Leveraging Artificial Intelligence in Supply Chain Execution in E-commerce

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***Abstract*— Modern perspective of consumer satisfaction has changed due to the proliferation of online businesses. E-commerce has opened up a whole new world to the consumers. The consumers can now get what they want, when they want, delivered at their doorstep. While the ease of online shopping has increased consumerism and consumer demand, it poses significant challenges for the e-commerce players as the consumers are seldom willing to shell out money for availing the convenience of doorstep deliveries. Under such circumstances, the e-commerce players are left with little choices but to significantly enhance their supply chain efficiencies through the improvement of logistics and the delivery services they offer to their customers. Artificial Intelligence or AI, as it is popularly known, is altering the ways and means of these e-commerce businesses. It is changing the manner in which supply chains are managed. Through the use of smart algorithms, data analysis, and automation, it is possible for businesses to employ AI effectively for the optimization of their supply chain management involving inventory and logistics management, demand forecasting, and customer service. This article focuses on logistics management and the application of AI to optimize costs and efficiency in first mile, middle mile and last mile delivery.**

***Keywords*—** *Artificial Intelligence, AI, e-commerce, logistics, logistics management, supply chain, supply chain management, mile, delivery.*

1. Introduction

The logistics and supply chain management spectra has been pervaded by Artificial Intelligence (AI). With the ever-increasing volume of operational data becoming available and the ongoing innovations in data computation capacity provides novel prospects to improve decision making in supply chain operations. Data gets generated both from digital logistics applications as also through the application of IoT (Internet of Things) where these assets are connected digitally to generate continuous logistical data. Workflows can also be optimized and made seamless through the use of AI powered automation. [1]. This paper tries to delve into and interpret the opportunities of AI in logistics segment of supply chain management. This qualitative study attempts to through light on the ways in which the AI technology can be employed to optimize First Mile, Middle Mile and Last Mile delivery of a manufactured product.

2. Literature Review

Digitization of logistics operations is a relatively recent breakthrough and this has only been possible due to enhanced bandwidth and the real time interactions between IoT assets and onto a data processing and repository facility. It is now possible to monitor machines, freight vehicles and mechanical devices using advanced sensor technologies which enable all kinds of data capture on a real-time basis [1]. Additionally, when sensors become redundant due to data connectivity or any other issues it is possible for the operators/ drivers to provide information on current status and feedback on variety of parameters through mobile and harness devices. This widespread web like connectivity is coined as the fourth industrial revolution or referred to as Industry 4.0.

One of the most important of modern technologies driving industry 4.0 and taking the world towards the digital future is artificial intelligence (AI) which is defined to be the capacity of machines to interact with humans and communicate with them and replicate human capabilities [2]. Technology

has now become not only an important part but also an integral part of modern life, with a large number of factors pushing, enabling, and steering this transition. The customers are becoming increasingly tech-savvy and they now ask for faster and seamless digital experiences and seek and expect instant gratification of their needs. To handle this changing consumer behavior, firms are changing the manner in which they conduct their businesses by hastening the application of technology and re-discovering the processes, streamlining organizations operations, and restructuring business models [3]. All these necessitate the wider spread of robust network connectivity.

This tentacled connectivity makes real time visibility and monitoring possible over all extended workflows. To draw a parallel from the airline industry, a "Digital control tower" akin to the Airport control tower, is able to provide oversight notifications of possible shortfalls in inventory or likely bottlenecks appearing in process that may increase waiting time for other players in the workflow even before they appear and thus help to avoid such scenarios by taking pre-emptive measures [1]. Usage of not-so-complicated control algorithmic can provide directions to frontline teams who can correct their course of action and mitigate the risk before it crops up as a major issue in the system. Added to this the availability of historical data make these algorithms very complex and intricate thereby adding more intelligence that can better define the control rules besides providing enhanced decision-making capability to the control tower. Predictive analytics take lessons from historical data to paint patterns and correlations inherently invisible to the human eye [4].

2.2 Growth of e-commerce business in recent years

In the recent era, the proliferation of e-commerce business in various parts of the globe has been influenced by a variety of factors. The most important among them is the changing nature of the consumer behavior, as has been discussed in the above paragraphs. Other factors include culture, buying power, growth and development of information and communication technologies (ICT) which includes penetration of internet and increased use of mobile devices that have made access to online stores easier alongside ease of payment [5].

