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Artificial Intelligence and E-commerce Logistics Management towards Operational Excellence

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Abstract— **The world of trade and commerce has undergone a sea change over the last 2-3 decades with the marvelous development in technology which has revolutionized communication and has brought artificial intelligence (AI) into our world. AI has made our lives easier in several ways and its impact on buyers' behavior is not far to seek. From the retailers' perspective, happy customers are satisfied customers who would help to not only maintain the business but also in its expansion. Using AI to achieve operational excellence especially from the perspective of logistics management, an e-retailer can achieve competitive edge that will help it stay ahead of peers. This article shows that AI plays a crucial role in achieving operational excellence in e-commerce, especially from the perspective of Quick Commerce (QC), through efficient management of delivery logistics.**

Keywords— *artificial intelligence, AI, e-commers, logistics, delivery, logistics, management.*

1.   Introduction

In the present world e-commerce is a booming industry [1], riding on the back of greater and wider application of modern information and communication technologies (ICT) and growing demand for shopping online [2].

1.2   Exponential rise in e-commerce

Both domestically and internationally, during the last decade or so, e-commerce and operations management have emerged as the crucial factors determining and driving success for contemporary businesses. They helped in delivering a product that is in demand, particularly a branded product, directly to the end-user, thus ensuring superior consumer satisfaction which is a key success factor for modern business [3]. This is the age of convenience and instant gratification and e-commerce operations of a business determine how successful it will be in satisfying the customers when it comes to delivering a brand direct-to-consumer (DTC) [4]. In retail sales in the US, more than 40% of the growth is because of e-commerce; and experts say, by 2040, almost 95% of aggregate purchases are likely to happen online [5].

1.3   Factors that drove the rise

In the past decade the e-commerce industry has undergone remarkable transformation, with global e-commerce sales skyrocketing to $3.46 trillion in 2019 from 572 million USD in 2010. Amazon alone recorded over $256.4 billion in sales in 2019 [6]. Global e-commerce sales were expected to cross $6 trillion in 2024, growing by more than 8% over 2023 [7]. With more than one third of the world's population purchasing goods and services online, global e-commerce industry now stands at $6.8 trillion and is expected to reach $8 trillion by 2027.

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Global eCommerce sales will surpass $8 trillion by 2027.

"$ value in trillions"

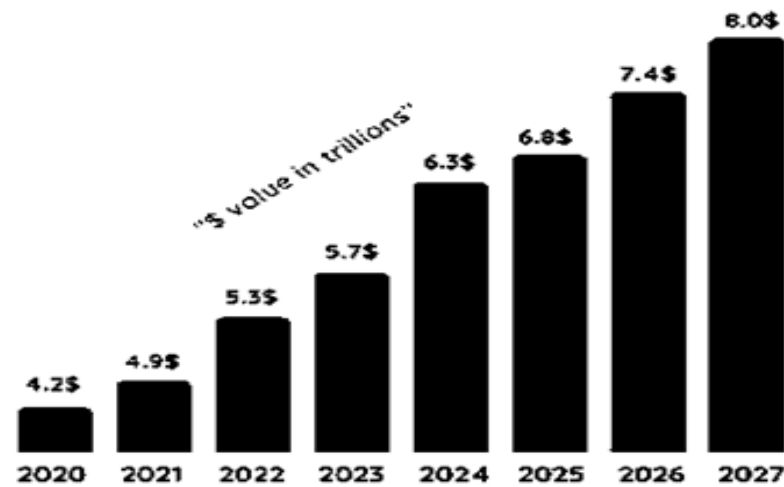| 2020	2021	2022	2023	2024	2025	2026	2027
4.2$	4.9$	5.3$	5.7$	6.3$	6.8$	7.4$	8.0$

Figure 1: Growth in Global e-commerce Sales [8]

