EU-Japan Centre
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THE DRONE MARKET IN JAPAN

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1. Executive Summary / Abstract

Drones have been used in Japan in agricultural applications for more than 25 years. These were, however, not really regarded as drones but just remotely controlled, small-unmanned helicopters, which were used for spraying crops.

The major interest in drones started when U.S. began to use military drones. Chinese manufacturers developed toy drones, which swamped the market not only in China, but also in Europe, US and Japan. Half of all drones registered with the authorities in U.S. and Japan are from one single Chinese manufacturer, DJI.

At present, the worldwide drone market consists mainly of military drones, supplied by U.S. and Israel. However, the consumer market is growing and the enterprise (commercial) market is growing even faster. In a few years' time, the enterprise market will be the dominating market segment.

In Japan, it is predicted that the drone market will grow from today's 3 Billion yen to 100 Billion yen in 2030. Only around 5% of the estimated market value will come from hardware, the rest are services and software applications. More than 50 different application areas have been identified for the coming 5 years.

The Japanese government has allocated some small areas in Japan for trials with drones. A number of companies have started with several field tests of home delivery, emergency delivery and other similar applications.

In Japan, the legislation for drones is still under development. Until a drone landed on the roof of the prime minister's office in 2015, drones were regarded as toys. However, this incident caused a lot of concern about possible terror and accidents. Therefore, new legal restrictions for the usage of drones have been implemented in the end of 2015 and the beginning of 2016. Some people appreciate the clarity of the restrictions, however other people think it is too strict. Future changes in the law can be expected.

In Japan, there are around 20 major drone manufacturers, but only a few of them have commercial products available. Yamaha Motor Co has already developed and sold several thousands of unmanned helicopters for agricultural applications. SECOM, a security company, claim that they also have commercial drones ready for reconnaissance at premises such as factories or industrial plants.

There are still a number of legal, social and technical issues that need to be solved. However, the Japanese market is very high-tech orientated. Drones will therefore likely become a very interesting market in Japan.

For European SMEs there will be several possibilities in niche applications, which require special competence regarding processes and behaviours of such applications. European companies are usually strong in software development of specialized applications, and consequently this market should be very interesting.

2. Definition

Photo 1

A drone, known as an unmanned aerial vehicle (UAV), as an unmanned aircraft system (UAS), or by several other names, is an aircraft without a human pilot aboard. The flight of drones may operate with various degrees of autonomy: either under remote control by a human operator, or fully or intermittently autonomously, by an on-board computer.

Compared to manned aircrafts, drones are often preferred for missions that are too "dull, dirty or dangerous" for humans. They originated mostly in military applications, although their use is expanding in commercial, scientific, recreational and other applications, such as policing and surveillance, aerial photography, agriculture and drone racing. Civilian drones now vastly outnumber military drones, with estimates of over a million sold by 2015. [1]

3. Scope of the Report

This report is the result of extensive research into the Japanese drone market. It presents an industry overview and provides insights into the market trends, market size, market drivers and challenges.

A detailed review of publicly available sources including specialised press, research publications, portals as well as annual reports of drone manufacturers, whenever available, have been undertaken.

4. World-wide Market

4.1. History

With the maturing and miniaturization of applicable technologies in the 1980s and 1990s, interest in drones grew within the U.S. military. In the 1990s, the U.S. Department of Defence (DoD) gave a contract to AAI Corporation along with Malat (Israel Aerospace Industry).

The U.S. Navy bought the AAI Pioneer UAV that AAI and Malat developed jointly. Many of these UAVs were in service during the 1991 Gulf War. UAVs demonstrated the possibility of cheaper, more capable fighting machines, deployable without risk to aircrews. Initial generations primarily involved surveillance aircraft, but some carried armaments, such as the General Atomics MQ-1 Predator, that launched AGM-114 Hellfire air-to-ground missiles.

CAPECON was a European Union project to develop UAVs, running from May 1st, 2002 to December 31st, 2005.

As of 2012, the U.S. Air Force (USAF) employed 7,494 UAVs – almost one third of USAF aircrafts. The Central Intelligence Agency (CIA) also operated UAVs.