Manufacturers of physical products have also turned to the Internet as a direct channel of distribution. The direct channel poses a different set of decisions and challenges from those in the existing "bricks-and-mortar" retail channel. These two channels differ in customer types, operations of order fulfillment, cost structure, profit contributions, priority in rationing, logistical requirement, expectations of service quality, degree of market segmentation, access to demand/supply information, and returns policies

2.3 Challenges faced by e-commerce businesses

The internet has changed the way modern businesses interact with each other and with their customers. An increasing number of companies are opening their online souks and a larger number of customers are now placing their orders online with the e-retailer of their choice. With the passage of time and with the development in ICT, operations are becoming increasingly complex. The web has, therefore, changed the ways in which the companies manage their supply chains especially in the era when a substantial portion of shopping by the customers happen online and the delivery is timed in a manner that is most convenient for the consumers. Customers can now choose the time of delivery of the product and the retailers have no choice but to oblige. The products are often delivered to the customers' doorstep, that too within the same day of placing the order. These are the defining factors that differentiates one e-retailer from its rivals. An efficient product delivery is hence an important attribute in creating the competitive edge that entices customers. There are several challenges that are being faced by modern e-commerce businesses. Following are the broad description of the trials faced by today's e-commerce businesses.

2.3.1. Management of Inventory

A key challenge for e-commerce businesses is to maintain the balance between demand for and supply of their products [6]. Demand is dynamic and for several products is highly dependent on such variables as season and festivities [7]. Accordingly, the biggest test for an e-commerce enterprise is to maintain a lean inventory by doing a tight rope walk to maintain

their supply in line with the demand of their produce. The perils of maintaining a high level of inventory is wastage, obsolescence and high cost of inventory storage. On the other hand, with too little inventory there is a risk of a gap between demand and supply resulting in stocks getting sold out and a large part of the demand remaining unfulfilled, resulting in loss of sales and unsatisfied and unhappy customers.

2.3.2. Forecasting Demand

Appropriate demand forecasting is directly related to the success of supply chain management (SCM) of any business. Modern manufacturing companies are faced with several continuous challenges due to uncertain and dynamic markets [8]. Hence, demand forecasting is becoming increasingly important for making the right managerial decisions. Any effective logistics management system is generally based on sub-system of demand forecasting. [9]. Projection of demand, especially during times of peak demand such as the festive season, promotions and special events, becomes an imperative factor driving production and capacity utilization.

2.3.2. Customer service

E-commerce enterprises are constantly appraised on the quality of customer service they provide and this becomes a benchmark to retain and satisfy customers. A high performing and lean supply chain contributes to the business by making it more efficient and attentive to consumer requirements – simultaneously helping to serve customers by promptly providing them their wanted products at designated location and enhancing the organization profitability and doing their part in the sustenance of the supply chain [10].

2.3.4. Optimization of Logistics

For companies operating in the retail industry efficient logistics management is their key to success. Economically viable, fast, and dependable shipment of the end products to customers is another challenge for e-commerce enterprises. Both timing and accuracy are essential elements that keep the customers happy. With the growth in popularity of online shopping, it has become essential for most businesses to implement efficient logistics practices to satisfy customers alongside cost rationalization in order to create and maintain their respective competitive edges [11]

2.4 How AI can help in Supply Chain Management

Supply chain management (SCM) and operational capabilities are crucial to a company's competitive prowess. SCM refers to the handling of the whole gamut of activities from the procurement of raw material to the delivery of the finished product to the customers. In today's context this delivery may even take the form of doorstep delivery. Artificial intelligence has turned out to be very beneficial for the modern ecommerce businesses as the technology helps to deliver exceptional customer experience besides facilitating intelligent decision-making in businesses by utilizing relevant consumer data. Ecommerce uses AI in powerful ways in the online shopping space. [12].

Figure 1: Leveraging AI in SC

2.4.1. How AI can Help in Inventory Management

AI can help to solve this problem by churning data pertaining to sales history, purchasing behavior of customers, market tendencies and various external factors such as festive jump in sales etc. to forecast the optimum inventory levels that need to be maintained for individual products at each specific location of stores, etc. In addition to this AI can also help in the automation of the process of inventory replenishment, ordering new stock as and when required which helps to avoid both overstocking and understocking of goods.