This staggering growth has been the outcome of the transformation occurring within the e-commerce industry over the last 10 years. Such options as cash-on-delivery (COD), UPI (Unified Payments Interface) and other payment options through third-party payment integration, have been instrumental in changing both the persona and the perspective of the buyer encouraging more people to buy online where they have better offers and deals to cater to their respective needs. Another key contributor to this phenomenal growth had been the Cashback offers from several third-party mobile payment channels including Amazon Pay, Apple Pay, PayPal, etc. that have not only helped by increasing the ease of shopping but have also enticed people to shop online confidently. [6]. But with growth came complexities of operations and the need for prompt and accurate delivery of products too actual consumers. The problems of supply chain management (SCM) especially logistics management especially with respect to first, middle and last mile delivery got accentuated further with the growth in Quick Commerce, which has made e-commerce companies turn to advanced technologies to maintain their operational excellence. This article highlights the use of AI in logistics management to maintain competitive edge and operational sustainability in a fiercely competitive environment.

2.   Literature Review

2.2   Changing consumer needs induced by certain events

The development and expansion of e-commerce is the outcome of the change in consumer demand. The alteration has been induced by several incidents occurring across the globe, some of which have been discussed below.

2.2.1 COVID-19 Pandemic

The COVID-19 Pandemic brought significant and permanent changes to various aspects of human life, one of which is the consumption behavior. The lockdowns relegated and confined consumers to their homes. Made them dependent on online shopping to fulfil their daily needs. While this was necessary for the time being, it also made us addicted to the convenience of shopping from the comfort of our homes. It showed how we can purchase almost everything without ever having to physically visiting the stores. e-commerce, hence, witnessed phenomenal growth during the COVID era and became an essential feature of modern man's life. Of course, this was possible because of the growth and development of ICT.

2.2.2 Development and expansion in mobile technology

The massive growth in the number of online buyers over the last few years can be attributed to the remarkable growth and development in the application of mobile technology on the back of

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higher global penetration of internet connectivity which has made online shopping increasingly convenient [9]. The number of internet users, globally, has crossed 5 billion and is still growing [10]. The expected number of digital buyers in 2024, was 2.71 billion - 70 million over and above the number reached in 2023, which translates to a 2.7% year-over-year increase, and is expected to reach 2.77 billion in 2025 [11, 12].
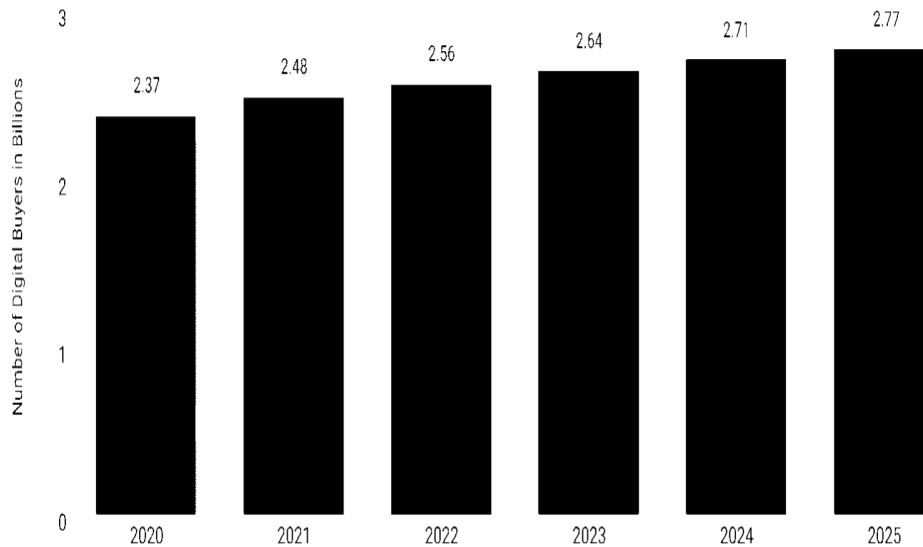

Figure 2: No. Of People Shopping Online (Source: eMarketer)

Cloud storage, wireless technologies, affordable sensors, and the internet of things, are some of the aspects of latest information systems, that act as the technologies supporting artificial intelligence. Nowadays, it is possible to connect business processes and value chains both within and across an organization. It is possible for organizations to apply smart devices, mobile applications, and point of sale (PoS) technologies for accumulating real-time customer data pertaining to behavior, demography, and geography that can help develop and then deliver precise products and services in a timely manner. Employing robotics and system automation, such applications help in improving business functions while allowing marketing to more precisely understand and estimate of customer's demands [13]. Corporate innovation investment drives are strongly connected with the digitalization of the manufacturing industry and the supply side of e-commerce which has ultimately resulted in the huge expansion in the number of online stores [14].

