







#### 1.4 Scope of research

As the utilization of drones' delivery increases during COVID-19, the revolution of drone delivery is shortly estimated to grow. However, there are various challenges during COVID-19 for using drones for transportation purposes in Oman. Nevertheless, in the future, several opportunities will be available for drone delivery services in Oman, which will make the drone delivery service more efficient. This study seeks to investigate the vision and revolution of drone delivery services in Oman during and after COVID-19. The research study intended to highlight the efficiency and challenges for drone delivery services in Oman during and after the COVID-19 pandemic. The scope of the study's limits in the drone delivery industry during and post COVID-19 crisis. Correspondingly, the study area for this research is Oman. With its vision 2040, which targets the fourth industrial revolution's adaptation and the investment in logistics and transportation sectors to build smart cities, Oman is enabled to keep its competitive spot as a logistics hub.

#### Literature review

Currently, UAVs or drones are one of the rapid-growing sectors. Nowadays, the applications of drones are widely increasing in diverse aspects due to their significant values. Hong Jiang and Xinhui Ren (2020) believe that commercial drones become efficient means of delivery with the popularisation of drones. They mentioned that commercial drones are fast, reliable, sustainable, and cost-efficient than other transportation modalities (Jiang and Ren, 2020). There is a share of consistent evidence that utilising technologies such as drones delivery enhance transportation efficiency, avoid the impact of congestion and make the delivery path more diversified. Thus, commercial drones become an essential part of the intelligent logistics supply chain. It brings commodities, people and places closer, easier and faster. Here in Oman, Oman's vision 2040 aims to adapt and promote the fourth industrial revolution and invest in the logistics industry for building

smart cities. Therefore, Oman will keep its competitive position as a logistics hub (Oman Vision 2040, 2020).

#### 1.5 The efficiency of drone delivery in Oman during COVID-19

Recently, global is witnessing the emergence of a new era in the automotive industry. Lately, the usage of drones for commercial purposes receives much attention. Nowadays, Oman Logistics Centre (OLC) and ASYAD utilise drones for parcel delivery and inventory stock counting. According to the ASYAD (2020), since the beginning of the COVID-19 pandemic, the OLC and other drone companies in Oman start to invest various resources for testing drone delivery services. They have been lobbying to apply these services (ASYAD, 2020). The first experiment of conveying goods via drones in Oman was in Nizwa. The Nizwa drones transported a parcel weighing approximately about 1.5 kg around three Kilometers within four minutes. As a result, it matches the best global drone delivery speed (ASYAD, 2020). Furthermore, the Muscat drone conveyed a parcel weighing almost about 1.5 Kg in less than four and a half minutes over three Kilometers (ASYAD, 2020). Both deliveries showed magnificent evidence for the rapid growth of drone delivery services in Oman by the near future. From the researcher's point of view, the increase in drone delivery services in Oman helps to enhance logistics operations' efficiency, minimise cost, and maximise productivity.

Vyshnave, Elysee, Patrick and Lorie (2020) theorise that drones' delivery holds a great promise to succour infectious diseases control and respond to public health emergencies (Jeyabalan *et al.*, 2020). Several studies mentioned that drone operators worldwide started to cater to the new demand due to the COVID-19 crisis. They transport medical supplies, groceries and other necessary goods via drones (OECD, 2020; EUCHI, 2020; Jeyabalan *et al.*, 2020). A systematic review by the International Transport Forum confirmed that since the coronavirus outbreak, drones used to transport daily necessities and medical

supplies to avoid human interaction, monitor social distances and confined citizens (OECD, 2020). Throughout the literature, drones facilitate impractical travels, whether simply being able to fast deliver medicines and essentials to humans who need them, or emergency, where the saved minutes means saving lives.

### **2.1.1 The efficiency of drone delivery during COVID-19 in the healthcare aspect**

Drone technology extensively utilised in the healthcare industry to combat the COVID-19 pandemic. Arguably, considering COVID-19, drone applications are used chiefly in the healthcare aspect as human lives are at stake. Previous studies emphasised that drone applications in healthcare comprise the delivery of medicines, blood samples, lab samples, vaccines, defibrillators, and other medical supplies (Scott and Scott, 2018; Hii, Courtney and Royall, 2019; UNICEF, 2020; Jeyabalan *et al.*, 2020). Mohsen Guizani and other researchers who are members of the Qatar National Research Fund mentioned in their article that in September 2019, researchers from the National University of Ireland tested a drone to transport diabetes medicines (Chamola *et al.*, 2020). Michelle Hii, Patrick Courtney and Paul Royall from King's College London conducted another experiment to test insulin delivery via drone to remote areas (Hii, Courtney and Royall, 2019). Both successful experiments provided evidence to the world on how UAVs can deliver healthcare supplies reliably. According to the published article by the ITF<sup>1</sup>, considering the COVID-19 crisis, about eighteen countries utilised drone technology for transportation purposes, including Oman. It also highlighted that China was the first country that operates the drone for delivery services. It successfully delivered medical supplies and test samples from a local hospital in Zhejiang to a neighbouring disease monitor centre (OECD, 2020). More recent evidence cited in the ITF<sup>6</sup> article, wherein the USA, after devastating the impact of COVID-