2.4.2. How AI can Help in Demand Forecasting

AI can help forecast demand, through the application of advanced machine learning techniques, by analyzing historical data, trends driving the market, preferences of various customers and external factors like weather reinforcing customer behavior. AI can further help in defining pricing strategies and marketing tactics

based on demand forecast thus helping to maximize revenue and profitability. By using these technologies, logistics demand forecasting becomes not only more reliable but also more agile and self-adjusting, with better insight into changing market conditions in the real-time perspective [9].

2.4.3. How AI can Help in Customer Service

AI can improve customer service through the employment of voice assistants, chatbots, and natural language processing for answering common queries which provide information and also log complaints which are handled by the company following due processes [13]. Personalizing customer experience by customizing catalogues, segmentation of customers and thereby offering relevant products, offers and content to target specific customer segments can also be achieved by AI [14].

2.4.4. How AI can Help Logistics Management

Artificial Intelligence can help a business make superior and speedier decisions for its logistics operations, such as allocating resources, managing risks, and solving problems [15]. AI can help optimize logistics by finding most convenient routes, modes and freight for the shipments. It provides the scope for real time monitoring, sends prompt alert notifications in case of delay, route disruptions and other risks [16]. AI can also be instrumental in reducing the carbon footprint of the enterprise by helping to choose eco-friendly packaging and freight options for packaging and transportation. Artificial Intelligence can be construed as a key enabler for Smart Logistics [17]. The technology can be used to automate routine tasks in order to reduce costs, improve efficiency and provide better customer service

3. Application of AI in Logistics Management to Optimize Costs & Efficiency

The global logistics industry is predicted to grow at a CAGR of 8.5% between 2022 and 2027 [18] driven by exponential growth of e-commerce sales, greater adoption of contact less delivery and rising demand for express delivery services [19].

The ever-increasing challenge faced by online retail operations is to streamline their supply chains in order to be able to cater to increased demand while ensuring profitability is maintained if not enhanced [20]. Ecommerce have applied and implemented AI in powerful ways in the domain of online shopping [12] to not only handle customer interaction but to also handle logistics effectively – an important activity the ensures that the customers remain happy and satisfied.

AI is the principal driver of the transformation of eCommerce delivery [21]. If one were to revisit the evolution of logistics industry, it is nothing very unique compared to other industries. Just like several others industries, logistics has always aimed at achieving cost-optimization. Digitization at an increasing pace along with usage of other technologies have been able to curtail the turnaround time for online services constantly, which is why today's customers have started to expect and even demand, more prompt delivery service levels. This trend is particularly evident in last mile delivery or the final step of the delivery process where the finished product is delivered directly to the customer [22].

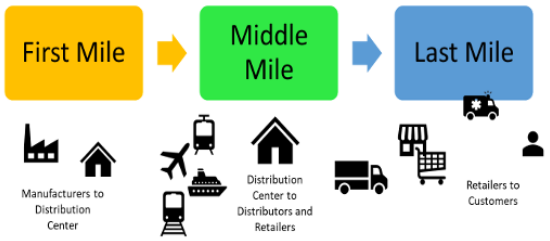

Figure 2: Relation between First, Middle & Last Mile Delivery

3.2 AI & First Mile Delivery

As the first stage in the supply chain, first-mile delivery has a significant bearing on the way an ecommerce business performs [23]. First-mile delivery refers to the transportation of products or orders from a merchant's or retailer's warehouse to the next stop of the shipment process [24]. First-mile could have different connotations for different platforms. To cite an example a manufacturer would see it as the shipment of finished products from the manufacturing and packaging plant to the distribution center or warehouse. Whatever be the platform, first-mile delivery would usually be the initial stage of the whole transport and logistics process [25]. In cargo transport, the first and last mile are the most expensive parts [24]. Many a times businesses undermine the importance of first mile delivery but any delay or mishap in the first mile delivery will ultimately adversely impact last

mile delivery through domino effect. The root cause of several of these inefficiencies is improper purchase ordering [23].