Digital transformation now plays an increasingly significant role in operating decisions of modern enterprises, in both manufacturing and service sectors [15]. In a similar manner, technology has now turned into a major growth driver in e-commerce. Last 5 years have witnessed magnificent technical advancements such as AI, machine learning (ML), augmented reality (AR) and blockchain, that brought in a new era in the e-commerce industry. With e-retailers leveraging technology for analyzing buyer behavior and offering customized recommendations to the consumers, personalization has become the key feature typifying contemporary online shopping experiences [16].

According to an article published by McKinsey & Company [17], despite being well lubricated, a logistics chain can be wasteful, especially during transaction between two parties while handing over goods on their journey from manufacturers to warehouses to retail stores and consumers' homes [17]. From personalizing product recommendations to streamlining SCM, AI and ML are leading this e-commerce revolution with their capacity to analyze enormous volumes of data for generating valuable insights that assist in immensely improving shopping experiences of the customers [14].

2.2.3 Disruptions

Global supply chains are immensely impacted by the Geopolitical events. Such regulatory obstacles as sanctions, can impede access to raw materials

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including critical components, to suppliers, and even to markets [18]. The recent incidents have already demonstrated this aspect. The global supply of oil and natural gas have been disrupted by the sanctions imposed on Russia. Similarly, the Russia-Ukraine war and the Middle Eastern unrest resulted in the Red Sea crisis and led to rerouting of ships. All these have caused global supply chains disruptions [19].

Where the systems supporting the supply chain undergo failures, or suffer from vulnerabilities or weaknesses, technological disruptions normally take place induced by a number of factors such as software glitches, equipment breakdowns, and power outages [20]. Disruptions from emerging technologies have facilitated the emergence and rapid expansion of quick commerce.

2.2.4 Need for speed - Growth in Quick Commerce

The US quick commerce market is undergoing rapid expansion fueled by the changing consumer needs for both convenience and speed. QC is a novel trend in e-commerce where speed is of utmost importance and customers' orders are fulfilled and delivered within hours, not days [21]. The growth of e-commerce giants such as Amazon and Walmart providing same-day delivery options has magnified the demand for quick and efficient fulfilment to a never-before proportion.

For e-commerce logistics ecosystem across the board, the development and expansion of QC have profound implications. QC has redefined consumer expectations and established new delivery performance benchmarks through prioritization of speed and convenience. Consequently, conventional e-commerce players have come under a lot of pressure in order to adjust, modify and restructure their business operations, especially the logistics part, to retain their competitiveness in market that is becoming increasingly dynamic [22]. Among the supply chain procedures, responsiveness has assumed a lot of importance since the consumers demand expeditious delivery of custom-made products and peculiar services [13].

2.3   Article's Contribution

The topic of supply chain resilience (SCR) is well covered by literary work. However, there is dearth of articles on quick commerce and the related issues and the ways in which technology can provide a solution. These topics and perspectives being relatively new

there is still significant scope for research in this area. This article looks at the problems of SCM from the angle of rapidly developing QC and application of modern-technology as a solution and a way to build sustainability.

3.   Methodology

To present an in-depth analysis of the subject matter, this qualitative research scans and scrutinizes published literature and data on the same. The textual part presents theoretical concepts, data and examples sourced from a large number published materials that can be accessed using the internet. These includes journal articles published in renowned peer reviewed journals such as IJSCM and newspapers, articles in business periodicals and other reputed publications, and reports published by renowned organizations such as McKinsey &Company. The data is obtained from research publications and to the best of our knowledge is authentic. The charts and diagrams have been prepared using these data. They provide a visual representation and are helpful in crisply displaying the crux of the data and in bringing out their significance

