

Preliminary Study of Drone Delivery Systems in Hong Kong

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The rise of drone delivery systems due to the wave of industry 4.0. The outbreak of the COVID-19 pandemic reinforces the importance of the drone delivery systems in order to minimize the spread of the virus, facilitate the economic revitalization processes, and encourage the growth of smart logistics operations in the post-COVID-19 era. In this study, we conduct a preliminary study to address the three main research questions, namely Are the citizens welcome to have drones delivering their packages and other issues associated with the drones? (2) Do the citizens perceive a difference in the risks associated with human delivery and drone delivery? (3) What are the public's concerns associated with drone delivery? As such, survey questionnaires were collected from Hong Kong residents. The findings highlight that Hong Kong residents are concerned about protecting the drone or package when falling to the ground or water; and (2) minimizing damages to humans, structures, vehicles, or vessels. This pilot study can provide valuable insights and constructive feedbacks to policymakers and industrial practitioners to design and implement drone delivery systems in Hong Kong in the future.

Keywords: Drone Delivery Systems, COVID-19 Pandemic, Hong Kong Residents, Smart Logistics.

1 Introduction

Digital disruption by technological advancement has hugely affected the supply chain in many ways. Lowering computing costs, better information connection, and larger data management capabilities result in a virtual world that not only mirrors the physical world as a “digital twin”, but also informs the decision make to physical supply chain activities. Traditional supply chains are now updated to digital supply chains to support new production models and transportation modes so as to enhance customer experiences [14].

Different terms are now being used to describe such changes to the supply chain. In this work, the term digital supply chain was used as the word ‘digital’ provides more clues to the interconnected and data-driven nature of the modern supply chain. In general, the data with artificial intelligence (AI) are adopted. Seeing a strong influence of the industry 4.0 on the advancement of the supply chain, Winkelhaus and Grosse (2020, p.21) [19] defined logistics 4.0 as “the logistical system that enables the sustainable satisfaction of individualized customer demands ... using digital technologies.” Meanwhile, according to the official document for industry 4.0, the term smart logistics was used [21]. This is to express the vision of industry 4.0, which is to drive a smart and connected world.

A digital supply chain is no longer understood in a sequential way as a plan-source-make-deliver process (Delottie, 2016). With digital at the core, supply chain activities, including planning, fulfillment, customer services, and manufacturing are linked to one another to minimize latency, risks, and waste. As commented by Hampstead (2019) [8], green supply chains must be digital supply chains. Digital tools are key enablers for a supply chain to meet the Sustainable Development Goals (SDGs) raised by the industry, regulators, and emerging market demand.

With such a strong focus on the interconnectivity of the digital supply chain, quite a lot of the contemporary research on the digital supply chain covers the topic of optimization strategy, enhancing transparency across supply chain members with a different digital buzzword, such as Internet of Things (IoT), big data analytics, cloud technology, and Autonomous Vehicles promoted under the industry 4.0 [13]. However, fewer discussions are provided in explaining how the digital supply chain reshapes the transportation activities that change from manual to smart and have a positive influence on an organization’s digital supply chain capabilities and competitiveness [14]. When it comes to transportation automation in supply chain operations, scholars either focus on subjective conceptual designs or different optimization and simulation tools in the fields of operations research and management science. Such studies might have less practical value in supporting effective integration and use of transport automation technologies towards establishing digital supply chains under a wide range of realistic challenges, especially at the operational level [16].

2 Literature Review

2.1 Drones

Still, automation in transportation systems plays a critical role in developing an efficient and effective logistics management system [6]. With the growing demand for the amount of product being handled, multiple automation technological tools are widely used in warehouse management at logistics operators’ premises. As an increasing trustful substitute part of human work, the use of automation is expected to extend to product transportation [2]. Unmanned Aerial Vehicle (UAV) or Unmanned Aircraft System (UAS) that yields low human cost and transport infrastructure cost is a non-conventional mode of transport that could fully unleash the potential of automating transport operations [20].

