Influence of Artificial Intelligence (AI) on E-Commerce Supply Chain Logistics

by Melanie Cheung

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Abstract

This paper examines how Artificial Intelligence (AI) is utilized in the online retail sector to enhance operational efficiency and reliability. Using data from 10 e-commerce companies, the paper examines benefits of AI integration, including reduced operational costs, faster order processing, and fewer inventory errors. However, challenges caused by AI are also highlighted. By reviewing past literature, the report argues that AI incorporation is ultimately beneficial to e-commerce companies and is worth investing in despite the high costs because businesses will be able to make more profit in the long run due to the increased efficiency.

All monetary values in the report are in the currency of the U.S. dollar (USD).

Introduction

Artificial Intelligence has made supply chain logistics more efficient and convenient for the six billion internet users worldwide. Retail e-commerce sales even reached $6.88 trillion worldwide (Feger, 2025). The industry has shown no signs of slowing down, having a CAGR of 6.29% ("Global: E-Commerce"). China as the world's lead in e-commerce has a market worth $3450 billion, followed by $1380 billion in the United States ("Largest E-commerce"). The US is home to the world's biggest e-commerce platform, Amazon, with over 310 million active users worldwide, and 200 million users purchasing their Amazon Prime subscription (Taylor, 2021).

As the e-commerce industry continues growing, its prosperity has an undeniable relationship with AI. This gives rise to the research question, "To what extent is an e-commerce company's performance, specifically in supply chain logistics, impacted by the integration of artificial intelligence?" This paper investigates how AI influences e-commerce supply chains by examining past studies on e-commerce companies with varying levels of AI incorporation and their respective performance. Their performance will be measured by three aspects: delivery performance, cost efficiency, and inventory management.

1. Hypothesis

To address my research question, my hypothesis is that e-commerce companies with high levels of AI integration in their supply chain logistics will have a significantly better performance compared to those with low levels of AI incorporation. This means that e-commerce companies with high AI

incorporation will be more cost-efficient, have smarter delivery processes, and have more organized inventory management.

2. Background

The e-commerce industry is a sector of the global retail market, involving the digital sales of goods. The typical relationships in e-commerce include Business-to-Consumer (B2C), Business-to-Business (B2B), Consumer-to-Consumer (C2C), and sometimes Consumer-to-Business (C2B).
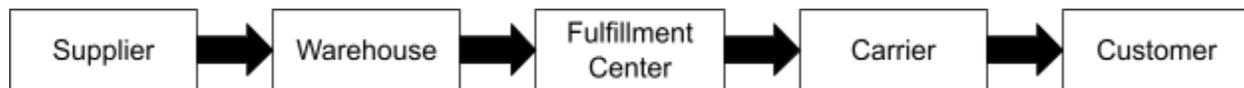

Figure 1. Supply chain flow in an e-commerce business

The success of e-commerce firms is dependent on their supply chain logistics, which refers to how online businesses manage the flow of goods from suppliers to consumers. There are five stages in the supply chain flow, as shown in Figure 1. The first stage is **Supplier**, which is when inbound goods get delivered to the business' warehouse. By analysing historical sales trends, AI can accurately predict demand and identify the ideal size of inventory. Next, the **Warehouse** stage is when inventory is stored prior to the products being purchased by consumers. AI-driven tools can streamline warehouse operations, from inventory tracking to picking, packing, and shipping, as well as replenish stock by monitoring it based on real-time data, saving costs of businesses to hire labor to perform such tasks. The **Fulfillment Center** is where goods are transported to handle packing to get ready for delivery to consumers. At the **Carrier** stage, where parcels are handed to carriers to deliver to consumers, AI-powered systems continue to play a crucial role. AI is able to execute deliveries more efficiently by analyzing delivery time windows and vehicle capacity to optimize delivery routes, minimizing disruptions. Lastly, the **Customer** stage is when consumers receive their products, completing a cycle of supply chain logistics. However, there is the possibility of reverse logistics, which is the supply chain process of moving goods from the consumer back to the manufacturer for returns, repairs, or recycling. In the same way AI benefits the delivery of the product from the warehouse to the consumer, it can ensure the smooth shipping of the product back to the firm.

AI in e-commerce supply chain logistics goes beyond identifying the number of stock, its influence also encompasses predictive analytics for market demand and consumer behavior, automated warehouse operations, route optimization for delivery services, inventory management, and real-time supply chain visibility. As a result, AI in e-commerce has the ability to improve customer satisfaction, reduce operational costs, and create a global reach for e-commerce operations, increasing profits.