19 pandemic, US agencies took various steps to apply the utilisation of drones for delivery services. A zip line was established as an active medical supply transportation network to deliver urgent medicines directly to human's doorsteps (OECD, 2020). Therefore, the utilisation of drones in infected countries helps to minimise human interaction. From the researcher's perspective, the idea of utilising a drone to deliver healthcare supplies considering the COVID-19 pandemic helps to reduce the exposure to infection, reduce transportation time, and decrease the risk of transmission.

### **2.1.2 The efficiency of drone delivery during COVID-19 in the food field**

Apart from being a quick and safe approach to deliver medical supplies, commercial drones facilitate the transportation of foods and necessary goods considering the COVID-19 pandemic. Jinsoo, Dohyung and Jjinkyung, who specialise in hospitality and tourism management, hypothesised that after the outbreak of COVID-19, people tended to prefer home delivery services to eat or shop outside. They theorised that drone delivery services are attracting attention to transport foods and other goods. They use drones to deliver foods because the drone is contactless services and provide delivery without face-to-face encounters (Hwang, Kim and Kim, 2020). Several recent studies pointed out drones' application to deliver food and other necessary commodities in various countries during the COVID-19 outbreak. International Transport Forum stated in its recent article that in China, JD.com, a Chinese e-commerce company, launched a group of drones to distribute food. This implementation of drones replaced one-hour delivery times with a flight of almost 10 minutes (OECD, 2020). Jinsoo (2020) and other researchers mentioned in their journal article that in the USA, Uber, which is a delivery company, tested drones in the food and groceries delivery aspect during the COVID-19 crisis. Uber estimates to start food transportation via drone in San Diego at the beginning of 2021.

In contrast, the customers will receive food in front of their door within five to thirty minutes (Hwang, Kim and Kim, 2020). Insoo Hwang, Insan Kim and Muhammad Gulzar, who specialise in transportation and tourism, highlighted in their journal article that Costa Coffee in Dubai utilises drones to deliver coffee without human interaction to control social distancing (Hwang, Kim and Gulzar, 2020). These drone applications in various countries prove how UAVs or drones can respond to public health emergencies. The researcher strongly agrees with the idea of using the drone for delivering food and other goods where this let the whole world understands the capability and ability of drones to bring positive change and facilitate commodities movement considering the COVID-19 outbreak.

### **1.6 Challenges of drones in Oman during COVID-19**

Hailong Huang and Andrey Savkin, who are specialised in electrical engineering and telecommunication, postulate that although parcel delivery via drones brings several attractive advantages, its application is limited due to several challenges. These challenges could prevent drones from transporting goods to the far customer (Huang and Savkin, 2020). Mohsen Guizani and other academic researchers theorise that despite the various benefits drones provide in response to world crises like the COVID-19 pandemic, the utilisation of drones confronts certain limitations and challenges. Until then, several countries worldwide do not yet adapt drones to fight against the COVID-19 crisis (Chamola *et al.*, 2020). The researcher finds many journal articles close their attention to the drone's challenges considering the COVID-19 outbreak. The researcher divides the challenges into three significant challenges: technical challenges, legislation challenges, and safety and privacy challenges.

#### **2.2.1 Technical challenges that drone delivery may face**

The first challenges that drones may face during the COVID-19 pandemic are technical. Several

studies mentioned that the significant technical challenges include limited battery life, short coverable distance and limited payload capacity (Lai, Liu and Tsay, 2020; Alwateer and Loke, 2020; Hii, Courtney and Royall, 2019). Suttinee Sawdsitang and other researchers who are specialised in the field of computer science and engineering at Nanyang University confirmed in their research study that customers who are located far from the serving area, the supplier cannot utilise drones for delivery due to its limited battery life (Sawdsitang *et al.*, 2018). Vyshnave, Elysee, Patrick and Lorie (2020) conducted a research study and investigated many other technical challenges resulting from drone crashes and network issues (Jeyabalan *et al.*, 2020). From the researcher's point of view, drones' limited battery life and load capacity inhabit their capability to make multiple transportations at once and cover long distances.

