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An Analysis of JD.com's Transportation System in Support of Operational and Logistics Activities

Jinshan Zhao [1,*]

[1] City university of Hong Kong, Hong Kong, China
* Correspondence: Jinshan Zhao, City university of Hong Kong, Hong Kong, China

Abstract: JD.com, also known as Jingdong, is China's largest online retailer and a leader in e-commerce, renowned for its vast selection of products, quality, and authenticity. Founded by CEO Richard Liu, JD.com has grown from a small electronics store into the third-largest Internet company globally, behind Amazon and Alphabet. It has pioneered advanced technologies like AI, robotics, and drones, transforming the retail industry. The company's extensive national distribution network covers 99% of China's population, allowing efficient deliveries, often within a day. JD.com's collaborations with Tencent, Walmart, and Google have further enhanced its logistics and customer experience. The platform's diverse transportation modes, including trucks, planes, and drones, ensure swift and reliable deliveries, while innovative self-driving trucks and automated warehouses streamline operations. JD.com continues to invest in software, data technologies, and sustainable transportation to maintain its competitive edge in the global e-commerce market.

Keywords: JD.com; logistics; transportation; drone delivery; autonomous vehicles

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1. Introduction

China's e-commerce platform Jingdong or JD.com is the largest online retailer in China as well as a leading e-commerce online shopping platform and the top-grossing online store in the country.JD.com sets the standard for online shopping through its commitment to quality, authenticity and a wide selection of products covering every major category from fresh groceries to homewares and electronics, serving hundreds of millions of Chinese consumers (Jingdong active customer accounts increased 24.8% to 387.4 million in the 12 months ended March 31, 2020)(Annual reports 2022).

The company was founded as a tiny offline electronic store by CEO Richard Liu. Today JD is the third largest Internet company in the world (No.1 Amazon, No.2 Alphabet). It is also a pioneer of advanced technologies that are transforming global retail. Richard's vision was to provide consumers all over China with access to high-quality, authentic products, even in less developed areas like his hometown in rural Jiangsu Province. However, because China did not have enough logistics and retail infrastructure, he decided to build his own network. This national distribution network now covers 99% of China's population and reaches more homes than other distribution networks with unrivaled speed and efficiency.

Using the vast amounts of data on its platforms and through strategic partnerships with Tencent, Walmart and Google, JD is creating a new shopping experience so consumers can buy whatever they want, whenever and wherever they want it. This technology

and infrastructure allow partners to build trust with Chinese consumers in a more efficient and sustainable way. Moreover, JD is widely sharing the retail technology and infrastructure, as a service. It is enabling the expansion of other retailers, industries and organizations for a positive impact on society.

JD.com currently employs more than 150,000 people, including thousands of engineers in China and Silicon Valley. They are working on AI, robotics, drones, autonomous vehicles and other cutting-edge technologies that are revolutionizing the industry. For-instance, in China's most far-flung regions, its delivery drones can cut a full day delivery time down to just minutes. Meanwhile, JD operates hundreds of automated warehouses and a last-mile delivery network that can ship more than 90% of orders the same or next day (Jeff,2022).JD works with and sources its products from the world's leading brands and suppliers, bringing high quality, authentic and imported products to customers in major cities, remote rural villages and international markets.

2. Basic Information of Transportation Modes Used by JD.Com

2.1. Warehouse Network

JD.com generated over 30 logistics parks as of March 31,2021,which are among the biggest and most automated intellectualized operation centers in Asia. JD.com also takes advantage of a network of more than 1,000 warehouses covering over 21 million square feet that include cloud warehouses' spaces (Jeff,2022).JD.com provides the software, brand and the core network connection. Some of the warehouses are owned by third parties but operated within the JD Logistics Open Warehouse Platform. Warehouses offer spaces for storing, robot (and human) picking and packaging with the use of tools like forklifts. Warehouses are seen as logistic nodes and the linkages are the trucks, planes and autonomous vehicles. JD has built a very large and labor-intensive physical network.

2.2. Major Transportation modes

Jingdong applies many different delivery methods. Some of the most commonly used methods will be analyzed. Land transportation involves the appliance of trucks, cold chain vehicles for fresh and perishable products, etc. This method is the company's most common method for generating freight, including line-haul transportation. Second, aircrafts are used for urgent needs and cross-border logistics networks. There are demands from Chinese consumers overseas and foreign customers, so air transportation is required. Furthermore, JD.com started to use automated transportation technologies that are faster, more cost-effective, easier to manage, such as drones.