However, the true question lies within whether its benefits are worth it for the high costs. While costs for basic AI models in e-commerce businesses can be as low as $5000, cutting-edge technologies can go beyond billions ("AI Pricing"). Amazon, for example, has invested over $100 billion in AI initiatives to stay ahead of the e-commerce market (Rafe Rosner-Uddin, 2025). In this paper, the performance of companies with high AI integration will be contrasted against those with low AI integration. The level of AI implementation will be determined based on the amount of AI investments and also the general integration of AI in the business. The costs and benefits of the usage of AI will answer whether it creates a significant enough influence in an e-commerce business to be worth the expensive resources.

3. Methodology

To measure a company's performance, the three metrics of delivery operations, cost efficiency, and inventory management will be explored, as explained in Table 1 below:

Delivery operations	Average delivery time
	Same-day delivery capability
	Delivery accuracy
	Last-mile efficiency
Cost efficiency	Labor costs
	Transportation Costs
	Inventory Holding Costs
	Warehouse Operating Costs
Inventory management	Inventory Turnover
	Demand Forecast Accuracy
	Overstock reduction
	Stockout Rate

Table 1. Performance metrics

To understand the role of AI in supply chain logistics, 10 e-commerce companies will be divided into two categories: AI-enabled companies and non-AI companies. Each company's data in the performance metrics, as stated in Table 1, will be recorded, and each category's average will be calculated.

With the rapid growth of AI, it is nearly impossible to identify a company with zero AI integration. Thus, it is key to note that "non-AI companies" refer to companies with significantly less AI incorporation compared to other e-commerce companies, only carrying out basic AI operations. In contrast, AI-enabled companies are categorized based on how integrated AI is in their services, and also the amount of investments in AI in the past decade.

In this study, 10 e-commerce companies will be divided as follows.

AI-enabled companies include: Amazon, Alibaba, Flipkart, Walmart, and Shopify

Non-AI companies include: Warby Parker, Newegg, Threadless, Redbubble, Zibbet

4. Quantitative Data

The following datasets took the averages of the two groups of companies' performance.

Metric: Delivery operations	AI-enabled companies	Non-AI companies
Average delivery time (days)	4	6.8
Same-day delivery capability (%)	53	20
Delivery accuracy (%)	95	88
Last-mile efficiency (%)	86	71

Table 2. Data on delivery operations (Appendix A and B)

Metric: Inventory management	AI-enabled companies	Non-AI companies
Inventory Turnover (times per year)	9	4
Demand Forecast Accuracy (%)	88	74
Overstock reduction (%)	24	11
Stockout Rate (%)	8	14

Table 3. Data on inventory management (Appendix A and B)

Metric: Cost efficiency	AI-enabled companies	Non-AI companies
Labor costs (in millions of $)	16640	79
Transportation Costs (in millions of $)	19200	192
Inventory Holding Costs (in millions of $)	6360	89
Revenue (in millions of $)	282240	494

Table 4. Data on cost efficiency (Appendix A and B)

Metric: Cost efficiency	AI-enabled companies	Non-AI companies
Labor costs (in millions of $)	5.9%	16%
Transportation Costs (in millions of $)	6.8%	38.9%
Inventory Holding Costs (in millions of $)	2.3%	18%

Table 5. Proportion of operational costs in total revenue (Appendix A and B)

4.2. Qualitative Data

When interviewing users of Amazon and Alibaba, they cited the convenience of the companies' AI lens function, where users can upload an image of an item to purchase the product. While AI has optimized shipping and inventory management in the supply chain, it has also improved the shopping experience of customers, making it more personalized and efficient.

In contrast, when speaking with users of companies with less AI implementation and reading company reviews, it was clear that their efficiency was not up to par with the AI-enabled companies, supported by the data in Figure 3. Specifically, Redbubble customers have complained about the long delivery time, taking up to a month for their order to be processed and shipped. Thus, the varying levels of customer satisfaction between the two types of companies can be clearly established: AI-enabled companies are able to fulfil customers' needs quicker.

5. Discussions

In terms of delivery operations, AI-enabled companies perform better than non-AI companies, as shown in Table 2. While delivery accuracy and last-mile efficiency were similar, AI-enabled companies stood out for being able to maintain a 95% delivery accuracy rate, partially due to how AI can minimise errors and ensure orders are placed and shipped correctly. As for delivery speed, AI-enabled companies are able to ship around 2.8 days before non-AI companies, yet the non-AI companies' 6.8 delivery days is reasonable even without AI integration. However, non-AI companies only have a 20% capability of handling same-day deliveries, because by using manual labor rather than AI assistance, they are unable to process and ship orders as quickly as AI-enabled companies, with a capability of 53%.