UAV, generally known as a drone, is often a small, unmanned aircraft capable of flying autonomously under the support of onboard circuits, processing units, and sensors [10]. Drones could be grossly

defined into fixed-wing systems and multirotor systems according to their technical characteristics. A drone running a fixed-wing system uses fixed, static wings together with forward airspeed to generate lift like traditional airplanes. A drone that uses rotary wings to generate lift is operating under a multirotor system. In general, multirotor drones own the advantages of making less noise, and the ability to hover in the air and operate without a landing strip, but are less ideal for long-distance travel when compared with fixed-wing drones.

Drones were firstly used for military purposes [9]. Nowadays, the use of UAVs is extended to many other sectors, such as aerial inspection, photography, traffic control, emergency services, and package delivery. As one type of air-freight delivery service, drone delivery is considered a premium service [1], such that it should be transporting items with emergency or high values. For example, Amukele et al. (2017) [20] conducted a feasibility study on using drones to transport blood products and concluded that drones could potentially become a cost-effective and responsive option for transporting blood components. The trend of drone delivery is also fueled by the COVID-19 outbreak, as autonomous transportation could provide contactless delivery during the pandemic [18].

Drone delivery faces numerous operating concerns. Operating a large UAV often required formal flight applications which decreases the flexibility of drone operations. However, a smaller drone often means less payload volume which imposed restrictions on the size and weight of cargo carried [5]. Besides, small UAV missions are often limited by time and weather conditions. Some small UAVs could only operate with good visibility and during daylight hours in order to monitor erratic behavior during flight. To avoid harm to people and manned aircraft, the operations of drones are often subject to a number of flight restrictions. Apart from denying entry to the controlled airspace, some countries like the USA, Canada, and Colombia define the maximum flying height for drones. Besides, the regulations on horizontal distances, lateral distances to people, and maximum flight time may also limit drone delivery operations.

2.2 Diffusion of Innovation (DOI) Theory

Now a days, the use of drones in goods delivery is still in its early stages [3]. In the urban area, it seems that the potential of drone delivery is offset by the perceived threats of drones, including various privacy and security concerns [5]. As commented by Bianchi et al. (2017) [12], the commercialization phase of technological innovation is often neglected. As a clear, systemic framework to explain whether the adoption or non-adoption of new technology [7], this study adopts the Diffusion of Innovation (DOI) Theory to provide further discussion on the drone used. Developed by E.M. Rogers back in 1962, the DOI Theory has been one of the most widely used theories adopted by researchers in explaining the incorporation of innovation [15]. In the area of logistics and supply chain management, the DOI Theory has appeared in many previous pieces of research and scholarly works covering topics of electronic data interchange (EDI), containerization, omni-channel retailing, and green reverse logistics [4]. As such, we address the three main research questions in this study: (1) Are the citizens welcome to have drones delivering their packages and other issues associated with the drones? (2) Do the citizens perceive a difference in the risks associated with human delivery and drone delivery? (3) What are the public's concerns associated with drone delivery?

3 Research Methodology

The data collection period for the survey lies between late March and late April 2020, the survey was distributed through social media platforms and there are a total of 45 responses. Most of the questions that require the respondents to answer are linear scale questions, in which they have to choose a number from 1 to 5 according to their intentions toward the situation mentioned in the question, as the quantitative method has the advantage of precisely obtaining and analyzing the data of the respondents' answers [17]. There are a total of three sections in the survey. The first section covers the demographic information of the respondents. The second section aims to investigate the respondents' habit of ordering the service. The third section intends to explore the respondents' perceived risks of drone delivery operations.

4 Findings

4.1 The Demographic Information of Respondents

Table 1. The demographic information of the respondent.

Gender	
Male	89%
Female	11%
Age	
19-25	69%
26-35	16%
36-45	4%
46-55	9%
55 above	2%
Educational Level	
Secondary school	27%
Associate degree/Higher diploma	29%
Bachelor's degree	40%
Master degree	4%
Income Level	
Less than HKD 5,000 per month	62%
HKD 5,000 to HKD10,000 per month	2%
HKD 10,001 to HKD 20,000 per month	29%
HKD 20,001 to HKD 30,000 per month	2%
HKD 30,001 to HKD 40,000 per month	2%
HKD 40,001 or above per month	7%

The profile of survey respondents is mainly male (89%). 85% of respondents are young generations (aged 35 or below). Over 70% of respondents are acquired higher education qualifications. However, their income level is relatively low due to most of the respondents being full-time students.