3. Analyzing Transportation Modes

3.1. Domestic Ground Transportation Equipment

3.1.1 Introduction

Jingdong provides efficient logistics and delivery services. The company uses various types of ground transportation equipment to transport goods to customers, such as trucks, vans, electric bicycles, and scooters. Supported by China's extensive infrastructure network, trucks, and vans are efficient for long-distance transportation nationwide. They also have a strong loading capacity and can be refueled quickly, allowing for long working hours. These logistics equipment bring convenience to the company but also bring some negative effects, which is what we will discuss in this section.

3.1.2. Advantages

Efficient and flexible: According to Technavio's report (2020), one of the benefits that trucks offer in delivery is their impressive carrying capacity, which allows these vehicles to transport multiple packages per trip. This aspect reduces transportation costs and en-

hances the overall efficiency of last-mile delivery. By employing efficient routing and pricing strategies, it is possible to optimize such advantages further, thus mitigating environmental degradation caused by increased fuel consumption.

Traceability: The installation of GPS systems in delivery trucks and vans has made them a popular choice among businesses. This technology enables real-time tracking of packages, thus allowing for efficient delivery, reduced errors, and improved customer satisfaction (Allied Market Research, 2020). Through the use of GPS, businesses can precisely locate their vehicles, which facilitates accurate delivery timings, route optimization for cost-cutting measures, and prompt responses to customer inquiries. Furthermore, driver behaviors can also be monitored with this technology promoting safer driving. The maintenance of a secure and expedient fleet, which minimizes the probability of accidents or delays, is facilitated by GPS systems utilized by businesses.

Agility: Electric bikes and scooters, on the other hand, are better suited for navigating narrow streets and delivering packages to places that are hard to reach. They are instrumental in urban areas with heavy traffic and limited parking space. According to McKinsey Global Institute (2016), more than half of the world's population now lives in urban cities, and this number will keep rising in the future. Using scooters and electric bicycles can reduce traffic congestion and make delivering goods in urban areas easier.

Cost savings relieving financial pressure: From an economic viewpoint, Utilizing electric bicycles and scooters for delivery is a cost-effective choice for businesses. Silva, Amaral, and Bandeira (2023) asserted that electric bicycles have lower operating expenses than traditional delivery vehicles. Bikes and scooters require less maintenance and lower fuel expenditures, providing a more economical alternative for companies aiming to curtail their delivery expenses. Reduced operating costs permit firms to devote resources toward other aspects of their operations. Moreover, electric bicycles do not mandate costly insurance policies, thus diminishing the overall expense of employing them for delivery.

Convenient and easy to maintain: Electric bicycles and scooters are less challenging and less expensive to park than larger vehicles, particularly in densely populated urban areas. This strength reduces parking costs and saves valuable time for riders. Also, electric bicycles entail considerably lower operating expenses than cars, trucks, and motorcycles (Wamburu et al., 2021). The research indicated that electric bicycles have lower fuel and maintenance expenses, culminating in an estimated 62% lowr total ownership cost than cars. The result emphasizes that electric bicycles are a cost-effective option for businesses that necessitate last-mile delivery services.

3.1.3. Disadvantages

Traffic pressure and air pollution: While ground transportation offers significant advantages, it also presents drawbacks. Large delivery trucks require considerable space for parking and maneuvering, making it challenging to operate in densely populated urban areas. A large number of trucks and vans often leads to traffic congestion, lengthier delivery times, and increased costs. Moreover, for higher reliability and greater power, delivery trucks are usually powered by diesel engines, which are considered one of the largest contributors to environmental pollution caused by exhaust emissions (Reşitoğlu et al., 2015). Last-mile delivery, which primarily involves trucks and vans, generates a high proportion of emissions from urban freight (Silva et al., 2023). Furthermore, traditional delivery vehicles entail higher operating costs, including fuel, maintenance, and insurance expenses, which can significantly burden a company's finances.

Battery disposal problem: As for using electric bicycles and scooters, one of the main concerns is the disposal of lithium-ion batteries (LIBs), a severe environmental concern associated with these vehicles. LIBs are commonly used in electric bicycles and scooters, and they can leach toxic substances and pose a significant risk to the environment if not properly disposed of (Meegoda et al., 2022). The manufacturing of LIBs will also cause pollution since it releases toxic substances and heavy metals, which can contaminate the

environment, including air, soil, and water. (Li et al., 2018). During the production process, the energy required to produce LIBs will also contribute to greenhouse gas emissions, worsening climate change(Li et al., 2018).Moreover, recycling rates for LIBs remain low, leading to landfill and incinerator waste and further environmental pollution(Costa et al., 2021).

High accident risk: Using electric bicycles and scooters for delivery also presents a significant safety concern. With their increasing prevalence on roads, there is a higher risk of accidents involving these vehicles, resulting in fatalities and injuries, as evidenced by the rise of electric bike-related accidents in China.

