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Last-Mile-Delivery (LMD) Solutions Via Autonomous Carriers in A Supply Chain 4.0 Context- A Way Forward to A Greener Supply Chain

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Abstract

With the growing global population, the demand for e-commerce business have substantially increased in the last decade. This has required business leaders to think out of the box and to acquire the customers perspective. Urbanisation also captivated people to heading their livelihood from village to cities, which leads to severe congestion in urban areas. This issue is directly impacting the logistics providers to supply their deliveries in urban areas, resulting in unexpected delays in delivering customers. According to a report by the U.N. (2014), states that about 54% of the population live in the cities today, and about 66% is expected in 2050. It seems a massive problem of the cloud is about to cover over the sky, and this is the best time to think meticulously and to take preventive measures for the future. The surge of Industry 4.0 brings numerous technologies along with and the digitalisation is one of them. To provide seamless Last-mile-delivery, adoption of digitalisation is crucial, as Last-mile-delivery is considered as the essential activity of logistics providers. Therefore, the Last-mile-delivery (LMD) by autonomous vehicles could bring a significant transformation in the Supply Chain. Though many organisations have started LMD by autonomous vehicles, still it is waiting to be used widely.

KEYWORDS: Industry 4.0, Unmanned Aerial Vehicles (UAVs), Last Mile Delivery (LMD)**,** Green Supply Chain.

1. Introduction

Some call it “digitalisation,” some call it “smart manufacturing,” and others call it “the next industrial revolution” or “Industry 4.0.” (PWC, 2016). Industry 4.0 has created a massive transformation in adopting intelligent technologies, including robotics, artificial intelligence, self-learning systems, unmanned aerial vehicles, big data, and Internet of things (IoT) etc. (DHL, 2016). Autonomous carriers (Unmanned Vehicles & Drones) are one of the paramount creations

of Industry 4.0, and the last decade has witnessed the sharp development of such technologies. Earlier the autonomous carriers such as drones and unmanned vehicles were used in military activities; however, now it became a vital part of most of the supply chain business. It has also been seen that unmanned vehicles (robots) used in the medical sectors to deliver food and medicines to COVID-19 patients (Arthur & Shuhui, 2020). The drones are also used in policing for the surveillance purpose to tackle the current disastrous situation occurred due to the outbreak of the global pandemic COVID-19 (Tripathi, 2020). Therefore, the autonomous carriers can also be used widely in extreme conditions to curb the disruptions. Primarily, autonomous vehicles were an excellent solution for last-mile-deliveries in urban areas, whereas now it can also be used in rural areas, where access to the standard delivery vehicle is not viable.

Growing population in the urban areas led to severe traffic congestion, unavailability of parking places in the city centres, as well as environmental concerns such as carbon emission and noise pollution. In essence, last-mile delivery is operated by the low-skilled labours in the logistics industries, which leads to several operational faults such as delivery speed issues and the accuracy of the delivery. In result, customers questioned the logistics provider on their operational excellencies, which is not a good gesture of any customer-oriented business. Based on the digital supply chains, autonomous carriers could eliminate the errors and accelerate the delivery, so that the efficiency would be guaranteed, and the supply chain could be impeccable. Nevertheless, autonomous carriers' delivery still is not widely accepted, and a long way to go that would replace the current modes of delivery. Elite market leaders have made some extraordinary efforts in this area, e.g., Amazon started drone delivery projects in the year 2013 (Conforti, 2017) and similarly Dominos has also made their first-ever pizza delivery by drone in 2016 (Reid, 2016).

Additionally, FedEx recently embarked their last-mile delivery by the autonomous delivery robot (Vincent, 2019) and similarly, Amazon's delivery robot has also been evinced on the streets of California (Nichols, 2019). However, present challenges include transforming this digital adoption need for significant investment in infrastructure, the advancement of I.T. and the state-of-the-art maintenance and the charging facilities. Additionally, social issues like unemployment could undermine in promoting autonomous vehicles deliveries. In this research, the challenges in adopting the automated vehicles deliveries in the urban environment will be examined; further, it would stimulate the potential practical applications and will propose the novel ways to use automated vehicles as a part of supply chain 4.0. Moreover, it would further analyse how to robust these technologies and how it can be made the sustainable one.