AI can help in the optimization of first mile delivery through automation of such tasks as mapping the supply chain, analyze the data, understand customer demand to plan strategic locations of warehouses, study inventory turnover data to understand when to replenish inventory. Manual labeling which is still in vogue in most businesses causes delays and errors due to such issues as incomplete address details. AI could be used to automate the process. Continuous collection of data is necessary for the optimization of first mile delivery. This data can be analyzed and interpreted to generate valuable insights pertaining to the different timelines such as time to ship, time to stock, time for transportation, shipping damages, etc which is essential for successful optimization. AI makes all this possible without the problems of human flaws of errors and omissions and within the allotted time [26]. The shipping experience of an e-commerce business is directly influenced by the first mile delivery stage which is why its optimization will give rise to significant downstream gains [27].

3.3 AI & Middle Mile Delivery

Supply chain complexity is ever increasing and the tag along growth of third-party logistics service providers in middle-mile activities in the retail sector is also visible. These factors catapult the middle-mile as the main focus area for optimizing efficiency and cost [20]. Although this phase of logistics is often overlooked by those who are not from the industry, the middle mile of any retail supply chain is the phase in which activities of major importance in the supply chain take place. Inbound logistics, outbound logistics, consolidation, sorting, and inventory management are all part of the middle mile and a lot depends on the efficiency of these activities.

In the complex world of e-commerce and supply chain management, middle-mile logistic management has developed as the key element that regulates the very pace of the supply chain process. Middle mile is that part of the supply chain domain in which both meticulousness and synchronization between the delivery drivers and the operation managers assumes paramount importance. The reason behind this is that this is the segment where the products go on board a journey to a number of fulfillment destinations, which ultimately decides the timely accomplishment of last-mile delivery. Despite the critical role that middle-mile logistics plays, it is riddled with challenges which apart from hindering its own productivity, also work towards casting a shadow on the vital last-mile deliveries [28]. The problem of erroneous routing between distribution centers is a significant threat and is a crucial challenge which has the potential lead to the elongation of delivery routes thus delaying delivery. Wherever there are silos breaking down information flow, there will be lack of visibility due to obstacles to critical data sharing which works against creating a transparent decision-making system. Integration of various tracking systems entail significant costs. There are also problems of delays in hub operations (encompasses such crucial activities as picking, packing, sorting and storing) which gets particularly painful in times of peak demand. With modern customers expecting greater visibility for deliveries that are time-critical, the dependence on the middle mile magnifies further and becomes crucial [29].

Various AI solutions can provide the much-needed visibility and control to business owners over the middle mile of the supply chain. Superior utilization of truck space along with prioritization of freight transport, determination of the best routes to ensure on time deliveries and better operational sustainability through the reduction in turnaround times and many such operational improvements can happen if AI is implemented in middle mile delivery. An effectively controlled middle mile logistics provides a strategic advantage over the competitors. Putting money into advanced logistics technology and processes can become the differentiating factor among the retailers in the market when it comes to attracting the customers through competitive pricing and better services. A supply chain the is fine tuned to reach the optimization level provides enterprise the flexibility to react quickly to altering market conditions, exploit opportunities and remain ahead of the curve [20].

3.4 AI & Last Mile Delivery

Last Mile Delivery stands for product transport logistics over the last part of the way to the end user. In freight transport, like the first mile, the last mile is also very cost intensive [24]. Considered to be “the most important element of the process of

processing all order" last mile delivery forms that part of logistics which covers the whole range of activities from the direction of the delivery vehicles to the physical distribution of products and thus plays a crucial role in ensuring the delivery of the right product, in the right quantity and within scheduled deadlines, to the right consumers. For e-commerce, where the delivery date (for certain products where the delivery occurs on the same day, it is the delivery time) is always intimated to the customer at the time of confirming the order. Failing to adhere to this deadline will mean loss of reputation and hence loss of business.

A huge issue is that the customers don't wish to spend substantially for shipping. Most would prefer a free delivery — even for same day shipping. As per "Small Business Trends", 28% of online buyers are likely to abandon their cart if they find the shipping price to be too much [30], irrespective of whether they want same-day delivery or delivery at a later date. This leg of logistics is the costliest but not much of the cost can be passed onto the customer to ensure that they don't switchover to rivals. In the world of e-commerce, switchover is neither tedious nor expensive for the clients. Hence, businesses would walk the extra mile to make the last mile delivery have a lasting impact on customer loyalty.