#### **2.2.2 Legislation challenges that drone delivery may face**

The second major challenge is the legislation challenges. According to several previous studies, legislation challenges involve government limitations and the delivery of illegal drugs (Alwateer and Loke, 2020; Stolaroff *et al.*, 2018; Lai, Liu and Tsay, 2020). According to Oman Civil Aviation (2020), the Civil Aviation in Oman limited drones. Operators require licenses and permits from Civil Aviation to allow them to use drones. However, maximum 10,000 OMR as a fine and jail for utilising the drone without permission (Civil Aviation, 2020). Joshua Stolaroff and other academic researchers specialising in geological engineering stated that commercial drones recently are limited in the United States and other countries worldwide. They added that the EASA<sup>7</sup> and the FAA<sup>8</sup> are developing regulations and laws to allow the use of commercial drones (Stolaroff *et al.*, 2018). Mei Lai, Dan Liu, Wu Tsay from the Fuzhou University of International Trade in China mentioned no special applicable regulations and laws for commercial drones in China. The entry

of drones into the trade field will challenge drone operators (Lai, Liu and Tsay, 2020). The other issue which comes under legislation challenges is the delivery of illegal drugs. Several recent studies confirmed that several sellers utilise a drone to deliver cocaine during the COVID-19 lockdown in the United Kingdom (Das, Mohanta and Jena, 2020; Alsamhi *et al.*, 2021). From the researcher's perspective, FAA and countries' governments set laws and policies applicable to supervise drones' operators under the promise of respecting their health, lives and rights. The researcher agrees with the idea of applying clear government regulatory policies to fight against coronavirus.

### **2.2.3 Safety and privacy challenges that drone delivery may face**

The third prime challenge is safety and privacy challenges. Majed Alwateer and Seng Loke, who are specialised in Information technology, hypothesise in their research article that drones utilised to enhance public and private safety and security levels, but drones exposed to many safety and privacy challenges. These issues related to drones' control and information about stakeholders, clients or service providers (Alwateer and Loke, 2020). Many current studies confirm that safety and privacy challenges could include GPS<sup>1</sup> jamming and hacking (Alwateer and Loke, 2020; Das, Mohanta and Jena, 2020; Chamola *et al.*, 2020; Jeyabalan *et al.*, 2020). Vyshnave Jeyabalan and other researchers emphasised in their research study that the increase in aircraft and areophane and the large size of some cities and villages create an issue to the GPS<sup>9</sup> collection (Jeyabalan *et al.*, 2020). This issue leads to GPS problems. The hacking issue is one of the securities and safety risks posed by drones. Majed Alwateer and Seng Loke confirmed in their research that hackers could control drones operated by the service providers and utilise a drone for unintended purposes (Alwateer and Loke, 2020). From the researcher's point of view, when drones' users give their confidential information such as account number, name, and

location, hackers can attack it. They should maintain their privacy.

### **2.2.4 Other challenges that drone delivery may face**

Weather conditions can be another challenge that drone delivery may face during the COVID-19 pandemic. Vyshnave Jeyabalan and other researchers assert that drones or UAVs cannot be operated in certain weather conditions such as thunderstorms and severe wind (Jeyabalan *et al.*, 2020). According to UNICEF recent article, the lack of understanding of drones' use in such emergence cases and the insufficient support system for drones can be another challenge that drone face during the coronavirus pandemic (UNICEF, 2020). A sound understanding of drone utilisation for delivery in such a situation can add value during the pandemic.

### **2.3 Future of drone delivery services in Oman post-COVID-19**

Several recent research studies estimated that commercial drone delivery would rapidly grow shortly. They also expected that with the success of drones in the logistics and transportation aspect, drone delivery would improve soon to be time-sensitive, more critical and larger payloads (Frachtenberg, 2019; Huang and Savkin, 2020). According to the ITF article, drones or UAVs prove themselves practical and versatile tools during and post COVID-19 pandemic. It states that the application of drones in the coronavirus crisis offers a learning opportunity for how to utilise drones for delivery in such emergency cases in the future. It also estimates that the airspace regulation will be updated to facilitate drones for delivery in future emergencies (OECD, 2020).

On the other hand, Michael Nentwich and Delila Horvath, who are specialised in science and technology studies, stated that there is a prospective impact of employing drones for transportation purposes in the future. They hypothesised that the potential impact could be on the job market. The growth of drone utilisation in future may lead to a shrink in the

employment of delivery drivers (Nentwich and Horváth, 2018). The researcher strongly agrees that states drones or UAVs are a promising modality to reshape the future of the delivery system, whether in Oman or other countries. Thus, it is attracting the attention of researchers and industrial practitioners.

