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BUSINESS DEVELOPMENT MODEL IN AN EMERGING SECTOR: DRONE CITIES

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Abstract

Recently, the use of Unmanned Aerial Vehicles (UAV), also known as “drones”, has changed from a mainly military use into finding some potential applications in the civil field, and it is raising as a solution for a wide range of businesses. Some cities aiming to be “smart” are seeking to implement these devices with different purposes such as crowd and traffic management, natural disasters monitoring or civil security control.

However, there is a lack of information about government regulations, available suppliers, value proposition, revenue model, etc. for this technology. Thus, this thesis aims to develop a business model for the emerging sector of drone cities, with the focus on those UAVs capable of providing passenger transportation services in Dubai, the city in which its implementation is most advanced.

With this purpose, the literature will be extensively reviewed. After obtaining a good understanding of the technology and its business, a framework for drone cities will be elaborated, containing all the elements that must be considered for drone integration in smart cities. Finally, the author will develop the business model with the Canvas approach and evaluate it via expert judgement.

Key words: Unmanned aerial vehicles, Business model Canvas, drone cities, drone technology.

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UAV	Unmanned aerial Vehicle
RPA	Remotely piloted aircraft
UAS	Unmanned aerial systems
ICT	Information and communication technology
MAV	Micro aerial vehicles
VTOL	Vertical taking-off and landing drone models
LASE	Low altitude and short endurance drone models
LALE	Low altitude and long endurance drone models
MALE	Medium altitude and long endurance drone models
HALE	High altitude and long endurance drone models
AAV	Autonomous aerial vehicles
UTM	UAS traffic management
NASA	National aeronautics and space administration of the US
ASTM	American society of testing materials
FAA	Federal aviation administration
EASA	European aviation safety agency
IoT	Internet of things
B2B	Business to business

1 Introduction

This section gives an overview of the thesis research project as provided in the following headings: background of the Study, aim and objectives, significance of the Study and research methodology.

1.1 Background of the study

There is a new generation of Unmanned Ground Vehicles, Unmanned Maritime Systems and Unmanned Aerial Vehicles. The last one is going to be the focus of the thesis. They are also referred to as drones or Remotely Piloted Aircraft (RPA) (Lemieux, 2013).

Unmanned Aircraft Systems have shown many applications, such as agriculture or goods transportation, and specially the topic has acquired more importance with the appearance of smart cities and the willingness of some governments to integrate drones in them. Well-known transportation companies like Amazon or UPS contributed too to the diffusion of the technology.

Drone sales in the United States exceeded 250,000 units in 2014 and are forecasted to increase exponentially in the coming years (Foina et al., 2015). Even though this technology offers a wide range of applications, there is a gap on the literature regarding drones and their integration in smart cities. Therefore, this thesis seeks to understand this emerging market and to develop a business model for an innovative passenger transportation service.

1.2 Aim and objectives

1.2.1 Aim

The aim is to perform a study about drone technology and the suitable business development model for their implementation in smart cities. This will be based on performing a literature review, this will give the author the understanding for developing the business model, which will be later evaluated via expert judgement.

1.2.2 Objectives

To achieve the above aim of the project the following objectives were set:

1. To perform an extensive literature review about drone technology, applications and legislations.
2. To propose a conceptual business model for Drone cities.
3. To validate the business model via expert judgment.

1.3 Significance of the study

The absence of a business model for drone use in cities means that there is a lack of a structured thinking about how to provide this service offering and how to make a benefit out of it. This study offers an initial framework to bridge this gap.

Further work is however needed in terms of analysing business acceptance, research on new technologies with potential applications to the business and finding how advanced are the regulations of the government for unmanned aerial vehicles.

1.4 Structure of the report

The thesis report is structured in the following way. First, the research methodology is shown, where the phases of the project are detailed as well as the main deliverable for each of them. Second, the author included an introduction to drone technology and their current business applications, which is a result of a review of the literature. After, the different elements needed for drone integration in smart cities are presented in the form of a framework for their implementation, result of the understanding obtained from the literature review and the feedback provided by the top management of *Al-Zahra Private Hospital Dubai*. Finally, the author developed a business model for drone cities and evaluated it via expert judgement. As a summary, and for concluding the report, the author will present a discussion or analysis of his confidence in the results and the main problems that had to be faced through the project, a conclusion and future steps.

2 Research methodology

The following table shows the research methodology followed by the author for the elaboration of the thesis. The phases, the different tasks that compose each phase and its deliverables will be explained with detail.

Phases	Key Tasks	Deliverables
1. Review of the related Unmanned Aerial Vehicles literature	1.1 Identification of the different elements involved in drone technology 1.2 Smart cities and drone integration	Literature review report and understanding of drone technology
2. Development of the conceptual framework	2.1 Identification of the different elements needed for drone integration in cities 2.2 Representation of the different elements needed for drone integration 2.3 Identification of drivers, challenges and current situation of each element	A framework for drone implementation in smart cities
3. Drone cities business model development	3.1 Research on different business models 3.2 Definition of the business model and its characteristics 3.3 Business model representation 3.4 Development of the different elements of the model	Drone cities business model for drone cities
4. Evaluation of the business model via expert judgement	4.1 Evaluation of the model via expert judgement in *Al-Zahra PVT Hospital Dubai*	A validated business model

Table 1. Research methodology.

The following describes the key tasks for each phase in the research methodology.

<u>Key task 1: Review of the related UAV literature review.</u>

1.1 A literature review was performed to synthesise the different elements that compose drone technology, how developed it is and the current capabilities of different drone models. In addition, the author will seek to find a generally

accepted drone classification and obtain an understanding on the different specifications of each class, as well as researching on the different UAV applications and on the different business models that are currently being applied, and how effective and reliable they are.

1.2 Identification of the concept of smart cities, currently existing ones, willingness of the government for integrating drones and the different challenges for this implementation consecution.

Key task 2: Development of a drone city framework.

2.1 Identification of the different elements that need to be considered for allowing an effective drone integration in cities.

2.2 Representation of the requirements for drone integration in the form of an ad-hoc chart.

2.3 Further development of these elements with a focus on the drivers, challenges and their current situation in terms of how advanced their development is.

Key task 3: Canvas business model development.

3.1 Research on different accepted business model and their advantages and disadvantages

3.2 Presenting and defining the chosen business model, and analysing its characteristics.

3.3 One-page representation of the business model for allowing a more visual understanding of it.

3.4 Developing of the different perspectives of the business model, which will serve as framework for any business willing to exploit drone services in cities.

Key task 4: Evaluation of the model via expert judgement.

4.1 The author travelled to Dubai, a city willing to integrate drones for passenger transportation, and the top management of *Al-Zahra Private Hospital Dubai*, who are in direct collaboration with the *Dubai Future Foundation*, evaluated the business model.

3 Introduction to drone technology and businesses

The unmanned aerial vehicles, also known as unmanned aerial systems or drones, have reached a good level of development. This section is aiming to review the literature in order to obtain a good understanding of this technology. Their classification, the current applications of these systems and the role of the industry 4.0 are shown in the following points.

3.1 UAS Classification

UAS could be divided into three different categories depending on their purposes, which are safety control, scientific research and commercial applications (Mohammed *et al.*, 2014a).