4.2 The Respondent's Habit of Ordering the Service

Table 2. The respondent's habit of ordering the service – Part I.

How often do you order packages for doorstep delivery?	
Never	22%
Less than 1 times a month	33%
1-2 times a month	27%
3-5 times a month	9%
6-10 times a month	2%
More than 10 times a month	7%

According to Table 2, 78% of respondents indicated that they have experience in ordering packages for doorstep delivery. Thus, they have the knowledge and experience in participating in our study.

Table 3. The respondent's habit of ordering the service – Part II.

To what extent do you accept package delivery to your doorstep?	4.29
To what extent do you accept package delivery done by drone? (Situations including but not limited to picking up packages on the street near your household's lobby)	3.84
To what extent do you accept drones flying near your household? (Situations including but not limited to flying 5-10 meters away from your windows, flying 5-10 meters away from lobby area)	3.24
Compared to delivering packages by humans, how risky do you think drone delivery is? (e.g., cargo stolen/ lost in transit)	3.82

Remarks: 1 = Lowest Score; 5 = Highest Score

Based on Table 3, most of the respondents are likely to accept package delivery to their doorstep. However, their acceptance is relatively low in the case of drones flying near their household. In other words, the situation pertaining to flying 5-10 meters away from their windows or flying 5-10 meters away from the lobby area is not preferable. In the meantime, the majority of respondents indicated that drone delivery may face a higher risk than human delivery like cargo stolen or lost in transit. Thus, the technical issue of drones may need to be further reviewed in the future.

4.3 The Respondent's Perceived Risks of Drone Delivery Operations

Table 4. The respondent's perceived risks of drone delivery operations.

In your opinion, how dangerous are drones flying on street? (Flying at least 50 meters above the ground)	3.17
Which of the following factors are you concerned about most regarding drones flying above the streets?	
Drone collision with birds	33%
Drone collision with streetlights or other structures	18%
Drone falling on pedestrians or vehicles during flight	69%
Packages carried by drones fall on pedestrians or vehicles	67%

Remarks: 1 = Lowest Score; 5 = Highest Score

In accordance with Table 4, the respondents perceived the higher risks of drone delivery operations mainly from the drone falling on pedestrians or vehicles during flight, as well as packages carried by drones falling on pedestrians or vehicles.

5 Discussion and Conclusions

The results of the survey have indicated that the public is having a positive attitude toward doorstep delivery services and most of them will be ordering such service at least once a year, the public is positive towards drones as a method of delivery and neutral to drones flying near their household. Overall, the public is concerned with the risks when their package is being delivered by drones, as well as the fact that drones are flying on the street. During the flight, the most concerning risks for the public regarding the drones are the drones themselves falling on pedestrians or vehicles, and the package carried by the drone falling on pedestrians or vehicles.

In accordance with the survey results, the respondents are most concerned with the security issues when drones are flying near their households, the risks of their packages being lost or stolen in transit as well

as the drones are malfunctioning during flight, which leads to the drone itself or the package it carried to fall and potentially harming pedestrians or vehicles in the vicinity. If a drone delivery system is to be implemented in Hong Kong, the most urgent factor is to ensure that there are protective measures taken to the drones or the packages that aim at two purposes: (1) protecting the drone or package when falling to the ground or water; (2) minimizing damages to human, structures, vehicles or vessels.

For security issues, the public is most concerned about privacy issues in their households since the current major usage of drones is for photography purposes, and they are concerned about drones acting as delivery robotics will possibly expose their house to surveillance due to the cameras installed on it [22]. This is a relatively strong stand since the drones must be able to identify obstacles during autonomous flight, and the common approach is using cameras combined with sensors to identify objects [11]. To gain trust from the public and mitigate the concerns, the best hope is to use sensors only when installing obstacle avoidance systems on the drones to avoid possible imaging of households.

In the future, the study may focus on the various geographical regions so as to generalize the research study. In the next research, the study may also consider the logistics engineering area so as to increase the scope of the study. Moreover, the study may consider conducting semi-structured, in-depth interviews with relevant stakeholders including the policymakers, logistics associations, logistics firms, and government bodies to develop policy papers in the forthcoming years.

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