Unsatisfied working environment: More notaby, another issue with using electric bicycles for delivery is that they are not able to provide a safe and essential work environment for delivery personnel, particularly during adverse weather conditions such as heavy rain and accidents. Unlike trucks and vans, electric bicycles do not offer the same level of protection to delivery personnel, which can increase health and safety risks. Moreover, the pressure to meet delivery targets during periods of high demand can exacerbate these risks. It is difficult for delivery companies to provide a safe and comfortable working environment for their personnel when using electric bicycles for delivery.

3.2. Air Transportation

3.2.1. Introduction

For Air transportation, Jing dong has taken some actions to improve itself-established logistic system. To begin with, in 2019, JD.com established JD International Air Cargo to enhance its global market presence. This enabled the company to offer more efficient worldwide air transportation services. For example, during the COVID-19 pandemic, JD International Air Cargo played a vital role in delivering large amounts of epidemic prevention supplies worldwide, demonstrating its strong air transportation capabilities. By creating its own international air cargo company, JD.com gains greater control over its logistics network and can further refine the delivery process. This also allows JD.com to adapt to market fluctuations more rapidly and cater to customer needs more effectively. Additionally, Jiangsu

Jingdong Cargo Airlines received its air operator certificate from the General Administration of Civil Aviation of China's East China Regional Administration on August 31,2022. The airline will initially concentrate on economic centers in the Yangtze River Delta, before extending its coverage to all major Chinese cities by 2025.In terms of international services, the company will begin with flights to Southeast Asia, Japan, and South Korea. By the end of 2025, it aims to have established a global network of cargo routes. Possessing an international air cargo company allows JD.com to exercise more control over its logistics network, streamlining operations, optimizing routing, and reducing transit times. Moreover, with enhanced control over its air freight, JD.com can prioritize shipments, allocate resources effectively, and make data-driven decisions to boost efficiency.

Furthermore, JD.com has formed strategic alliances with major airlines to utilize cargo air transportation for delivering goods to various domestic and international locations. By collaborating with airlines, JD.com can take advantage of existing air rutes, drawing on the airlines' expertise and infrastructure, which can result in reduced costs and faster delivery speeds.JD.com consistently explores new air cargo routes to broaden its delivery network and reach more consumers. During peak seasons, such as the well-known "Double 11" shopping festival (also known as Singles' Day), JD.com increases its cargo air transportation capacity to handle the influx of orders. The company charters additional flights or works with airlines to ensure a seamless delivery process. In 2020, for instance, JD.com chartered over 100 international cargo flights during the Double 11 shopping festival to accommodate the high demand for imported products and swiftly deliver them to Chinese customers.

3.2.2. Advantage

Expedited delivery times: One of the primary advantages of air transportation is its ability to deliver goods rapidly, particularly over long distances. In the competitive e-commerce landscape, fast delivery times can enhance customer satisfaction and brand loyalty. By integrating air transportation into its logistics network, JD.com can ensure that time-sensitive or high-demand products reach customers promptly, thereby improving the overall shopping experience.

Scalability and flexibility: Air transportation offers JD.com the flexibility to rapidly scale its operations and adapt to fluctuations in demand. By collaborating with multiple airline partners, the company can quickly increase or decrease its cargo capacity as needed, ensuring seamless delivery operations even during peak seasons or unforeseen events.

Enhanced control and customization: By establishing its own international air cargo company, JD.com gains greater control over its logistics network, enabling it to optimize routes, reduce transit times, and prioritize shipments. Moreover, the in-house air cargo provider can offer tailored services to meet specific customer requirements, such as express deliveries or temperature-controlled shipments, leading to a better overall customer experience.

3.2.3. Disadvantage

High operating costs: Operating air cargo services can be expensive, involving costs related to aircraft maintenance, fuel, airport fees, and personnel. These higher costs may be passed on to consumers in the form of increased product prices or delivery fees, potentially affecting the competitiveness of JD.com in the e-commerce market.

Limited cargo capacity: The cargo capacity of aircraft is often smaller than that of trucks or trains, limiting the volume of goods that can be transported by air. This constraint may necessitate more frequent shipments or the use of multiple modes of transportation to meet demand, potentially increasing the complexity and cost of JD.com's logistics operations. Regulatory compliance and customs clearance: Air transportation often involves navigating complex international shipping regulations and customs procedures, which can result in delays and increased administrative burdens. JD.com must invest in resources and expertise to ensure compliance with these regulations, adding to the overall cost and complexity of its air transportation operations.

3.3. Advanced Transportation

Also, JD.com is not only attached to traditional transportation methods. JD.com is continuously exploring new and advanced transportation models.