Even though there is no such an international generally accepted classification for UAV's, the United States department of defence has divided them into 6 different groups depending on their size, flight endurance and capabilities. Many authors such as Lemieux (2013), Watts, Ambrosia and Hinkley (2012), Bristeau, Callou and Vissière (2011) and Homainejad and Rizos (2015) have adopted this classification for their research purposes, so this nomenclature is the most frequently stated and generally accepted. The classification is as follows:

1. **Micro or Nano (MAV):** These devices are often used with spy purposes by the military defence public departments, as their size is too small for carrying loads or to combine it with embedded sensors. They fly at very low altitudes and always within the Visual Line of Sight (VLS), with short-duration batteries of around 5 minutes. They often imitate the shapes of little birds or insects and their commercial uses are constrained by their size.
2. **Vertical take-off and landing (VTOL):** UAV's with fixed-wings become a problem as their dimensions are enlarged; they require runways and flat and wide spaces for taking-off and landing. The use of VTOL raised as a solution to this problem, as they have many manoeuvrability benefits and can be used in remote areas or disaster regions where conventional aeroplanes flights are constrained. The size of this drones varies widely,

and depending on its smallness the requirements for sensor embedding, endurance, wind influence, altitude, range of operation, etc. are increased.

3. **Low altitude and short endurance (LASE):** This type of UAV can only fly within the Visual Line of Sight and during times of between 45 minutes to 2 hours. Typically, require small runways for taking-off and landing, but due to their small size some models could also been launched by hand or with catapult systems.
5. **Low altitude and long endurance (LALE):** It flies at altitudes of up to 3.100feet with an endurance of 20 hours or more, and are usually designed for carrying payloads of several kilograms.
6. **Medium altitude and long endurance (MALE):** MALE UAV's fly at an altitude range of 9.800feet to 30.200feet for extended durations of time, typically 24 to 48 hours, and distances of up to hundreds of kilometres.
7. **High altitude and long endurance (HALE):** These are the heaviest vehicles of the classification, and often it is often found that they are larger than manned aircrafts. These UAV's could operate at altitudes over 65.000feet, being capable to carry heavy payloads during thousands of kilometres.

In the following Figure 1, we can see the representation of the different type of drones and where they operate.

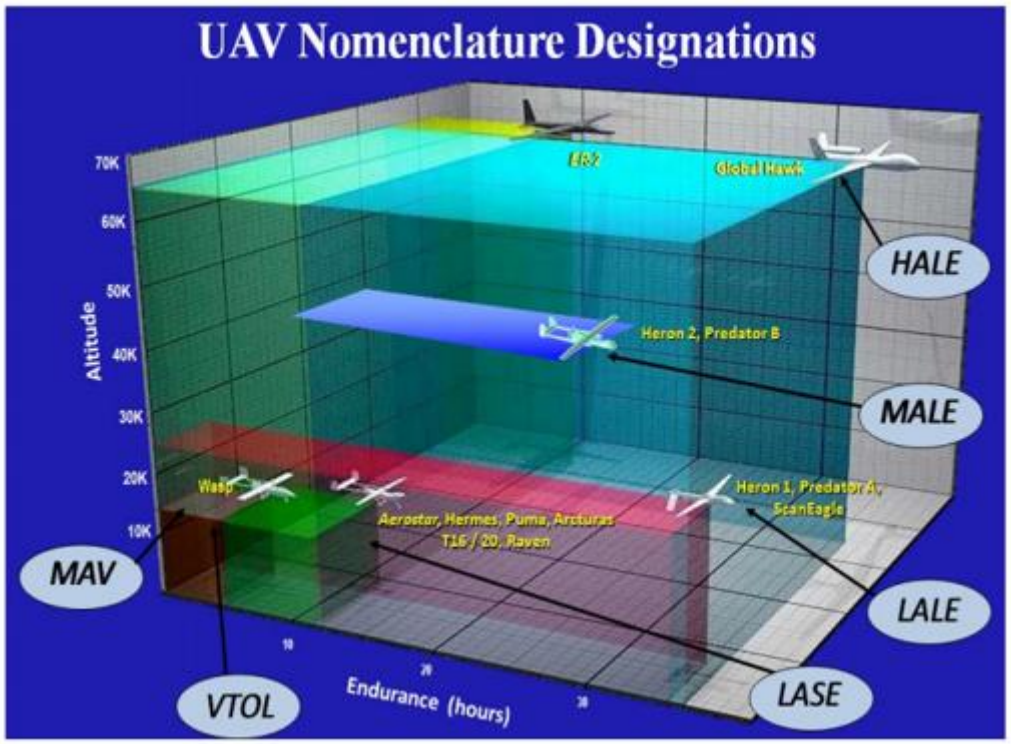

Figure 1. Representation of the different type of UAV's depending on the altitude on where they operate and they endurance (adapted from the US department of Homeland Security).

3.2 UAV Applications

UAV could be applied into many different sectors and businesses. These applications are categorized under three main titles: Safety control, scientific research, and commercial applications (Kharchenko and Prusov, 2012; Watts, Ambrosia and Hinkley, 2012; Mohammed *et al.*, 2014b).

The first point refers to the activities of surveillance and monitoring, natural disaster and emergency situations control, crowd traffic management, borders patrolling, etc.

Scientific purposes include but are not constraint to those which are addressed to monitor the environmental variables, such as the pollution, water, vegetation, wildlife, etc. Surface analysis and any other purposes that could be carried out from the air are also included in this category.

Finally, commercial applications are those applied within the context of private companies with the aim of improving business processes or service offering, at a

reduced cost or through a reduce in the needed resources, leading to an increased advantage of the organisation against its competitors. Transportation, crops fertilisation or building maintenance are just some examples from a huge list.

However, according to the author, the most important is not to state all those applications where UAV have already been tested, but to analyse the trends and future of the commonly called drones, so every involved stakeholder will have the capability to imagine and understand the potential uses of this technology. With that purpose, a list of “basic directions of unmanned aircraft applications in civil fields” has been developed (Kharchenko and Prusov, 2012) as follows:

- Detection of small size objects
- Air traffic control
- Maritime traffic control
- Development of the telecommunications network
- Aerial photography and earth’s surface control
- Control of environmental conditions
- Application in agriculture and exploration
- Oceanology

Even though there are many possible applications of UAV, the use of aircrafts for applying fertilizers and pesticides is the most evolved of the previously stated applications, until the point that are currently being used in agriculture. However, their use entails some drawbacks such as the existence of air forces which result in overlapped or non-covered areas or the difficulty of the crops edge spraying. Recently, the development of UAV technology has sorted out most of these problems, and it is starting to replace other spraying methods, which are getting obsolete (Grenzdörffer, Engel and Teichert, 2008; Braun *et al.*, 2012; Tang, 2015).

3.3 The role of the industry 4.0

The term Industry 4.0 refers to the fourth industrial revolution. Same way the previous three revolutions did, it means a change in how the industry is currently perceived, and will increase exponentially the potential of every business when

effectively implemented (Rüßmann *et al.*, 2015). The industry 4.0 involves the integration of the physical and the digital world, allowing an increased adaptability of businesses (León, Hernández-Serrano and Soriano, 2010; Gubbi *et al.*, 2013). Its importance to the drone technology could be summarized in the following:

1. Allows a huge increase in data volumes, computational power and connectivity. This is a major for being able to gather data from UAV's and analyse it (Borgia, 2014; Mukherjee *et al.*, 2017).
2. The emergence of big data analytics and business-intelligence capabilities will allow to extract knowledge from the previously collected data, and to act consequently to it (Li, Xu and Zhao, 2015). Decision-making will be therefore more accurate and automated.
3. The improvements in transferring digital instructions to the physical world will enhance the drone performance.