### 2.3.1 drone delivery in future

Various researchers conducted statistics regarding drone delivery in the future. According to Mei Lai, Dan Liu, Wu Tsay, due to expanding the e-commerce market, the annual parcel volume delivered via drone will be doubled to reach 25 billion in the USA in the next ten years (Lai, Liu and Tsay, 2020). Gino Brunner and other researchers from the computer engineering and network laboratory at ETH Zurich<sup>10</sup> predicted that self-driving, including drones, would soon transport 80 per cent of parcels (Brunner *et al.*, 2019). Thus, drone delivery can be profitable and feasible. Hong Jiang and Xinhui Ren, who are specialised in economic and management at the Civil Aviation University of China, estimated that by 2050, the number of drones utilised in Urban delivery would reach 1 million (Jiang and Ren, 2020). The researcher predicts that the drone may fly directly from the retailer's warehouse to the consumer's door shortly.

### 2.3.2 The opportunity of drone delivery to serve various aspects in future

Eitan Frachtenberg, a computer science professor at Reed College, assumed that drones would employ several aspects soon (Frachtenberg, 2019). The first aspect is merchandise delivery. Eitan Frachtenberg believes that merchandise delivery is one of the cores uses cases for drone delivery. He expected that Walmart might utilise drones in its extensive network, which can deliver commodities to approximately 90 per cent of Americans via drones (Frachtenberg, 2019). The second aspect is the courier delivery. Eitan Frachtenberg postulated that various companies might use drones to deliver couriers between two private parties (Frachtenberg, 2019). The

third aspect that will use the drone for delivery in the future is food. Due to the time-sensitivity, drones would be applicable to deliver perishable cargo and floral. Eitan Frachtenberg estimated that with the utilisation of drones to deliver food in the future, the food market would grow globally to reach more than \$ 160 billion by 2023 (Frachtenberg, 2019). Another aspect that will particularly suit drone delivery is humanitarian aid. Professor Eitan Frachtenberg (2019) predicted that drone delivery applications in the humanitarian assistance industry include delivering supplies to people in war or disaster areas and transporting medical supplies post-COVID-19 crisis (Frachtenberg, 2019).

Similarly, passenger delivery could take advantage of drone delivery in the far future. Jinsoo and other researchers alluded in their journal article that Uber company collaborated with aviation companies such as Pipistrel to develop short-range and autonomous drones for delivering passengers in the future (Hwang, Kim and Kim, 2020). According to Mohamed Ferrag and Leandros Maglaras, who are specialised in computer sciences mentioned in their journal article that DHL, UPS and Amazon, which are the world's leading logistics company currently launched a new service call the drone-based delivery system. They assumed that this system would be used for rural delivery and urban first and last-mile delivery (Ferrag and Maglaras, 2019). From the researcher's perspective, the drone-based delivery system aims to modernise the delivery system shortly.

## 3. Methodology

The methodology chapter is one of the most substantial chapters in research. Research methodology is specified techniques or approaches used to determine, identify, analyse and process data regarding the research topic. It allows the readers to evaluate the study's reliability and validity critically. In this chapter, the researcher elucidates the mechanism used to illustrate actions taken to answer research questions,



investigate the research problem and fills the research gap. The methodology chapter presents the result from the information obtained during the study period. It is done by applying procedures and approaches to meet and understand research objectives. In the methodology part, the researcher would discuss the methodological flow that answers research questions.

### 3.1 Research approach

The researcher decided to use the inductive mechanism because it does not follow any hypotheses which fitted the research study. According to Theophilus Azungah, a lecturer at Bolgatanga Polytechnic in Ghana (2018), the inductive approach generates new theory emerging from the information and learning from various experiences. Moreover, it helps the researcher establish an apparent link between the summary findings and the research objectives (Azungah, 2018). The researcher selected a qualitative method to be conducted where the narrative approach will be used in this research. Qualitative research focuses on obtaining information via informal and open-ended communication where it stems from the human's experiences. The bright side of using the qualitative method is that it is a flexible mechanism, allowing collecting detailed-orientated data and understanding attitudes. It also enables the researcher to investigate methodology with more accuracy. The descriptive data collection is written in the research study (Huang, 2019). The researcher strongly agrees that the qualitative approach provides information experienced by specialists, which added value to the research study. On the other hand, the qualitative technique offers linguistic information where it is complicated to compare across respondents who have various regarding the drone delivery challenges during COVID-19 and the future of drone post the COVID-19 era.