4.   Discussion

4.2   Rapid development of Quick Commerce Caused Operational Challenges

The turn of events mentioned above expedited the development of QC. Industry 4.0 has brought in digital revolution which worked in tandem with global disruptions such as the COVID-19 pandemic, to alter and influence global supply chains [23]. Pollution, global warming, and other persistent problems continue to expose supply chains to operational challenges. Of late, these disruptions begun to affect the supply of crucial inputs, including steel and semiconductors, together with such essential consumer products as formula food for babies, presenting substantial challenges for global businesses. The impacts get further intensified due to geopolitical tensions, technological advancements, and changes in labor market, which keep adding fresh layers of both risk and complexity to prevailing business operations. However, these challenges can be blessings in disguise, bringing in new opportunities to drive business growth [24].

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4.2.1 Putting Pressure on Supply Chain

QC prioritized speed and convenience and in the process redefined consumer expectations, setting fresh benchmarks to be matched by logistics and operations management. Consequently, traditional e-commerce players have come under a lot of pressure due to increasing need to adapt and streamline their logistics operations to remain viable in a highly dynamic and fiercely competitive market that continues to pick up speed every moment. Speed and accuracy are at central to operational efficiency and determine the success and sustenance of an e-commerce player. Ultra-fast delivery feature is unique to quick commerce and the prime reason behind its success but this emphasis on Ultra-fast delivery is also creating severe pressure on SCM in the U.S. since it demands utmost efficiency in logistics networks, as it requires nearly instantaneous fulfillment of orders. This, in turn, is putting significant strain on inventory management, specifically in urban areas that are densely populated and where there is need for minimizing delivery times fighting against odds such as traffic congestions [25].

I. First Mile - Warehousing and manpower

For e-commerce businesses, first mile delivery (the very first step in the supply chain) refers to the process of picking up products from a merchant and then passing them on to third-party logistics or courier service so that they can be delivered to the customer. It is therefore the first step in successful order fulfilment [26]. A significant hurdle faced in first-mile delivery pertains to labeling and packaging. Shipping damages can result from insufficient packaging. A key challenge of first mile logistics is poor visibility that eventually affects not only mid-mile operations but also adversely impacts the last-mile processes [27]. Providing accurate details about buyers is necessary for ensuring that there are no delays caused at customs during overseas movement of packages or during interstate movement of products [28].
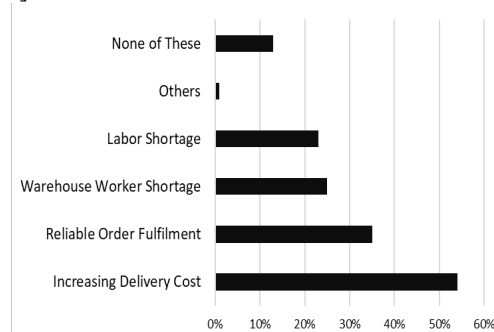
Figure 3: Major challenges faced by logistics providers in all-mile delivery in the U.S. [29]

In the quick commerce industry, the "first mile" problems primarily involve issues with accurate and efficient product picking, packaging, and documentation at the warehouse, often leading to delays due to poor inventory management, improper labeling, inadequate packaging, and a lack of real-time tracking visibility, ultimately impacting delivery speed and customer satisfaction; this is especially critical in quick commerce where fast delivery is key [27].

Manually carrying out every first-mile-related operation generally leads to mammoth expenses and obviously errors. Generally, it will lead to poor operational visibility and difficulties in tracking product [30]. Naturally this would cause lack of optimization the obvious outcome of which is significant cost escalation while transporting the goods.

II. Middle Mile

In the context of quick commerce, middle mile logistics primarily faces such problems as: inefficient route planning, complexity of coordinating more than one mode of transportation, issues related to effective inventory management, possibility delays caused by geographical factors, elevated operational costs, and the necessity to respond rapidly to demand fluctuations. Every one of these problems contribute towards making it increasingly challenging to deliver goods economically, swiftly, and proficiently from the large warehouses to smaller fulfillment centers to get them ready for last-mile delivery [31].