In addition to the previously stated benefits, the manufacturing of drones will become more cost-effective. Big data analytics, the internet of things, cloud computing or system integration are some of the enabling technologies of the industry 4.0 and their direct application to drone technology will increase its potential of use by enhancing the collection, transmission, processing and utilization of larger amounts of data (Chen and Storey, 2012; Raghupathi and Raghupathi, 2014; Wortmann and Flüchter, 2015).

4 Smart cities and drone integration. A framework for its implementation.

This part of the report aims to identify the different elements needed for drone integration in smart cities.

The concept of “Smart city” is new and ambiguous, concerning the fact that many different definitions could be found in the literature review. Even though, through an extensive research some common patterns have been extracted, and a definition englobing the thinking of the different authors have been stated: A Smart city is determined by the using of web 2.0 and smart computing technologies for the integration of all the elements composing a city, leading to an automated self-decision making and a forward-thinking development and sustainable approach (Chourabi *et al.*, 2011; Foina *et al.*, 2015).

Due to the constant developing and shifting nature of smart cities, a framework that helps and promotes innovation must be implemented within it. According to Mohammed et al. (2014a and 2014b) and Chourabi et al. (2011), there are eight main elements which drive smart cities initiatives, impacting in their possible success or failure:

1. Management and organisation – It refers to the top-management of the smart city, their skills, attitude, leadership, behaviour, willingness to change, etc. In resume, the alignment of the organisation and the city goals.
2. Technology – Every smart city must be backed up by a well-developed set of hardware, software and network technologies. Big data analytics, internet of things, different sensors allowing data gathering, etc. are raising topics that must be considered for the consecution of a real-time monitoring and awareness of every relevant issue, and for detecting, forecasting and preventing possible disruptions or problems.
3. Governance – Refers to how the management communicate with the inhabitants of the city. It is important to take into account citizens participation, as well as regulate in collaboration with private stakeholders and organisations (Mohammed *et al.*, 2014a, 2014b)

4. Policy – Includes all the laws and regulations that constraint or enable the different initiatives within a smart city.
5. People and communities – Their acceptance has a direct impact in the success of an initiative or change within a smart city. The engagement with the management and government of the city becomes a main issue at this point.
6. Economy – With economy it's meant the competitiveness of the city. The entrepreneurship, growth, innovation, investment capabilities etc. are some of the economy factors and are the main driver of a smart city.
7. Infrastructure – The smart city must be based on a well-developed Information and Communication technology (ICT) infrastructure, with a high level of security and privacy at an efficient operational cost.
8. Natural environment – Sustainability, enhancing renewable energies, reducing pollution, protection of natural resources, etc. becomes a main issue for the city sustainability and must be enhanced with the use of new technologies.

For the specific purpose of integrating the unmanned aerial systems within a city, the author has developed a model based on the previous eight core drivers, as shown in Figure 2. This model evinces 5 main elements which influence the initiative, and will become a major for an efficient and safety drone integration in smart cities: "1. The UAV", "2. Infrastructure", "3. Technology", "4. External factors" and "5. Initiative acceptance". These elements are detailed in the following sections. Figure 3 is a 3D representation of the Dubai drone city scenario.

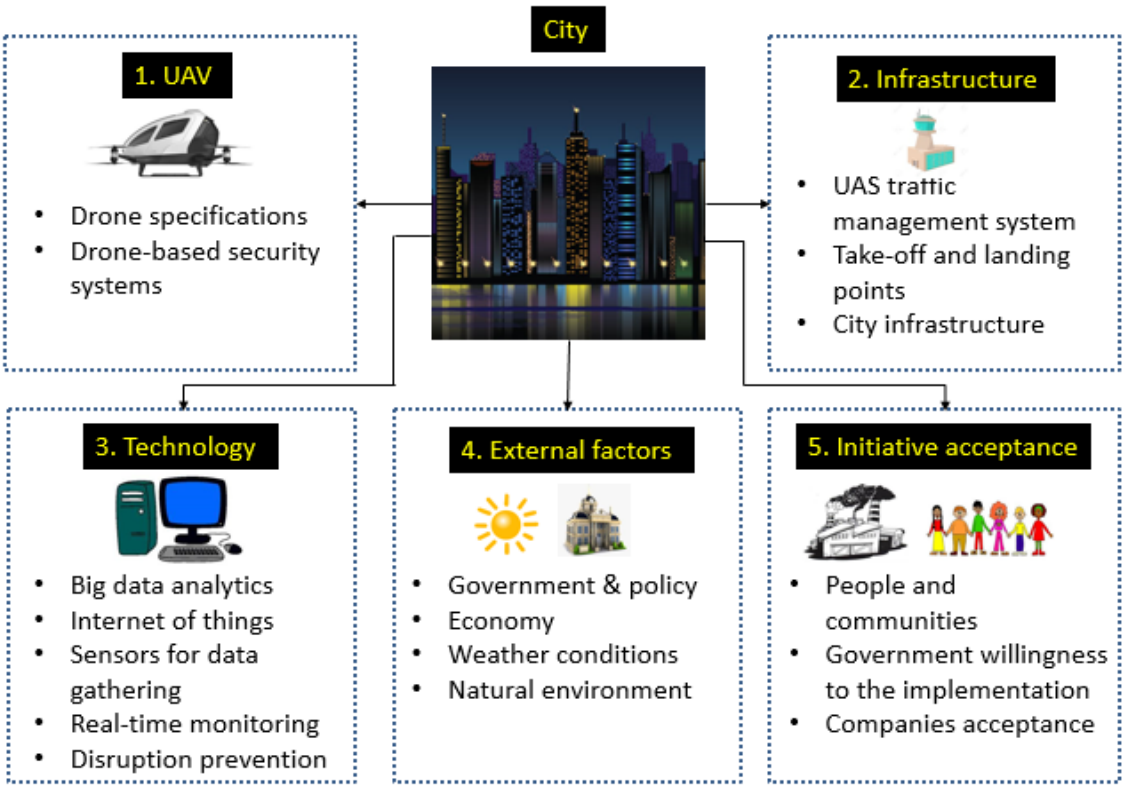

Figure 2. Elements needed for drone integration in cities.

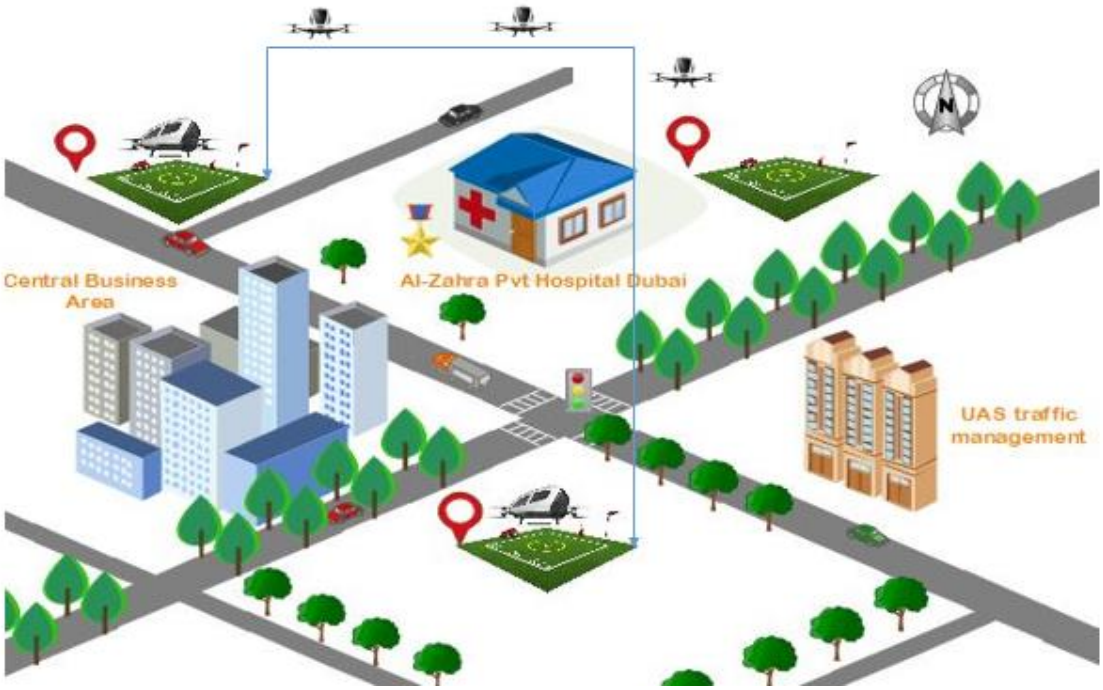

Figure 3. 3D representation of Dubai drone city.