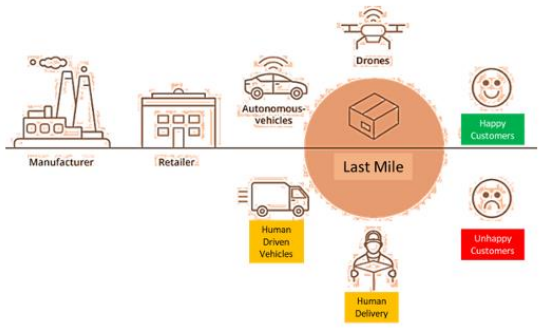

Figure 3: Application of AI in Last Mile Delivery

Application of AI in not just last mile coordination but also delivery, positively influences the last mile logistics. AI is capable of performing powerful calculations and facilitate machine learning. It can identify trends by securitizing historical data, investigate them, and forecast or anticipate specific patterns on the basis of its findings. It is possible to combine delivery options with AI generated situation analysis for determining the priority of specific orders in terms of processing and delivery which in turn increases the efficiency of the process [31]. Application of AI also aids in directing supply with better efficiency, which ultimately helps to drive profitability. Additionally, AI can assist retailers and specifically their shipping / delivery partners to better predict shipments on the basis of historical data, thus providing significant help to delivery services for advance planning of deliveries [30].

To ensure cost effective yet efficient delivery of finished products to customers, AI can be employed to perform a quick cost-benefit analysis to choose from the available delivery options. Using AI, e-commerce businesses can determine and provide the best possible last mile delivery by more efficient routing of deliveries while maintaining and even boosting profitability. AI together with streamlining processes, could aid e-retailers as also their logistics partners to predict shipments with higher accuracy using historical data, which can assist delivery services to formulate strategies and actions plans in advance to ride out the ebb and decline in consumer demand witnesses between festive season shipping, such as a Black Friday sale when the demand is nearly exploding and a dead-zone like the middle of February [30].

4. Discussion

Supply chain acts as the backbone of any business. When it comes to e-commerce logistics hogs the limelight. Timely delivery of products is of utmost importance in driving the success of any e-commerce business. The customers pick and choose products online and place order and expect their purchase to get delivered to their door step, on time and without any error. But errors are bound to happen wherever there is human effort involved. To reduce the errors of omission and commission, it is necessary to automate the mundane processes and keep the more sophisticated decision making for the humans. This is where AI becomes important.

4.2 Leveraging AI in supply chain execution

The ways in which modern businesses operate have changed significantly over the years due to such disruptive technologies as the internet of things (IoT), big data analytics, blockchain, and artificial intelligence (AI) [32]. Amidst the range of disruptive technologies available, artificial intelligence is the most recent technological disruptor and holds significant transformation

potential when it comes to supply chain management. SCM practitioners across the globe are trying to figure out which AI solutions would be best suited for their SCM endeavors. This article highlights the importance of artificial intelligence in supply chain management especially in the logistics segment and charts directions for future research. AI in collaboration with machine learning (ML) has the potential to revolutionize the industry by offering ways to optimize cost strategies that are more flexible, are better effective and have a higher degree of adaptability [16]. AI can be a powerful tool that helps by optimizing the supply chain and gain an edge over competition in the e-commerce market. Utilizing AI, businesses will be able to minimize costs, increase and sustain efficiency, improve quality of product or service being offered and, in the process, boost its customers' loyalty. Almost all businesses are using AI to optimize their supply chain.

AI can be employed effectively to gather rates, negotiate better terms for shipment of products, management of carrier contracts, etc. The AI-driven data platforms are capable of not just mining the data but also analyzing the same to bring about cost efficiency besides developing efficient revenue-generating3 standards. The integration of machine learning or ML system into vehicles helps to make maintenance recommendations and failure predictions on the basis of both historical and real-time data, which aids in avoiding delays of vehicles that might be caused by blockages. The service can be bettered through the application of AI. Implementation of AI will make it possible for firms to analyze data related to transportation, such as evaluation, on-time delivery, and live vehicle tracking which in turn helps to make ultimate decisions pertaining to specific suppliers [33].