Due to the huge number of variables that have to be considered for arriving at optimal routing decisions, the process is extremely complex and the complexity has all the more increased due to quick commerce [32]. Several big e-commerce retailers transport adequate freight volumes for operating private networks for middle-mile consolidation to help in order fulfillment, transfer of client shipments from stocking locations to last-mile delivery partners in combined loads in order to bring down freight costs [33].

III. Last Mile - Problems of Logistic Support

This stage involves transporting the packaged finished product to the buyers' doorstep from the courier company's warehouse [28]. This stage involves significant costs and most companies will not pass it on to the consumers to avoid losing them to peers. Hence, budget management for this stage has emerged as a key challenge, together with substituting for the added expenses. It is getting all the more testing with omnichannel retail and same-day deliveries surfacing in the ecosystem [27]. Inadequate technology and absence of a seamless

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supply chain process pose significant threat to the timeliness of deliveries which is the key differentiator when it comes to quick commerce.

10-minute delivery – a new-fangled feature of modern commerce puts relentless performance pressure on e-commerce operations, especially logistics. The logistics costs are rather bearable in smaller cities and towns where the cost associated with warehousing massive volume of goods is lower compared to big cities where the cost of warehousing large volumes of products becomes exorbitant and sometimes prohibitive when compared with average order size [34]. The shortage of skilled labor is also daunting.

Warehousing and manpower are the major elements that generate significant costs which cannot be passed on to the consumers because an average consumer is eager to spend very miniscule or zero amount for the delivery of the products they purchased online. For them the cost of online shopping should be no more than buying from a brick-and-mortar shop. Despite the convenience of shopping from the comfort of their home, they are reluctant to pay even a small premium for faster delivery. Hence, compared to conventional online grocery and food delivery, the margins in quick commerce are significantly low [35].

4.3   Need for operational excellence

Contemporary supply chains have become highly intricate and complex due to globalization and other economic transitions and trends especially the move to e-commerce. Their blueprint, configuration, efficiencies, interactions, development, and management throw major challenges for e-commerce companies [24]. To survive in fiercely e-commerce arena early adopters of AI-enabled supply chain management has become necessary. It provides such benefits, reduction in logistics costs by15%, 35% more accurate in inventory accounting, and 65% growth in service levels [36].

4.3.1 Maintain competitive edge
Integrating e-commerce with operations management improves operational efficiency and is most likely to enhance customer satisfaction, besides helping the company be avant-garde. Efficient e-commerce operations lead to cost savings alongside better productivity resulting in upscaling the business together with expanding online store presence [37]. For today's supply chain It has become increasingly important that leaders assume a holistic perspective supported by cutting-edge technology, such as Artificial Intelligence, at their earliest to beat the curve [25]. Not employing

fleet management software or other tech-enabled platforms and manually performing operations related to first-mile-related magnifies costs and errors together with offering poor operational visibility, inefficient tracking, and inadequate optimization of operations [30].

A middle-mile delivery system that is efficient brings significant benefits to logistics and SCM through cost reduction and superior customer satisfaction. Optimization of middle-mile management can help to achieve speedier deliveries with higher accuracy of Estimated Time of Arrivals (ETAs). For e-commerce enterprises, this creates a competitive edge [31]. Large U.S. shippers including The Home Depot, Wayfair, and Amazon, dynamically manage large-scale middle-mile networks to ensure e-commerce fulfillment. Amazon was among the pioneers. Presently, they assemble outbound truckloads of packages from Fulfilment Centers and send them directly to Amazon Prime delivery stations or devoted intermedia000te sort centers or third party (3P) parcel carrier facilities [32]. It is, therefore, understandable why optimization of middle-mile logistics almost certainly leads to superior last-mile delivery performance. The key to reducing setbacks in the last mile is having a seamless central transportation phase, which remains frequently burdened with complexities arising from uniqueness of delivery locations and the need to make multiple stops.