4.1 Unmanned Aerial Vehicles. Ehang 184 Autonomous drone model

The EHANG 184 Autonomous Aerial Vehicle (AAV) is a drone model shown in Figure 4 and developed in January 2016 by the Chinese company Ehang, Inc., a world-leading technology enterprise of intelligent aerial vehicles. This model is the only one currently providing a safety environment for passenger transportation and the company is looking forward to implementing their drones in Dubai city as a transportation service provider's.

This UAV is electric-powered, which make it a fully autonomous model. It can transport 1 person with a big luggage of 150kg with an endurance of 31miles or 30min, and flies at speeds up to 60miles/h, even though its design allows to fly at >99miles/h.

Figure 4. EHANG 184 design and specifications (Adapted from Ehang, Inc. Official website, http://www.ehang.com/ehang184/, accessed on 05/07/2017).

The 184 AAV has embedded with a fail-safe system, which purpose is to ensure the passenger safety in the case of the failure of one of its 8 motors or other component, by allowing a normal flight and designing a flight plan for an emergency landing. Its communication is secured with encrypted codes.

The UAV is equipped with a user-friendly interface, shown in Figure 5 which will only require the passenger to insert his/her destiny to the system and will give

information related to the battery, current location, speed, weather conditions, altitude, route, etc. Then, the drone will automatically perform an inverted “U” shape flight from point 1, where the passenger is actually located, to point 2, the destination, as shown in Figure 6. Regarding point 2 in the figure, where the landing takes place, this will be performed by previously settled points marked with a logo, which will be automatically recognised by a camera embedded in the UAV, resulting in a comfortable and accurate landing.

Figure 5. User interface of the EHANG 184 AAV model for passenger transportation (Adapted from Ehang, Inc. Official website, http://www.ehang.com/ehang184/, accessed on 05/07/2017).

Figure 6. Airway path followed by EHANG 184 AAV in a typical flight.

All the UAV's would be connected to a low-altitude command centre, which would together with other functions regulate the flights of all the devices, prohibit the taking-off when extreme weather conditions, monitor possible failures, etc.

4.2 City infrastructure

For integrating UAS into a smart city, a UAS traffic management system (UTM), which considers a wide range of inputs and variables playing an important role or could interfere on it, such as weather or air conditions, man built infrastructures, flight purposes, live-response to unpredicted issues, emergency landing procedures, etc. must be implemented. The National Aeronautics and Space Administration of United States (NASA), as explained on their extensive work, have been working on it, setting up the different UTM models and specifications. Through their research of the business, two UTM models have been envisioned (Kopardekar, 2014):

1. Portable UTM system – This type of system will be moved from one area to another, and could be useful for agriculture purposes, for example.
2. Persistent UTM system – This system will be based on high-complex data and will provide a wide range of solutions, as for example airspace configuration, air-traffic regulations, automated UAS monitoring, constraint management, contingency management, etc. These tools must be provided throughout a set of autonomous and automated system.

According to Foina et al. (2015), the implementation of UAS's in smart cities is challenged by the fact that it must be accompanied with such a network of people, tools, processes and technology that allow a safety environment for the population and a minimum number of disruptions. With this purpose, three main elements that must serve as a basis for managing the low-altitude air traffic within a smart city have been identified:

1. Planning cloud-based platform – The very first purpose of this platform would be to create the air-highways, considering buildings, possible interferences or any other elements that could constraint the UAS's pathway. In addition, it would involve the flight planning services.
2. Drone and smart city infrastructure coordination – The first step on this point is to assign responsibility of every UAV flight to one person. After, the specifications and requirements for drones must be settled. This could be done through a special licence or accreditation as well as analysing flight data to ensure that it follows all the city and authorities' regulations.
3. Drone-based security systems – Every drone must include a system for avoiding collision. This is a current challenge of the market as the range of detection mustn't be too far nor too close, as this could cause possible accidents or disruptions respectively. Further work on security is still needed on this point.

4.3 External factors

The allowance of implementation is highly influenced by external factors that are out of power or cannot be controlled. For example, the economy of the city in which UAV's want to be implemented is very important, as the initiative management will have to invest on it and they will be expecting a certain payback. Both the investor and the possible customers need the purchasing power for buying the technology and building the required network.

Another factor which may interfere the health and safety perspective of the drone service providing are the weather conditions, that could influence and hinder the UAS flight. The Ehang 184 drone model includes a balance system which ensures the safety of the passenger, being able to perform an emergent-landing if weather conditions become a hazard. The natural environment is also important

at this point. For example, in the Dubai city specific case, drone manufacturers may have to consider the drone protection against sand storms, as Dubai is located on the dessert.

Finally, the most important external from the author point of view are the government regulations, explained in the following point 4.4.

4.4 UAS Legislation

From the previous points there is a common pattern which can be inferenced, the potential of UAS's. However, due to their nature some risks are associated to them and it is critical to develop a set of rules, standards and regulations for managing them.

The American Society of Testing Materials (ASTM), which is a company in charge of publishing and organising international rules, developed three different categories into which the standards regulating the UAV's could be framed. (Cork *et al.*, 2007)

1. Airworthiness standards – Serve as a basis for regulating the design, specifications, materials and every element which makes part of the hardware of the UAS.
2. Operation standards – Are those related to the operational uses of the UAS's, such as its flight and interactions with other aerial vehicles when taking-off and landing.
3. Qualifications standards – Standards referred to the individuals who - manipulate and control the UAS's. Seek safety practices among the users.

Most of the regulations for UAV's are addressed to constrain somehow their use in order to prevent accidents within their airspace and to increase the safety of the people on the ground by not permitting the misuse of the unmanned aircraft vehicles. For example, in the United States, the Federal Aviation Administration (FAA) is the responsible for settling different requirements related to the equipment, space restrictions or guidance of both manned and unmanned aircrafts, as well as for the supervision of its proper accomplishment. This commission has even developed a certificate of authorization for every UAV belonging to a public entity, declaring that it is able to fly and witnessing that

drones meet with all the requirements and do not represent a threat for the security.

For civil-operated UAS and optionally piloted aircraft, the kindred standard in the USA is the “Special Airworthiness Certification”. However, there are some abstract regulations which forbid their commercial use and constrain their flight to only hobby affairs and during light hours, and it is only in the last few years when their use is opening to commercial operations.

The general regulations in Europe are very similar to those which apply in the United States, but the law could differ from one country to another. The entity which, as the Federal Aviation Administration does in the United States of America, regulates and unifies the different air standards and rules in the different members of the European Union is the European Aviation Safety Agency (EASA).