2. LITERATURE REVIEW

a) Digital Supply Chain and Industry 4.0

In the last 20 years, the digital supply chain has been a growing field of research (Bhatt, 2020). The Internet's invention and development since the 1990s have been enhanced and supported. In the meantime, the potential of the digital supply chain has become increasingly evident under the massive influence of the fourth industrial revolution (Industry 4.0) (Schrauf and Berttram, 2016). In essence, our daily lives are utterly paved by the Internet, starting from communication with loved ones by social media to online shopping; everything is based on the Internet (PWC, 2016). This concept comes under the umbrella of the Internet of things (IoT). The massive increment in population and the customer's interest in the online behaviour compelled the industry leaders to think manifold strategies to provide a seamless experience to the customers and the digital supply chain is one of the strategies of them (PWC, 2016). On the other hand, Industry 4.0 helped decision-makers to make precise planning of such activities and helped them to settle major problems during the manufacturing process (DHL, 2018). Smart manufacturing concept also evolved from Industry 4.0, which helped to increase the visibility and the transparency in the supply chain (DHL, 2018). Besides, it would be possible to replace the current transportation modes with revolutionised and more efficient ones. The significant increment vehicles lead to severe traffic problems in the major cities. In result, the delivery of these cities affects immensely. To overcome these problems delivering through the air by UAVs (drones) and on-road by UVs (robots) may be a profound solution for the logistics providers. However, some companies already have started adopting these technologies, but still, it is to be used widely. It has been seemingly seen that the demand of the autonomous vehicles skyrocketing as these vehicles widely accepted to tackle over the COVID-19 pandemic situation (Marr, 2020). These robots helped the firms to run their business at limited resources where social distancing was the priority. Meanwhile, the debate about replacing delivery vehicles is still on, and there is a mixed opinion in the academic community concerning this topic.

b) Types of Unmanned Vehicle

There are various types of unmanned vehicles (U.V.) or Automatic Guided Vehicles (AGVs), which can work last-mile deliveries soon, according to reports released by McKinsey (2016) and DHL (2018). McKinsey (2016) reported that drones, autonomous ground vehicles with lockers and droids (robots) under supervision could start replacing human’s occupation in last-mile delivery in both urban and rural areas in next ten years, with the mature in technology and legislations. Similarly, DHL (2018) also suggested the mobile autonomous vehicles would provide more agile delivery services with massively reduced costs within the next decades.

c) Sustainability of Unmanned Arial Vehicles (UAV)

At the present scenario, sustainability is considered as the most crucial aspect of any business and the business leaders investing billions on sustainability to make their business more sustainable one (Ahi and Searcy, 2013). According to Bruntland (1987) “Sustainability is commonly defined as utilising resources to meet the needs of the present without compromising future generations’ ability to meet their own needs.” This term used to relate to “environment-friendly”, or “green” (Ahi and Searcy, 2013), however, it has now been extended into triple bottom-lines: environment, social and economic. In light of a study conducted by Seuring and Müller (2008), stated that it is vital to consider three dimensions (environment, social and economic) into account while dealing with material flow, information and capital flows along supply chains, with different stakeholders. Academic studies have aimed at finding ways to make supply chains environmentally sustainable. Kellner and Igl (2015) argued for the reduction of greenhouse gas in freight transport. Further studies examined links between the delivery of UAVs and the environment. Figliozzi (2017) evaluated emissions of CO2 by comparing use of vehicles and manufacture and disposal between UAV and ground vehicles indicating that drones are more suitable for delivering small, light-weight products to meet the requirements of the green supply chain (Welser IV & Xu, 2016). Lohn (2017) argued in the case of drone supplies that the associated UAV infrastructure should be constructed, and noisy drones could undermine drone supply efforts. In the meantime, some technical issues should be resolved, such as job selection for UAVs (Grippa et al., 2016). There were limited arguments in other social issues, such as low-skilled workers' unemployment, indicating that further investigation was necessary.

d) Legal aspects of the UAVs

As drones are used more and more in different industries, rules for the regulation of drones must be laid down. Requirements for legislation vary between regions. UAV operations in the U.S. and China are strictly regulated by restricting the age, weight, area of flight and operating time of the user, similar to the UAV operations in the United Kingdom. The E.U. is, by contrast, not too restricted to the use of UAVs. The regulatory conditions may suggest that drone supplies in the U.K. and the USA will not be used in the near future, while it would be much easier at present to adopt drone supply in the E.U.