4.3.2 Retain Consumers & Expand Customer Base
The quality of customer experience offered by an e-commerce business is its key survival tactic. An effective SCM makes a lot of difference when it comes to providing superlative customer experience since it ensures on-time delivery of orders without any compromise on product quality. This also helps the company earn positive word of mouth and hence referrals which eventually helps to expand the business by widening the customer base while retaining the existing ones [2]. The enhances quality of service ensures repeat customers that bring in revenue recurrence, a key to maintaining if not expanding topline.

4.3.3 Sustainability
Generally operational excellence encompasses all-inclusive, systematic, and technological practices and procedures for industrial applications such as AI, Internet of Things, Blockchain, Machine Learning, Lean, Six Sigma, and Inter-organizational Information Technologies, etc. Besides improving performances of conventional supply chains, these measures strengthen their

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structures and ensure sustainability. Role of IT has been paramount in reinforcing strategies for achieving logistical operational excellence in e-commerce in general and QC in particular. A key function of IT is linking various logistics network participants such as producers, transport companies, retailers, and final consumers, using efficient information management. Fast pace IT adoption by Logistics Service Providers (LSPs) over the last few decades are attributable to the countless benefits derived from efficient operation management, including higher productivity, lower operating costs, improved transparency, and on-time goods delivery [38].

Sustainability demands restructuring of supply chain strategies, urging firms to increase transparency of their environmental impact and implement logistics practices having better chances of meeting the organization's ESG (Environmental, Social, and Governance) goals. Such sustainability initiatives as optimization of transportation routes for reducing fuel consumption while focusing on renewable energy sources and optimizing energy uses, help firms conform to growing regulatory demands, and meet the forever-growing expectations of consumers and investors prioritizing ESG metrics [25].

Modern consumers do not just desire fast service but also demand transparency, customization, and sustainability. AI holds lot of promises from the perspective of improving SCR. The literature on application of AI in SCM is still fragmented, with a dearth of comprehensive decision-making framework that can be used to identify and apply AI techniques effectively to promote SCR.

4.4   Technology to the Rescue

To keep pace with fast evolving consumer demands, supply chains are implementing technologies that provide personalized service options and real-time product tracking. Advanced analytics is crucial for comprehending and anticipating consumer behaviors, allowing businesses higher inventory management efficiency while reducing wastefulness. Integration of responsive logistics solutions allows businesses to satisfy existing consumer demands alongside adapting to forthcoming innovations and expectations. Data management, cloud computing, progresses in deep learning, development of data-based AI, integration of AI in operations and improvement in computing abilities of machines, are the key factors driving achievement of operational excellence using AI. AI can anticipate order volumes and interpret demand trends, by leveraging predictive analytics. This helps to align

stock levels with buyer needs preemptively. Streamlining inventory picking is possible using advanced AI-driven robotics while operational efficiency can be enhanced using intelligent systems to achieve optimal warehouse layouts [39].

However, barriers exist to adoption of AI. These are inadequate employee skills, cultural limitations, anxiety and apprehensions about something unknown, inadequate knowledge and lack of strategic planning for AI adoption [40].

4.4.1 Using Advanced Technology in SCM and Logistics Management

In view of the ongoing modifications being experienced by global SC and production network systems in advancing business environment, IT implementation has become imperative for driving operational excellence approaches in logistics sector [38]. Development of novel technological procedures and progresses in production intelligence positively impact strategies, decision-making, and operations management. Companies employ advanced technological solutions for extracting crucial information, like big data to develop automatic production capabilities, while systematizing business affiliation which helps to identify obstacles in improving organizational performance, including defect identification, equipment management, cycle-time reduction, demand speculation, human resource, and bioinformatics [40].

AI is among the most disruptive modern technologies. The concept covers statistics, mathematics, humanities, social sciences, philosophy, computer sciences, and operational management. AI is replication of human behavior, in terms of cognitive functions, by machines [13]. Evolution of novel technological procedures and developments in generating intelligence for machines generates positive influence on strategies, decision-making, and operation management included in the production of products [1]. AI can be used to automate mundane human tasks such as labeling to prevent human errors. In case of delivery logistics AI can analyze real-time traffic data for identifying shortest or fastest delivery route for both manually driven and autonomous vehicles. The process considers various relevant factors including road closures, accidents, and congestion.