Eurocontrol is another intergovernmental organisation which, in support to EASA, and covering both operational and technical elements, seeks to achieve a single European sky concept.

Another entity which has been recognised by the European Commission as competent for the standardisation and interoperability required for the European unique airspace is the European Organisation for Civil Aviation Equipment and more specifically the working group 73. This force is specialist on UAV and work closely with the EASA in order to enhance the development of airworthiness criteria based on the current air traffic management regulatory framework. This organisation is specialised in airborne electronic equipment.

As shown in Figure 7, there are six types of airspace. The FAA pays special attention to those where the risk is higher, as for example class A, where commercial planes fly, or classes B, C and D, where the airports and cities are allocated. Finally, airspace belonging to class G is where there are not many rules applying and it is the space reserved to unmanned aerial systems for the moment (between 700 and 1.200 feet) (Mohammed et al., 2014a).

Figure 7: Types of controlled airspace (adapted from the FAA webpage, accessed the 02/06/2017. www.faasafety.gov)

4.5 Drone cities initiative acceptance

After the research of the literature review, the author has identified a knowledge gap about the acceptance of such an initiative from both the customers and the businesses in the city. This gap should be addressed by a field study, through surveys and interviews with relevant people. This field study will be the main part of the future work needed for effectively running the business.

4.6 Business challenges of establishing drone cities

Every city seeking to implement UAS will face many different challenges which could be divided into two different categories: Technical and business challenges (Mohammed *et al.*, 2014a). For the purposes of this thesis, the development of the business model, the author has focused the research on business challenges, which are resumed on the following:

1. Ethics and privacy – Due to the increasing connection of the smartphones, sensors, etc. with each other, derived from the implementation of web 2.0 technologies, citizens could feel that their privacy is being invaded. This fact is leveraged by the use of UAVs for the surveillance activities. This issue must be addressed by the management and government of the city, making understand everybody the benefits it entails in terms of safety or risk management.

2. Cost – As UAVs are a relatively new technology, their cost of development could be high in comparison to the benefits they will have associated. Therefore, efficient product development techniques must be implemented and investment in research and development must be empowered.
3. Licensing and legislations – In a context of a fast-development technology, UAVs and their use must be controlled regulated. In addition, the law frame must be flexible in order to advance as fast as the technology and the city environment does.
4. Business adoption – Regarding the private company environment, it is a challenge to implement these new technologies due to their high cost. However, they could become a strategical advantage and well-known companies, as for example Amazon, are making a big effort in trying to implement them and being a first mover in the market.

5 Canvas business model for drone cities

After a research on the different available business models, the author has decided to use the Canvas business model. Due to the rapidly-evolving nature of the business, which is based in highly innovative technology and principles which have quickly shifting natures, there is a need to formulate a flexible framework which provides a single focus on long-term strategies, as well as defining short-term managerial and functional aspects of the business (Zott, Amit and Massa, 2011; Joyce, Paquin and Pigneur, 2015). Canvas takes into account all these elements with its definition of the 9 different perspectives of the business (Al-Debei and Avison, 2010; Dudin *et al.*, 2015):

1. Value propositions.
2. Customer segments.
3. Revenue streams.
4. Cost structure.
5. Key activities.
6. Key resources.
7. Customer relationships.
8. Channels.
9. Key partners.

If the model is effectively implemented it will allow the company to maximise their profits, competitiveness and sustainability (Massa and Tucci, 2013; Zolnowski, Weiß and Böhmann, 2014). Figure 8 shows the Canvas business model for drone cities. This business model Canvas have been revised and validated by expert judgement from the *Al-Zahra Private Hospital Dubai*, who are in collaboration with the *Dubai Future Foundation Accelerator Program*, the organisation responsible for researching and implementing new technologies in the United Arab Emirates.

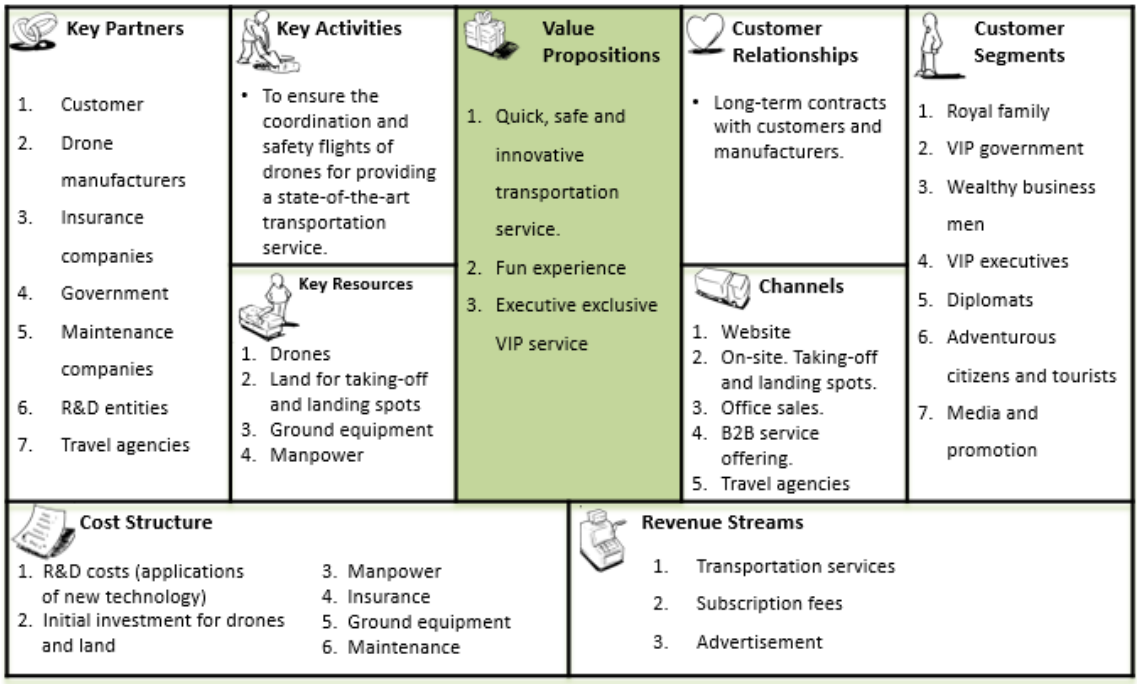

Figure 8. Canvas business model for drone cities

5.1 Value proposition.

The first element to be explained is the “value proposition”, highlighted in green in Figure 8. The whole business model is characterised by an explicit focus on value and value creation, and the added value return that the operator is able to provide to its customers, and thus the price they are willing to pay for the service, which will determine the benefits assuming an optimum productivity and performance by the company running the business (Zolnowski, Weiß and Böhmann, 2014). This value will become the difference between the business and its competitors. In the drone cities business model this value is characterised for being new and innovative, solving the problem of time constraints in a way it hadn’t been possible before.

As this Canvas model is being developed as an example of disruptive innovation, the main value creation is stated in point 1: “A quick, safe and innovative transportation service”. This means that the drone transportation service model offers the opportunity to overcome the main drawbacks associated with typical transportation methods to customers, such as traffic jams, a lack of security on non-automated vehicles, human error and the problem of long distances travel.

The second point of the value proposition is to provide a “fun experience”. Having the opportunity to observe the breath-taking landscape and views of the city will attract a wide range of customers, varying from local citizens to tourists who come to Dubai from all over the world. This latter group are increasingly looking forward to an experience-based tourism rather than the more traditional experience associated with cultural or monument visits (Stamboulis and Skayannis, 2003).