The researcher decides to conduct a semi-structured interview. The semi-structured interview helps the researcher to provide comparable and reliable qualitative data. Besides, it allows the researcher to gather information from the interviewees' perspective,

where various ideas will be argued later in the next stage. The semi-structured interview enables the research to ask open-ended questions that allow the discussion and accurate data (DeJonckheere and Vaughn, 2019). Due to coronavirus outbreaks nowadays, the researcher prefers to conduct an online interview via Microsoft teams, Google meet and Zoom. Through conducting an online- interview, the researcher can prepare well and record the interview. From the researcher perspective, conducting the online interview is fixable and cost-saving. The gathered data expects to demonstrate the efficiency of drone delivery services in Oman during the coronavirus outbreak. Besides, the research aims to determine the challenges that commercial drones face in Oman in the era of the COVID-19 pandemic. The study also seeks to estimate the future of drone delivery in Oman posts the COVID-19 crisis.

### 3.2 Research design

The researcher employed a qualitative approach to gather the data from respondents regarding the efficiency of drone delivery services in Oman. The researcher decided to conduct a semi-structured interview with an expert from various logistics and transportation companies in Oman. The probability sampling technique with a random selection from the targeted respondents will be used in this research study. Under the probability sampling mechanism, the researcher would prefer to use simple random sampling. Hence, this research study employed a qualitative research design to agree on the efficiency of drone delivery service in Oman during and post the coronavirus era. Patrik Aspers and Ugo Corte mentioned that qualitative research focuses on gathering and analysing non-numerical data to understand ideas, concepts or experiences. They said that this type of research design allows the researcher to collect in-depth information and generate new ideas into the research study (Aspers and Corte, 2019). Since it is a communicative approach, respondents can build their trust in the researcher where the information obtained is primary and unadulterated. Besides, the qualitative research

method works to solve complicated issues by dividing them into meaningful inferences that are simply understood and readable (Canyon Hydro *et al.*, 2013).

### 3.3 Population and sample size

The study population consists of logistics and transport institutes' employees in Oman as there is more representative of the logistics industry. The people of data is from transport companies, airports, seaports and logistics organisations. The researcher selects the respondents from the high positions because they are certified and accessible employees who could provide valid input to the research regarding the efficiency of drone delivery service in Oman during and after the coronavirus pandemic. The researcher planned to meet ten interviewees from several logistics and transport industries in Oman. Due to the outbreak of the coronavirus pandemic in Oman, the researcher prefers to conduct the interviews online with all respondents. The researcher expects 85% of respondents will give perspectives and ideas regarding the efficiency of drone delivery services in Oman. The researcher will ask for permits from the interviewees to record the interviews. The researcher will use simple random sampling to pick out the interviewees. The researcher uses this technique to ensure that each population members get an equal chance for the selection or the opportunity of getting responses.

### 3.4 Data collection

Data collection is a systematic process for gathering observations or measurements. The data collection allows the researcher to obtain initial-hand knowledge and primer insight into the research issue. The researcher uses primary and secondary data collection methods for the research study. Those data collection methods will show various experts and respondents' expectations and ideas regarding the efficiency of drone delivery services in Oman during and after the coronavirus crisis. The researcher aims to answer the study questions and collect valid and reliable information using primary and secondary data collection techniques.

#### 3.4.1 Primary data collection sources

The researcher decided to use a qualitative method as a primary data source for the entire research study. For this research, the researcher will conduct interviews, a loosely structured qualitative interview with people who know about the topic of the study. The semi-structured interview allows the researcher to ask questions, seek new insights and assess phenomena from several perspectives (Aspers and Corte, 2019). It also allows the researcher to learn in-depth about the efficiency of drone delivery services in Oman during and post the COVID-19 era. Using the interview as a primary data collection source allows the respondents to raise valuable data and problems that the interviewer may not expect.

#### 3.4.2 Secondary data collection sources

The secondary data collection source refers to the information collected by someone else other than the researcher. It provides insights into the research field of the recent state-of-the-art approach. The secondary data collection source also creates a kind of research gap that the research must fill. This type of data collection could be external and internal data sources of information that may cover a wide range of study fields (Aspers and Corte, 2019). The researcher conducts the literature review as a secondary data collection source via using several database sources. The search strategy of the literature review focused on academic articles, journal articles and books. Before the screening, the researcher reviewed a sample of more than 400 academic articles, journal articles, books, reports and websites to determine whether to include them for further review or reject them.

## 4. Findings and analysis

Chapter four will present the analysis and the findings inferred from the semi-structured interviews with several respondents. The outcomes linked with the research questions, which guided the whole research. This part of the research study solely focuses on earnestly





















