an in-depth survey with Tunisian companies.

This sampling is done online, which helps us to better understand the functioning of these companies.

We used thematic analysis to divide the results into categories based on a common divisor.

The data are collected from 27 January, 2024 to 27 November, 2024 from 7 Tunisian companies.

The demographic data collected include several categories, namely types of activity, sector of activity, company size, etc. (Table 1).

Table 1: Qualitative Analysis

Asked Question	Answer
What is the lead time for the initial order from the central warehouse to the retailer?	Constant
What is the quantity of the order to be delivered from the central warehouse to the retailer?	According to the law and the company
What is the distance between warehouse central and retailer?	Longer than that between different retailers of the same level
What is the law of random demand?	N (μ,σ), P (k)
What is the number of retailers?	Two or Multi-Retailer

Qualitative Analysis

The main objective is to minimize, as much as possible, the total cost of retailers and the Disservice rate. Delivery represents a cost for companies. As companies increasingly deliver to their customers with multiple delivery options, to limit costs, the company can direct the consumer to the most economically advantageous solution in relation to the available resources. This is where Artificial Intelligence comes in since it allows to anticipate several things based on delivery times and points.

The integration of AI in lateral transshipment presents significant opportunities for improvement in logistics operations. By fostering cooperation between human expertise and AI capabilities, organizations can achieve greater levels of efficiency and responsiveness. However, it is vital to address challenges such as data privacy, integration complexities, and the need for skilled personnel to manage AI tools effectively.

More than 79% of business leaders consider the lack of visibility on their supply chain as their main concern. They would like to have clear visibility on the entire supply chain in order to be able to react in the event of unforeseen events.

In the field of logistics, algorithms can be applied to identify in advance the products that are expected to sell faster or slower than expected. It is therefore possible to set up a very precise inventory to reduce shortages or surpluses of goods. Artificial Intelligence is also interested in forecasts to help decision-making in order to optimize the positioning of resources. From the data, AI will be able to anticipate consumers' purchasing intentions based on days, times, but also according to other factors such as weather, events, etc. But also to improve customer satisfaction, by optimizing delivery and return times. For the logistics manager, flow management can quickly become a headache. Artificial intelligence provides an answer to this problem by automatically optimizing the various logistics flows. AI in logistics can help you optimize… Human physical flows in the warehouse.

In warehouses, Artificial Intelligence is profoundly changing the game by managing the complete cycle from stock receipt to customer delivery, including packaging and order preparation.

Based on historical data, Artificial Intelligence detects current orders and stocks, predicts the needs of the entire network and suggests optimized decisions (purchases, transfers, etc.).

Improving the level of Disservice for customers has become a major concern in the management of distribution systems. For a network made up of two or multi-retailers, the imbalance of quantities stored in these sites due to random demand is a common problem. In the case where one retailer has a surplus of stocks while the other is facing a shortage, the collaboration between these retailers, called "Lateral Transshipment" could solve the problem and avoid any shortage.

It will thus identify the products that sell the fastest or the slowest and model a more precise inventory accordingly. This makes it possible to adjust stocks to avoid shortages and limit excess goods.

Artificial intelligence also makes it possible to considerably facilitate the work of order pickers, thanks to automation. In this way, they can save time in their

tasks and also gain in productivity.

To achieve this, artificial intelligence guides robots moving alone between the different retailers. It is then possible to optimize the quantity of Transshipment between warehouses for faster picking and a lower error rate.

The cooperation between artificial intelligence and lateral transshipment is poised to revolutionize logistics management. As this study highlights, leveraging AI's analytical and decision-support capabilities can profoundly impact operational efficiency and risk management in the transshipment process. Future research should explore quantitative measures of success and further investigate the long-term implications of these cooperative strategies.

Conclusion

In our research work, we emphasize the importance of cooperating "Transshipment - Lateral" and "Artificial Intelligence".

Overall, advancements in artificial intelligence and emerging technologies have undoubtedly revolutionized various aspects of the supply chain and transshipment between different retailers. With the clever application of AI, logistics operations have been able to be optimized substantially, leading to significant reductions in costs and processing times.

Furthermore, the integration of autonomous robots and cobots within warehouses has significantly increased the efficiency of the supply chain, freeing up valuable hours for teams.The power of AI to anticipate maintenance needs, closely monitor suppliers, and improve customer experience has profoundly transformed the face of the industry, thus offering a brighter logistics future.

By wisely adopting these innovations, companies can make the most of the opportunities offered by these technological advancements, for an ever more efficient supply chain and a brighter logistics future.

But this area is rare. For this, we put as a perspective the integrated cooperation between AI and transshipment in our Tunisian companies.

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