Finally, the drone transportation service will provide an “executive exclusive VIP service” to a more distinguished customer base, such as, those belonging to the royal family, government or to any other highly-influential group. In turn, this will emphasise their status difference against the rest of the society.

5.2 Key activities.

With the purpose of effectively delivering these previously stated values to the customer, the business operator will perform the different activities embedded within its main objective, which is to ensure the coordination and safe flight of drones in order to provide a state-of-the-art transportation service.

As a summary, all those tasks or activities that need to be performed for the consecution of the business processes and the company goals will be designed with a responsible, a set of tools and procedures and a pre-determined timing assigned for each task. Analysing the data coming from drones, gathered thanks to the Internet of Things (IoT) and the use of different sets of sensors, combined with the use of big data analytics for predicting possible disruptions or detecting problems, will allow the management to act to limit the potential for possible accidents or hazards to the passengers.

5.3 Customer segments

Once the value propositions have been defined, the next step is to target the different groups of customers to whom this value is addressed and among which the company will make up its customer basis. These have been divided into seven different groups according to different criteria such as wealth, social class or job position.

First, the royal family, who in the UAE culture are well-known and highly-respected. They will be interested on using the quickest and safetiest

transportation method, as they are busy and for them time is more valuable than money. They will serve as an example for the rest of inhabitants in the city, who would want to follow the trend created by their leaders. With many similarities to the royal family on the reason why they have been included as a customer segment, the author has included the top-government staff and diplomats, who are also influential to the rest of the citizens and their public opinions could determine the success or failure of the business.

On the other hand, even though royal family and public figures will be very important for the business, those segments from where the biggest number of customers will belong are the wealthy business men and executives. Again, these people meet all the conditions required for demanding the service: willingness to pay higher fees for transportation and time constraints due to their respective affairs.

Finally, and following the value proposition of providing a fun experience, we find those customers who are neither wealthy nor influential, but who are seeking to experience a great activity and in which they are willing to spend a high percentage of their saves; tourists and national citizens compose this group. In addition to all of the previously stated customers, the author has also considered important to include the media and promotion, as the service will be accompanied by some stir, which repercussion will reach the whole world. Therefore, including some visual advertising on the drone has been considered as another possible income stream.

5.4 Revenue streams

After the value proposition and the customer segments have been identified, the next step is to figure out how the company is going to make a benefit out of it, and to define the main revenue streams. It becomes a major for the company to plan the different activities and efforts on trying to maximise the profits and its customer orientation, and to take into account the different external factors with a potential impact on these variables. Such planning will allow the company not only to perform effectively in terms of finance but also to maintain and increase its competitiveness. Three main income sources have been defined: Transportation services, subscription fees and advertisement (Dudin *et al.*, 2015).

The biggest source for the business operator will be the fees charged from the transportation service. This payment could be either charged directly in the taking-off spot by the employee in charge or in the central office of the company. If a specific customer is interested on recurrent transportation services, he may want to buy a subscription, which could be either a weekly, monthly or annual one. This subscription will offer different options (e.g. unlimited transportation or a discount on each transportation).

Due to the innovative nature of the business, it will carry an associated relevance for the media. The company can exploit this business opportunity by collaborations with private companies for their sponsoring and advertisement of their brands in exchange of certain charges.

5.5 Cost structure

Following to the revenue streams and how to make money out of the service, the author will analyse the opposite perspective of the business model, the cost structure. This structure should be adaptive and oriented to the future, especially in such an innovative business model (Dudin *et al.*, 2015). Due to the financial nature of it and the deep level of detail with which the author has developed it, this cost structure is detailed in Appendix 1.1.

Research and development, drone technology, land costs, manpower, insurance fees, ground equipment, maintenance or taxes are the main costs the company will have to face, and have been classified depending on if they consist on a unique investment or if on the other hand they are recurrent costs.

5.6 Key partners

The business partnerships become of major importance for effectively delivering the value proposition to the customer. The following defined collaborations will be developed from year 1 and are planned for not to vary widely throughout the running of the business, although some of them, as for example the insurance company, could change from one provider to another one offering the same service at a lower price.

The importance of building and managing long-term relationships with customers becomes a major for the business, particularly with those wealthy and influential

users. The purpose of this partnership is to ensure a recurrent use of the service by them, as well as serving as a tool for promoting it to other potential clients.

As the market builds up and the customers become increasingly willing to use the service, the partnership with the drone manufacturer will become more and more important in order to be able to collaborate for developing customised drones with a more specific focus on the customer needs and requirements.

The third partnership the author considered important was the one with the insurance company. Even though the drone is seeking to ensure the patient safety and minimising the risk of possible accidents, the service is still taking place in airways and a minor mistake could lead to drastic consequences. Thus, the operator must secure the service to be covered against a possible accident, ensuring that if it happens it does not result in the closure of the business.

Carrying on with the explanation of the different stakeholders, the author identified the governance of the city, whose influence and regulations are the one constraining or allowing the business to take place. For instance, the airspace in which the drones must flight have an impact in the drone specifications (e.g. highness of flight and endurance capabilities), and so on with any other legislation the government could state, such as airworthiness standards or restricted flying areas. Furthermore, the collaboration between the government and the company will allow them to have a better understanding of the future trends and the different topics the runner of the business should address, being capable to do it at an early stage and thus to anticipating the competitors.

Finally, there is a need of working closely with maintenance companies for performing different recurrent revisions to the company vehicles in order to ensure their correct functioning.

5.7 Channels

Once the main elements needed for running the business have been defined, the company must develop a network of different channels throughout which they can give support to the revenue streams in order to promote and maximise the benefit. These called channels represent the different ways the company has for selling their service.

The first channel is the company website, which must be developed even before the service starts running so the potential customers can start their research on the company proposition, solve their doubts and check the fees, and thus contribute to increase initiative acceptance. Once the service offering is taking place, the customer will be able to purchase it on site.

Secondly, the customer should be able to buy the service in the moment they require it without previous planning, and that is why the service will be sold in the taking-off and landing spots. Basically, the customer will arrive and pay to the employee the transportation fee.

The fourth channel differs with the others in terms that is a direct marketing technique, and consist in B2B sales by approaching directly private companies, in which their management staff could be interested on the time savings that the business value will provide them.

The last channel, addressed to a completely different segment of customers, those who are motivated by living an experience rather than because of time constraints, is exploited throughout travel agencies

5.8 Key resources

The key resources for the business, without with which it cannot be run and in which the company will have to make the biggest effort when comes to the initial investment are mainly physical: Drones, land for taking-off and landing spots and ground equipment and manpower. In addition, the company will require a network of skilled people for managing the technology and settling all the business processes at the beginning of the company life cycle.

Finally, the company will form a set of intellectual resources through the research and development department, which will consist in different patents, the customer basis or the managing of the brand itself.

5.9 Customer relationships

This block of the business model analyses the nature of the relationship between the company and its customer segments. The customer acquisition process should be designed and the relationship established.

There are many different marketing techniques that can attract customers. The company will promote themselves via a website. With the purpose of promoting this website content, the search engine must be optimized for increasing the awareness of the potential customers and getting the service noticed. Social media marketing is another powerful tool that must be exploited.

On the other hand, the company must perform different analytics techniques. There are different companies in the market providing the data, and the runner of the business will have to analyse different patterns in order to obtain a better understanding of their customer requirements and needs.

On the other hand, the company will provide a dedicated personal assistance, with a contact inside the company who will guide them in their customer decision and in any post-service queries. The company will be looking forward to building a long-term relationship with them, as they are likely to use the service more frequently, since their satisfaction could be transmitted by word of mouth.