3.3.1. Drone Delivery

JD.com is one of the first companies in the world to use delivery drones to deliver packages to customers. JD.com began the drone delivery program in October 2015 and successfully completed its flight delivery test in June 2016. Since the beginning of the program, JD.com has been trying to develop more types of delivery drones. The load-bearing capacity of the drone increased from 5-30kg to hundreds of kilograms, and the maximum flight distance is also increasing ceaselessly. Now JD.com has put drone delivery into two areas. The one is responding to the coronavirus disrupting transportation in China. Since 2019, Covid-19 has continuously affected people's lives and transportation. In order to reduce contact between the person and person and to reduce the spread of the virus, JD.com invested some money in promoting drone delivery transportation in some cities, like Hebei Baiyang. This action made a big success. During the period of Covid-19, online purchases and home deliveries for supplies have been relied on. Drone delivery helped to ensure timely and safe shipments during the special time and helped to be in place of the role of ferry and continue to operate on the original route.

The other part of the work for drone delivery is in rural China. The complex terrain and weak infrastructure are common features of China's remote areas. Drone delivery helps with the logistics goals of meeting the 'last mile' and helps meet the online shopping expectations of people in remote areas. 'Vilage promoters' has been built in several villages. Orders from regional distribution stations are sent to JD.com's dedicated network of "village promoters" in each village, who then ship the orders directly to customers.

3.3.2. Self-Driving Trucks

Since 2020, autonomous truck technology has been unveiled and applied to use in some big cities in China, like Shanghai. These autonomous delivery vehicles helped to provide a contactless delivery service for locked-down neighborhoods. The load capacity of the vehicle could be reached 80 kilograms per charge. The vehicle is guided by AI technology and multiple sensors, which can help with recognizing, avoiding obstacles, and planning the route from the starting point to the destination. It was reported that during the peak, autonomous vehicles helped to deliver more than 13,000 packages and travel more than 6,800 kilometers, which is a great help to deliver people's daily necessities, food, and drinks. Even if the peak of the pandemic has already passed, autonomous delivery vehicles are still being used in more than 25 cities in China. The delivery need is met by these vehicles in some areas, like residential compounds, hotels, university campuses, commercial centers, and so on.

3.3.3. Advantages and Disadvantages

As JD.com introduced advanced transportation technologies, such as drone delivery and autonomous self-driving trucks, labor costs decreased by replacing human resources, allowing the reassignment of labor previously devoted to transportation. This shift enables the company to optimize resource allocation, improving efficiency and making better use of its workforce. Additionally, the integration of 5G and big data analytics ensures safe, reliable, and timely deliveries without the risk of human error.

However, developing and maintaining these advanced transportation systems involves high operating costs. JD.com must invest substantial resources in both their development and ongoing maintenance, raising concerns about whether these innovations will ultimately prove profitable. Furthermore, these technologies are limited by their load-bearing capacity. For instance, even after years of development, self-driving trucks can carry only up to 80 kilograms per charge, a modest capacity compared to traditional transportation methods.

4. Improvement in Survivability and Efficiency

In order to further improve efficiency, pioneering hardware and software that can make the transportation network digitized, connected and automated can be applied.

4.1. The Software and Data Technologies

The software and data technologies include:

Warehouse Management System (WMS) is used to track people and inventory inside and outside the warehouse network. WMS is real-time visibility.

Transportation Management System (TMS) can track available orders and transports and determine the optimal routes. In addition, it can track products and vehicles in real time.

Order Management System (OMS) is also important. It is used to split and combine incoming orders from different channels and then modify them in routes if needed.

Ideally, a connected, digital network should provide full visibility into the integrated supply chain. This will have a major impact on the decision-making process, whether made by humans or by AI.

4.2. The Hardware

The hardware components are significant as well. These contain automated inventory handling systems such as the storage system, robot picking and packaging. JD can continue to expand with its Autonomous Mobile Robots (AMR), Automated Guided Vehicles (AGV), sorting robots and autonomous vehicles. These can make it more competitive than competitors like Taobao, Tmall.

5. Conclusion

In conclusion, JD.com has developed a comprehensive transportation network that utilizes various modes of transportation to efficiently and effectively deliver its products to customers. The company has a very mature use of ground transportation, air transportation, and advanced transportation to deliver goods. The use of transportation equipment dramatically improves the efficiency of cargo transportation and enables the company to provide satisfactory service to customers. At the same time, every transportation method has its own characteristics, the company must carefully consider these factors and ensure optimal performance and customer experience. Under the trend of informatization, investing in software development and data technologies, as well as sustainable transportation, can help JD maintain its leading position in the e-commerce industry and continue providing high-quality products and services to customers globally.

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