4.4.2 Utility of AI in Solving Operational Problems

SCs are benefiting from investments and increasing interest in AI technologies [41]. Modern information systems, for instance wireless

technologies, affordable sensors, the internet of things, and cloud storage, are among the key technologies reinforcing AI. The supreme goal is fulfilling increasing customer expectations. They want shorter lead times, faster deliveries, and personalized experiences. Contemporary business owners leverage AI for achieving better efficiency and dexterity as traditional methods fall short in achieving competitive advantage [42]. AI-based workflow automation, and generative AI-driven contextual communication are two of the several solutions that have been develop by software Technology companies, shippers, and carriers that are aimed at streamlining coordination and communication [17].

Real-time data from websites, social media, and other places, are used for applying predictive analytics to forecast customer recommendations and business outcomes. Companies such as AWS and Coca-Cola have used predictive insights to set sales and supply chain targets. AI is used by eBay for providing personalized recommendations and customer advice, improvement in shipping and delivery times, product pricing, building seller-purchaser mutual trust and more. AI is also seen in such areas as eBay's image search and automated web page translations that assist buyers to fin quickly whatever they are looking for. Amazon and Walmart use AI-based marketplace optimization platforms that allow them to generate and handle advertisement campaigns, automate search engine optimization (SEO) growth along with tracking insight and inventory data [43].

Labor shortages, especially truck drivers and warehouse workers, have urged companies to reconsider their workforce strategies. AI and automation are increasingly becoming crucial for filling in gaps and improving productivity [25]. AI is there to replace human where work is mundane and repetitive. The technology can easily be deployed to deal with worker shortages to an extent.

In case of inventory management, where tracking and managing stock levels ensures operational efficiency, AI systems can simplify tasks significantly. Physical counting and stock taking, data entry, damage detection, real-time insights into inventory status, demand, and supply through analysis of data drawn from past transactions, sales, and suppliers — can be automated and be done away with in most cases. Amazon applies computer vision AI system for identifying damaged items. Trained using images of both damaged and undamaged products, this AI is thrice more efficient in detecting damage compared to human workers. While streamlining the pick-up and packing process, this system diverts flawed items for additional inspection while ensuring prompt packaging and shipping of undamaged items [44].

5. Conclusion

Modern business ecosystem being extremely volatile and chaotic, e-commerce player face challenges that range from natural disasters to geopolitical disruptions to global pandemics. Flexible and resilient supply chains and operational efficiencies have become imperatives to overcome emerging obstacles. Application of AI towards this direction has proved to be advantageous enabling faster decision-making, briefer cycle times, enhanced operational efficiency, and continuous upgrading. QC, a rather recent development, has magnified the problems faced by delivery logistics in e-commerce. As an advanced technology AI has turned out to be the philosophers' stone, converting challenging processes simultaneously into efficient and transparent ones.

Integration of e-commerce and OM is necessary for business evolution in the U.S. e-commerce efficiencies have become highly important, specifically is respect of demand fulfilment, measuring up to customers' expectations, cost rationalization, error minimization, and growth propulsion in the fiercely competitive online market. For an e-commerce enterprise both success and sustainability depend on the success of such integration. AI targets creating computers or machines to perform tasks that generally require human intelligence [13]. While this can make operations streamlined and error free, there could be retaliations from workers who are being replace by machines. Despite the fact that QC demands speed that can only be ensured through higher levels of automation, there enterprises need to be careful so as not to antagonize the labor.

While this article proves that AI is crucial to achieving operational excellence in e-commerce, it also underscores the importance of understanding the problem of using AI technologies and the difficulty in integration into modern society. There are ethical problems involved which U.S. must start to solve to ensure wider adoption. Technology is necessary but not sufficient. Retaining skilled labors ia a must and it requires improving working conditions and better pay packages. This article highlights the usefulness of adopting AI technology to ensure operational excellence. The focus has been on QC due to its unique feature. It also sets the stage for further research into the need for workforce development and engagement to help ensure easier adoption and integration of AI

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technology into operations and creating a reliable, skilled team that is ready to meet new challenges that keep emerging for QC businesses.

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