6 Discussions

It is obvious that there is a huge potential on the integration of drones in cities, and even though the technology progresses adequately there is still work to be done in terms of government regulations, adequation of the city infrastructure or researches on people and businesses acceptance. Different authors have proposed solutions and approaches for these topics, but these do not have transcended to a real environment, where an implementation of solutions is still needed. In addition, the forecasted increase on the number of drones will present as well other challenges that haven't been considered yet, such as managing drone interactions or the large amount of data that these systems will create. These problems will have to be addressed with the help of the wide range of possibilities that the industry 4.0. offers, and more specifically the IoT and big data analytics.

The research methodology developed at the beginning of the project was successfully followed, even though it presented some issues that the author had to face during its first phase. When it comes to the review of the related unmanned aerial vehicles literature, there was an absence of journal papers and other reliable sources of information in topics such as drone applications and smart cities, as both are relatively new concepts. The author had to enlarge the scope of his research into specialized magazines or articles as well. Regarding the development of the drone city framework, the methodology turned out to be practical and easy to follow, and thus it provided the right guidelines to the author. Finally, and after a research on different business models, the author developed the model, which turned to be accurate and with a good level of detail after the expert evaluation.

The author of this report is confident of the reliability of the business model in this project since it was developed from the understanding of a mixture of extensive literature review and the knowledge obtained from *Al-Zahra Private Hospital Dubai*, and extensively with the *Dubai Future Foundation*. Therefore, this mix of sources allowed to get the main elements needed for drone cities. First, a research on different business models showed that Canvas was the more flexible and easy to implement approach in such a futuristic market, as it provided a

standardised template that considered all the perspectives of the business. However, when it comes to the cost structure definition, the author made many assumptions motivated by the lack of specific data, which may reduce the reliability of this element of the model.

Finally, the author travelled to Dubai for obtaining an expert evaluation of the model. Experts agreed that this model will serve as a good start for the business, and that this thesis addressed and represented some of the existing gaps. However, the business model is still at its beginning. The next step in improving the reliability of the developed model would entail getting feedback from several experts, perform a case study for capturing the initiative acceptance from the potential customers and to further investigate the possible applications of industry 4.0 in the crone cities context.

7 Conclusion

The conclusions of this work are summarised in the following points:

- Drones reached a good level of development for considering them for commercial businesses.
- The framework for drone cities implementation has been developed as a result of the lack of information in the literature review, and shows a good representation of the elements needed for an effective integration of drones in smart cities.
- The author decided to represent the business model using Canvas approach as it provides a high level of detail for the first stages of the business combined with a flexible approach for the future, element that was considered essential due to the high uncertainty that the nature of the market entails. This model is visual, logic and shows a good interrelation of the nine core elements that compose it.
- After the expert evaluation of the business model in *Al-Zahra Pvt Hospital*, its potential has been appreciated by different investors, and it will serve as a good start for the development of a real business. In addition, an opportunity has raised, which is assuming the production of the UAVs as a tool for being the first mover and effectively differentiating the runner of the business from other possible future competitors.

8 Future work

Even though this work will serve as a good kick-off for the business, there is still a need of further work in some of its aspects. The future steps are summarized in the following:

- There is a need of investigating on the industry 4.0 applications in drone cities.
- A field study will have to be carried out in order to identify the initiative acceptance, the customer requirements and to determine the price of the service.
- An interview will have to be performed with the *Dubai Accelerator Future foundation* to find how advanzed is the project in their city, and the general guidelines of the government regulations.
- The drone technology has to be improved, focusing on its safety and the interaction between UAVs when flying in the same airspace. Improving the quality of the embedded fail-safe systems becomes a major before an effective integration in smart cities.

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APPENDIX A

DETAILED ANALYSIS OF THE COST STRUCTURE WITHIN THE DEVELOPMENT OF THE CANVAS BUSINESS MODEL

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1 Introduction

This report is an extension of the cost structure within the Canvas business model developed in thesis. The content of this report comprises a detailed initial investment and the subsequent recurrent costs. The different costs in which the runner of the company may have to incur have been divided into two different categories: Initial investment and recurrent costs.

2 Initial investment

In order to be able to provide the service, the company will have to make an initial investment in a wide range of products. The ground equipment is one element to consider before starting running the business.

The purchasing of the drones and the land for the taking-off and landing spots must be considered too. The breakdown of this investments is shown in the following points.

2.1 Drone model acquisition

Due to the uncertainty on the acceptance of the service and in order to reduce the risk for the company in case it is not successful, the company will make an initial effort on purchasing just two drones. This quantity will be enlarged gradually in case the use of both drones goes beyond the expectations, thanks to the flexibility allowed by the partnership with the drone manufacturing company, explained in point 5.6 of the main thesis report.

The drone will reportedly cost between 155.200GBP and 228.800GBP (Ehang.com, 2017). Following the accounting principle of prudence, the worst scenario for the investment should be considered. Thus, the estimated cost of the drone technology for the profit and loses will be 458.000GBP.

2.2 Land for taking-off and landing spots cost

According to the department of land and property and the Dubai annual transaction report (2016), the author has developed the following Table 2, where both the prices per square feet and per square meter are shown for the different areas of Dubai city, as well as the variance of the price between years 2015 and 2016 (Dubailand.gov.ae, 2017). These prices were calculated by dividing the total value of the transactions by the area of land sales. Figure 9 shows the trend in the variance of the price of the land.

Based on transacted rental prices					
Area	2015		2016		Variance (%)
	Price square feet	Price square Meter	Price square feet	Price square Meter	
Arabian Ranches	£155.611,13	£14.456,7608	£136.937,79	£12.721,95	-12,00
Downtown Dubai	£280.100,03	£26.022,1694	£263.501,51	£24.480,11	-5,93
Dubai Marina	£284.249,66	£26.407,6831	£259.351,88	£24.094,60	-8,76
IMPZ	£159.760,76	£14.842,2744	£161.835,57	£15.035,03	1,30
International City	£126.563,72	£11.758,1654	£118.264,46	£10.987,14	-6,56
Jumeirah Beach Residence	£186.733,35	£17.348,1130	£165.985,20	£15.420,54	-11,11
Jumeirah lake towers	£238.603,73	£22.167,0332	£222.005,21	£20.624,98	-6,96
Motor City	£122.414,09	£11.372,6518	£114.114,83	£10.601,62	-6,78
Palm Jumeirah	£238.603,73	£22.167,0332	£219.930,39	£20.432,22	-7,83
AVERAGE	£199.182,24	£18.504,65	£184.658,54	£17.155,36	-7,29

Table 2. Analysis of the land prices and their variation based on the different areas in Dubai.