In 2013, at least 50 countries used UAVs. U.S., China, Iran, Israel and other countries designed and built their own versions. [2]

4.2. Market Trends

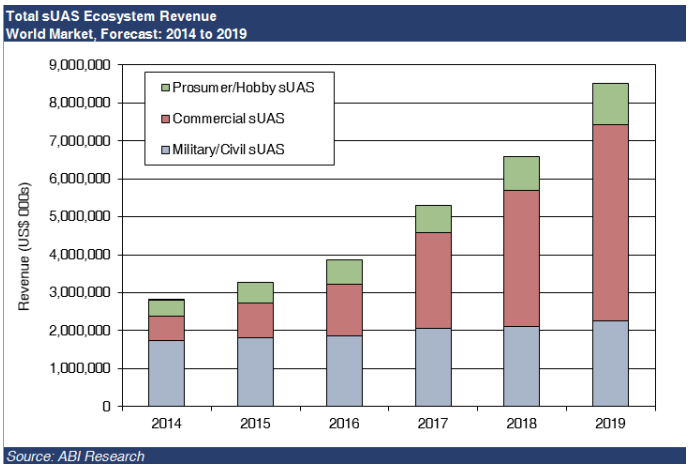

Figure 1

Military spending is considered to be more than half of the entire market, according to ABI Research. But the military spending on drones may flatten, and the consumer spending begins to grow, however slowly. It is the commercial sector that holds the potential to expand dramatically, reducing the importance of the other two areas. As new applications for drones develop, in areas as for example agriculture and entertainment, the business will grow fast. [3]

Drones are classified into 4 groups; toys, consumer, enterprise and military.

i. Toy (Hobby) drones are intended for pure amusement. They are priced as low as $40. They can carry very small payload, which usually is a simple camera.
ii. Consumer (Prosumer) drones are usually used for amateur photography. Some people modify these drones to create drones with additional functionality.
iii. Enterprise (Commercial) drones are used in many different applications, such as data mapping or professional video photography. They can inspect power lines, but recently parcel deliveries have also been tested. Enterprise drones have been used in several movies to capture video from above. However, the most common application is still in agriculture.
iv. Military drones are used as military aircrafts without a pilot on-board. Instead the pilot is sitting comfortably in some surveillance room. Military drones are used for reconnaissance, observation and attack. It is estimated that Pentagon has more than 7000 military drones.

Pioneers in United States and Israel dominate the UAV global military market. The US held a 60% military-market share in 2006. It operated over 9,000 UAVs in 2014. From 1985 to 2014, exported drones came predominantly from Israel (60 %) and the United States (24 %); top importers were The U.K. (34%) and India (13%). Northrop Grumman and General Atomics are the dominant manufacturers on the strength of the Global Hawk and Predator/Mariner systems.

The leading civil drone companies are currently Chinese DJI (with $500m global sales), French Parrot (with $110m) and US 3DRobotics (with $21.6m in 2014). As of February 2016, about 325,000 civilian drones were registered with the U.S. Federal Aviation Administration (FAA). However, it is estimated that more than a million have been sold in the United States alone.

Some universities offer drone-related research and training programs or degrees. [4]

The market is flooded with cheap hobby drones from many manufacturers, especially from China. However, many people will buy a drone for novelty purposes but not use it again. Companies like DJI are forced to move away from simple camera drones to new areas, which require specialized drones, for aerial mining surveys, pipeline inspection, search and rescue, crop spraying and hundreds of other commercial tasks that's expected to reach $127 billion by 2020.

Some of the key markets for commercial drones:

Agriculture

Farmers started very early in using drones to identify crop conditions. Yamaha Motor Co. in Japan has developed drones since late 1990's for agriculture applications. Since drones can carry more payloads, many manufacturers try to develop drones for spraying chemicals over the crops. With the help of sophisticated sensing technologies, it is also possible to minimize the usage of chemicals and improve the yields. 80 percent of the U.S. market for commercial drones is estimated to be for agriculture applications.

China has vast farmlands, and there is a high demand for drones to be used in pesticide spraying because the labour costs are rising. More than half of Chinese TT Aviation's drones are used in agriculture. [5]

In 2015, FAA in the U.S. issued the first exemption for an agricultural drone to be used outside of university research. Companies like Yamaha from Japan, DJI from China and local rivals like MicroMultiCopter Aero Technology Co. from Shenzhen are fighting for this market.