An area of concern is that wherever Artificial Intelligence is applied for the automation of mundane regular repetitive work, unskilled workers hitherto performing the job will be displaced. Otherwise, it will make no sense to have the job performed by AI and still retain the human labor for the job. It will, in fact, increase the cost. The whole purpose of employing artificial intelligence to improve efficiency while achieving cost rationalization would be lost. But there is not much talking about what will happen to the displaced or the retrenched labor. It is obvious that the low or unskilled labor would be the first ones to go. By virtue of their being unskilled there will not be many alternative employments within the organization. If the organization cannot absorb the displaced labor, then they have to look for alternative employment outside. It is doubtful that so many unskilled jobs would be created for the volume of retrenched labor. The obvious outcome, therefore, would be the steady rise in unemployment.

4.3 Academic Contribution

Logistics forms an indispensable part of e-commerce supply chain and a deciding factor in the success of the business. All 3 levels of delivery infrastructure have equal bearing on the effective fulfilment of customer demand. All 3 – first mile, middle mile and last mile deliveries need to be equally efficient to achieve this goal.

From the foregoing discussion it is evident that a significant volume of literature is available on the application of AI in last mile delivery. This article discusses the impact of AI on both first mile and middle mile delivery. Both are less discussed in modern literature on e-commerce despite the fact that failure in any of these levels will cause a trickledown effect impacting adversely not only the profitability of the company but also the company's reputation that is most essential in retaining old customers and adding new ones. This article sets the floor for further research on the topic.

5. Conclusion

Supply chain and logistics sector forms a critical component of the global e-business economy. It is vital to ensuring smooth transfer of finished products across the world. Today's business dynamics are different. The emergence and explosive growth of e-commerce has changed the way the customers want to be satisfied. Internet has made today's marketplace intricate and interconnected, facing a myriad of challenges, that range from inventory management to enhancement of overall operational efficiency, which necessitates immaculate coordination across several domains, encompassing scheduling, transportation, and customer service. While it has increased costs, the e-commerce business has little or no choice but to bear the costs while providing superior customer service. It also ensures survival and sustenance in the fiercely competitive e-commerce arena where players would compete constantly to maintain and expand customer base. Amidst such circumstances,

AI provides a possible solution to tacking the challenges through the automation of mundane tasks, optimization of routes, fortification of security, cost reduction, making them error free and faster, with need for little human intervention and in the process heightens customer experiences – a key success metric for e-commerce businesses.

In supply chain and logistics management, the application of Artificial Intelligence or AI involves using cutting-edge technologies to modernize processes, enhance decision-making, streamline operations, and increase operational efficiencies. AI algorithms analyze huge volumes of data to forecast demand with higher degree of accuracy, optimize routes, and efficiently manage inventory. Beyond a doubt, AI has emerged as the key differentiator bringing about significant changes in the way today's online businesses handle logistics and product delivery. By leveraging AI, it is possible for e-businesses to achieve improved operational efficiency while maintaining and even enhancing customer satisfaction as also profitability, without compromising on product quality.

Through the application of AI in logistics management, it will be possible to usurp several of the repetitive tasks leading to the automation of almost every workflow that is well-defined. However, it is our belief that AI will never be able to replace the logistics planner or make his / her job obsolete. AI serves through the enhancement of human capabilities and by empowering them in a manner that decision making becomes much easier. It is the need of the hour for every e-commerce company and modern e-businesses are spending handsomely on it and also creating scope for research and development that can further boost AI efficiency that will prove beneficial to the companies.

Everything said and done there will always be concern regarding retrenchment of labor. The rise in the number of disgruntled and displaced employees is not a healthy sign for any economy. So, while the impending wide adoption and application of artificial intelligence across the world would be desirable from the perspective of both the e-commerce players and their customers. so far as the quality of customer service if concerned, it is also essential to thing about the fate of the labor who would be displaced. There is need to find them alternative employment, train them and help them acquire new skills so that they can find employment. The continuously growing volume of unemployed labor would not be good for any industry or economy. It would be unsustainable making the adoption on AI, ultimately, futile.

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