In inventory management, AI-enabled and non-AI companies performed relatively similarly, yet AI-enabled companies stood out with better stock management. By using AI analytics, AI-enabled companies achieved an average 88% demand forecast accuracy, while non-AI companies only reached 74% accuracy. This ability allows companies to correctly assess market demand, increasing delivery speed since companies won't have to spend extra time restocking products, and prevents companies from monetary loss when unsold stock expires, as shown by AI-enabled companies' 24% overstock reduction compared to non-AI companies' 11%. AI-enabled companies also had an inventory turnover of 9 times a year in contrast to non-AI companies' 4 times a year, demonstrating that they are efficiently managing inventory ("Inventory Turnover"). From Table 3, it can be concluded that the integration of AI has assisted in the inventory management of e-commerce companies, allowing for effective stock regulation.

Tables 4 and 5 then captures cost efficiency and proportions of companies' operational costs to investigate whether companies should invest in AI despite its substantial costs.
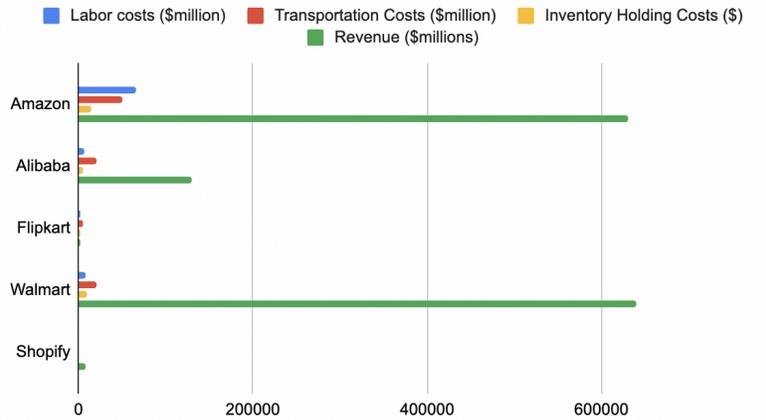
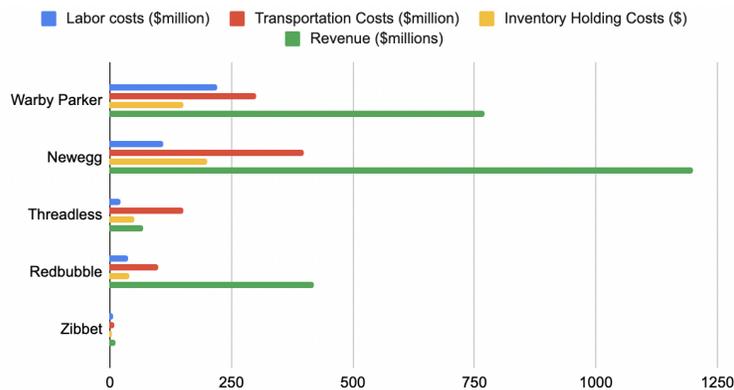Figure 2. AI-Enabled Companies' Cost Efficiency Data (in millions)

Figure 3. Non-AI Companies' Cost Efficiency Data (in millions)

When analysing data on cost efficiency, non-AI companies spend less on labor, transportation, and inventory holding. In fact, AI-enabled companies spent $6.36 billion on inventory management, while non-AI companies only spent $89 million, and this significant price difference is present in all three aspects. This may be interpreted as non-AI companies spending less on operational costs. However, this is because AI-enabled companies are all substantially larger-scale than the non-AI ones, more costs are needed to run the business. Amazon, one of the largest companies in this dataset, has over 1.5 million employees (Duarte, 2023), which explains the high labor cost of $66 billion. While this is a large expenditure, Amazon drew in 630 billion in revenue that year, so the labor cost was necessary to gain more profits. On the other hand, Zibbet, one of the non-AI companies, only spent $6 million in labor costs, raising questions on whether a company lacking AI integration could still minimize manual labor. The explanation for this is that Zibbet is a smaller company, raising only $13 million in revenue, a $617 billion difference with Amazon.