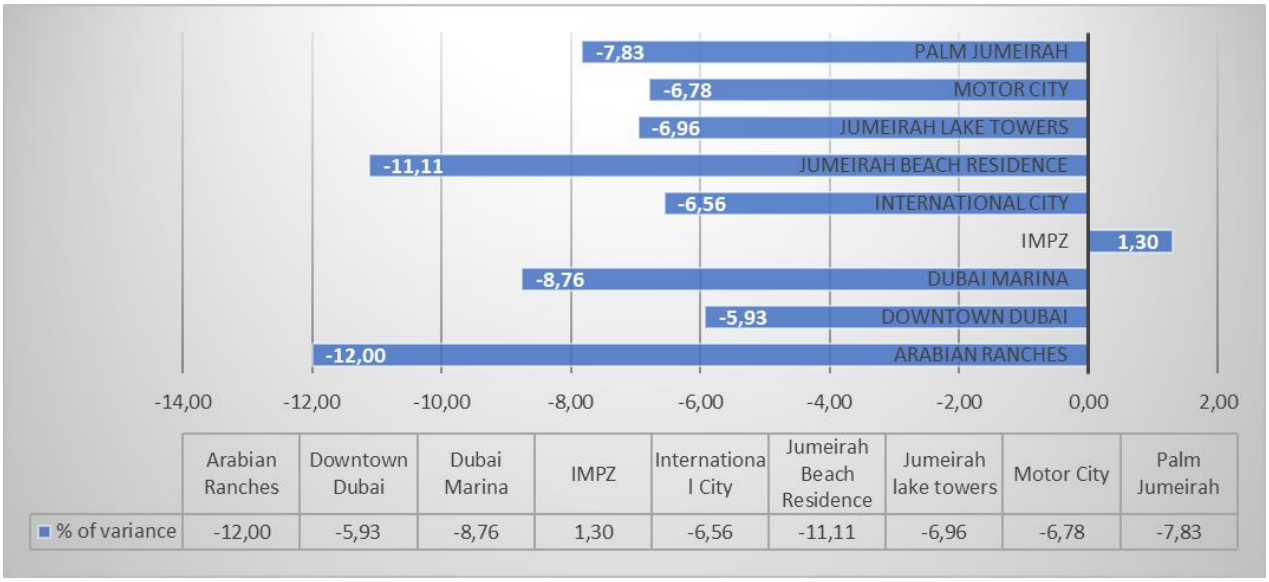

Figure 9. Analysis of the variance of the price of the land in Dubai areas between 2015 and 2016.

According to the analysis, apart from the *IMPZ*, every area in the city suffered an amortization in its value since year 2015. This is a cost that must be considered when investing as it may influence the result of the company.

Figure 10 shows the metering of the drone. The area needed by the UAV is approximately 5 square meters. However, in the take-off and landing spots there will be a need of a safety space and for employees to carry out the required revisions and sales. Thus, we will assume that each taking-off and landing spot comprises 20 square meters (feet).

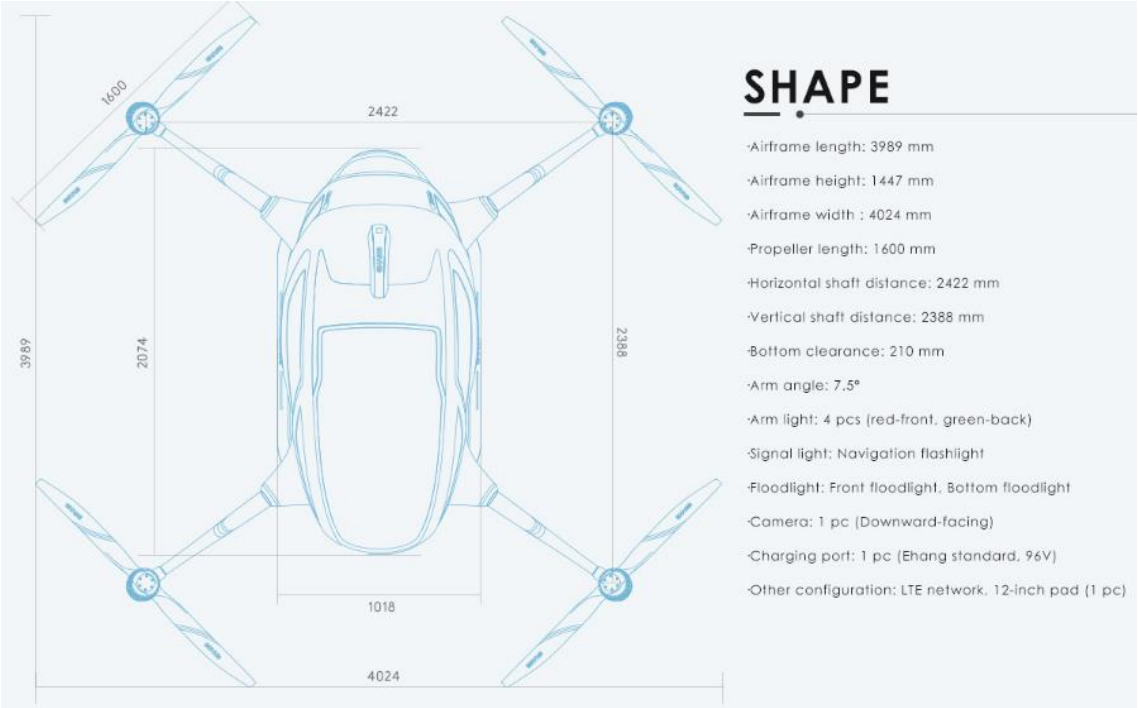

Figure 10. Metering of the ehang 184 drone model for passenger transportation.

18 spots will be allocated for the kick-off of the business, 2 in each area of the city. Therefore, the total cost of the required land is 6,176 million pounds.

2.3 Ground equipment

During the expert evaluation of the business model with the top management of *Al-Zahra Private Hospital* it has been found that the investment in the ground equipment and control tower has already been done and it will be available for whoever runs the business, but the amount of it remains confidential. Thus, this cost will not be considered in this model.

3 Recurrent costs

On the other hand, and after the initial investments have been analysed, there are certain costs that will be repeated constantly during the running of the business: Research and development, manpower, insurance and maintenance costs, both of the infrastructure and the drones. Following, an analysis of these is shown.

3.1 Research and development

In point 4.1.1 of the main thesis report, when analysing the literature review, it was shown that the ehang 184 drone model has an endurance of 31 miles and 30 min, which may not be enough for the purposes of some customers. Thus, for being able to provide a better service and continuously improving the customer experience, research and development costs become a major when it comes to improving the capabilities and comfort of drones. This investment will be of a small percentage at the beginning of the business life cycle due to the cash constraints derived from the initial investment, but will be increased in the following years depending on the business success and the customer requirements.

3.2 Manpower

The United Arab Emirates ministry of labour and economy published an article analysing the average cost of an employee in the country (http://www.dec.org.ae, 2017). The overall annual administrative and recruitment costs per worker are estimated at around 3,40AED (721GBP) for skilled workers and 2,296AED (486GBP) for unskilled workers. Annually cash and non-cash benefits are estimated at around 100,000AED (21.167GBP) (Goby, 2015).

2 employees will be allocated per spot and 5 employees for providing customer service, general queries and administration within the ground control building. Due to the technical nature of the business the author has considered that all the employees are highly skilled. The estimation of the total manpower cost during the first year will be 747.420GBP and 746.954GBP for the following years, increasing every year these salaries according to the inflation of the country.

3.3 Insurance

There are many different insurance coverture types available in the market. However, due to the business risk and the potential impact that the costs of an accident could have for the finance of the operator, it is convenient to sign a “Combined single limit”, covering all public damage and passenger and drone liabilities.

Even though there is a gap in the literature review for the price of such an insurance for drones, and due to the similarity of the service, the author has decided to consider the cost of a helicopter insurance with an increase of a 10% in the price. Thus, the estimated cost of the insurance per year will be 1 million pounds.

3.4 Maintenance

The ehang 184 technology is designed for being fully-autonomous and for not involving any human workforce. However, due to the risk associated with passenger transportation in a city environment, we will assign part of the budget for periodic revisions. Annually, the author has assumed that the drone will require a 5% of its total cost to be allocated to the maintenance and the resolution of unlikely disruptions. This means that the maintenance cost for the two drones will be 23.000 £ per year.

4 References

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