A) Drone Laws in the USA:

In view of the widespread use of drones in different civil applications such as news collecting, security parameters, supervision, etc. Use and rules that have been introduced. New FAA regulations for commercial drone use were implemented nationally on 29th August. Part 107 is the FAA's first effort to regulate UAV users' commercial use of airspace. The New Small UAS

Rule (107) covers all pilot and Operational Regulations for non-hobbyist operations of drones weighing less than 55 pounds. FAA should also be registered with drones weighing between 0.55 lbs and 55 lbs. The provisions of the rule are intended to minimise the risks to other aircraft, people and land. Unmanned aircraft are subject to Visual Line of Sight (VLOS) regulations. During the daylight hours, or under the hours of civil sunlight (instantly prior to and after sunset), operations are required only when the drone has collision-resistant lights. The new regulations also address height, speed and other operational restrictions such as prohibiting flights from non-protected persons on the ground who do not participate directly in the United States operation. The final rule requires the person flying a drone to be at least 16 years of age with a remote pilot's certificate with a small UAS rating or to be directly supervised (Dhande, 2016).

B) Drone Laws in the U.K.:

Drones are covered by the patchwork of English legislation, including the Civil Aviation Agency's (CAA) aviation laws. Articles 166 and 167 of the Air Navigation Order cover aircraft weighing 20 g or less. This is an order that contains fundamental security measures such as bans against dropping drone items that threaten property or persons. The altitude of four to five hundred meters from the pilot is similar to the limitations in the U.S. Drones with applied cameras must not float in the United Kingdom within 150 meters or 50 meters from an individual, vessel or other structure not under the control of the pilot, within the congested area. Anyone who uses a drone for trade shall be issued a CAA licence. You are required to obtain adequate levels of insurance in case of an accident when you are operating an aircraft that weighs more than 20 kilograms (Dhande, 2016).

C) Drone Laws in the E.U.:

Currently, 150 kg or less mass of civilian aircraft (RPA) is not regulated by the European Union (E.U.). Such aircraft are subject to E.U. Member States' national rules. RPA over the 150 kg threshold falls under the European Aviation Security Agency's (EASA) mandate. The European Union is committed to addressing the lack of a coherent regulatory regime which the European drone industry is thought to have hindered. The new RPAS package may not be completed by the target date of 2016 but will come, and the E.U. hopes that it will further boost a growing sector (Dhande, 2016).

D) Drone Laws in China:

As far as regulation in China is concerned, public and national security drones are monitored (official). Drones are divided according to sizes, with their own height, flight area and pilot age limitations for each category. Larger drones may have more travel space while registration and

flying proposals are necessary. These regulations do not act as a restriction to the development of drones in China but support the safe and healthy UAV operation. UAVs are commonly larger for supply chain practice in order to carry out delivery work. This requires examination and approval processes in accordance with existing regulations. However, following this technology, which is widely used in the supply chain industry, processes for higher efficiency could be simplified (Dhande, 2016).

3. Conclusion and Discussion

From the above study, it is evident that, though Industry 4.0 has created substantial transformation, still UAVs and unmanned grounded vehicles could not replicate manual interventions in the Last mile delivery. The drawbacks have been thoroughly discussed, firstly, financial and social aspects, secondly, local drone flying rules impeding most of its uses. Therefore, this study recommends, local government should change their aerial rules and motivates UAV start-ups so that last mile delivery as well as supply chain could be the sustainable one. Also, this study further suggests brooder research referring to public perceptions for UAVs and Unmanned vehicles.

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