The scale difference of companies is due to the lack of large-scale e-commerce companies that do not utilize AI in their supply chain operations, since they have the financial means to invest and expand. To further demonstrate the differences between the two categories' performance, Figure 2 and 3 capture each company's expenditure to revenue ratio. In Figure 2, it is clear that AI-enabled companies' revenue substantially exceeds spending. In contrast, non-AI companies have a smaller gap between their expenditure and revenue, with Newegg having the biggest gap.

A common observation between the two categories of companies is that transportation costs usually take up the largest percentage of total revenue, as supported by data in Table 5. For AI-enabled companies, it was 6.8%, and for non-AI companies, it was 38.9%. This highlights that AI plays a role in minimising costs for transportation of goods, using methods like assessing the most optimal and efficient delivery routes and delivery time windows. Overall, AI-enabled e-commerce companies were able to spend less proportion of their revenue on labor, transportation, and inventory management, with a smaller percentage in every category compared to non-AI companies, illustrating AI's influence.

6.1 Reflections

An ethical worry about the use of AI in e-commerce is that it exacerbates wealth inequality. Amazon has invested $100 billion in R&D of AI, yet this is a sum of money small-scale companies such as Zibbet and Threadless that earn $13 million and $68 million respectively cannot afford. As a result, large-scale corporations can expand and dominate the industry because they have higher financial ability to invest in AI and enhance their supply chain logistics to differentiate their company. Meanwhile, small-scale companies cannot invest as much and will fall behind, widening the wealth gap and pushing smaller firms out of business.

AI in e-commerce also poses a risk to the environment. Currently, data centers that facilitate the use of AI take up 1.5% of the Earth's total electricity consumption, and it is projected to increase to exceed Japan's total electrical consumption ("What Direct"). The environmental impact of AI in the e-commerce industry is substantial, with Amazon owning more than 100 data centers worldwide, each having approximately 50,000 servers to provide its cloud computing services (Zewe, 2025). Not only does AI incorporation require significant energy consumption from data centers that contribute to greenhouse gases and climate change, but it also causes a lot of water wastage. To prevent servers from overheating, data centers use a large amount of water to cool down machines.

6.2 Summary of Findings

After analysing 10 e-commerce companies on their performance in delivery operations, inventory management, and cost efficiency, it is apparent that AI-enabled e-commerce companies lead in all aspects

compared to non-AI companies. Therefore, in response to the research question, "to what extent is an e-commerce company's performance, specifically in supply chain logistics, impacted by the integration of artificial intelligence?", this paper concludes AI influences the e-commerce industry, specifically in supply chain logistics in delivery operations and inventory management, to a large extent.

The efficiency and analytical ability of AI allow a smooth supply chain logistics process, lowering costs for the transportation of goods and eliminating need for labor, maximizing profits. Customer satisfaction increases since customers benefit from faster delivery and lower prices. Overall, the integration of AI in e-commerce is beneficial for the firm and consumer, and is worth investing in despite the high costs, since it will boost the firm's profits in the long run.

Appendix A. Full raw dataset of AI-enabled companies in performance metrics

	Amazon	Alibaba	Flipkart	Walmart	Shopify
Average delivery time	4	4.5	3.5	4.4	3.5
Same-day delivery capability (%)	85	60	50	40	30
Delivery accuracy (%)	98	95	94	96	90
Last-mile efficiency (%)	92	90	88	85	75
Labor costs ($millions)	66000	6800	2000	7500	900
Transportation Costs ($millions)	50000	20000	5000	20000	1000
Inventory Holding Costs ($millions)	15000	5000	1500	10000	300
Revenue ($millions)	630000	130000	2400	640000	8800
Inventory Turnover (times per year)	12	9	7	9	6
Demand Forecast Accuracy (%)	95	90	85	92	80
Overstock reduction (%)	30	25	20	28	15
Stockout Rate (%)	5	8	10	6	12

Appendix B. Full raw dataset of non-AI companies in performance metrics

	Warby Parker	Newegg	Threadless	Redbubble	Zibbet
Average delivery time	10.5	5.5	3.5	7	7.5
Same-day delivery capability (%)	25	30	20	15	10
Delivery accuracy (%)	92	93	88	85	80
Last-mile efficiency (%)	80	78	70	65	60
Labor costs ($millions)	220	110	22	38	6
Transportation Costs ($millions)	300	400	150	100	10
Inventory Holding Costs ($millions)	150	200	50	40	5
Revenue ($millions)	770	1200	68	420	13
Inventory Turnover (times per year)	5	6	4	4	3
Demand Forecast Accuracy (%)	82	78	75	70	65
Overstock reduction (%)	18	12	10	8	5
Stockout Rate (%)	7	11	15	18	20

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