Imaging

Originally, imaging was the major application for consumer drones. It was used for filming, for example, weddings and festivals and to take photos of homes and gardens. This has now become an important market for commercial drones.

FAA has provided more than 5000 exemptions for some form of photography or surveying. A large number of those have been for real estate companies to show beautiful gardens or the view from apartments to be built.

Traditionally, helicopters have been used for filming or inspection and are now replaced by less expensive drone solutions. This can be filming of commercial movies, inspection of utility companies' facilities, or hard-to-reach places like oil-platforms or towers for mobile phone systems.

Canada was using drones to investigate the cause of a huge fire that displaced some 88,000 people. Elevated Robotic Services has deployed drones with infrared, ultraviolet and traditional optical cameras to pinpoint the hottest part of the fire and trace it to its source based on time, wind and other factors. [6]

The Chinese police will use drones for patrols, while utilities (utility companies) use them for maintaining electricity infrastructure or mapping pipelines. [7]

Major competitors in aerial imagery are DJI, Paris-based Parrot SA, which acquired Sensefly to expand into commercial quadcopters, and 3D Robotics Inc. in Berkeley, California.

Delivery

All the major retail companies are testing drones for deliveries. Examples of those are Wall-Mart Stores, Amazon.com and Alibaba Group. However, it will take some time until there will be any commercial usage, both due to practical and regulatory reasons. This is mainly due to the fact that most countries ban drones from flying out of operator's line of sight or over populated areas.

There are however some tests with sending medical supplies to remote areas. Zipline (San Francisco) is flying blood bags to remote hospitals in Rwanda. Matternet (California) and Flirtey have got FFA-approval to deliver emergency kits in U.S. by drones.

Racing

This is more a hobby, but at the Dubai World Drone Prix the top prize was $250,000. Some of the participating drones came from KC Frames, Arrishobby.com, Horizon Hobby LLC, Walker Technology Co, and Hubsan Intelligent Co (Shenzhen).

In Florida, the first drone race with a brain-controlled interface was performed in April 2016. Participants were wearing headsets with sensors trying to push the drones over a basketball court with the "will-power". [8]

Transport

A passenger drone will transport the passenger a few hundred meters above roads and buildings. It will however take some time until this kind of drones will be safe enough for people to step into and before they will be approved for commercial use.

The Chinese manufacturer Ehang (Guangzhou) has already demonstrated a personal flyer on the Consumer Electronics Show in Las Vegas, January 2016. It is a 200 kg personal flyer controlled by a smartphone. [9]

Military drones

Fifteen years after the first drone was used in combat, the U.S. military's drone program has expanded and become an everyday part of the war machine. Now, from control booths in the United States and bases around the Middle East, Afghanistan and parts of Africa, drone crews are flying surveillance missions and providing close air support for troops on the ground. The number of hours flown by the air force's newest attack drone, the MQ-9 Reaper, more than doubled globally between 2010 and 2015, to nearly as many hours as F-16 fighter jets. One major challenge for the U.S. military is recruiting enough staff to operate a growing fleet of drones. [10] [11]

The Pentagon's research centre, the Defence Advanced Research Projects Agency (DARPA), has developed the so-called Sea Hunter, which is a 40 meter unmanned, self-driving prototype ship designed to travel thousands of kilometres without crew. The ship was built to detect stealthy diesel-electric submarines but will most likely also pave the way to developing crewless cargo vessels for the commercial shipping industry someday. [12]

Drone schools

China has the world's largest drone manufacturers, but, as everywhere else, China lacks qualified pilots to fly them. Drone schools such as TT Aviation Technology Co., one of more than 40 in China, are providing a two-week intensive course for 8,000 Yuan where students learn regulations and how to pilot real drones. At the end of the course, they can try to earn the license required by China's Civil Aviation Administration to operate large drones that are heavier than 7 kg and fly higher than 120 meters. These licenses will open doors to piloting jobs that make at least 5,000 Chinese Yuan per month. More than 10,000 new pilots are needed this year in China, but only 1,000 pilots now have licenses. China needs pilots with licenses, because safety is the biggest concern. [13]

4.3. Major Manufacturers

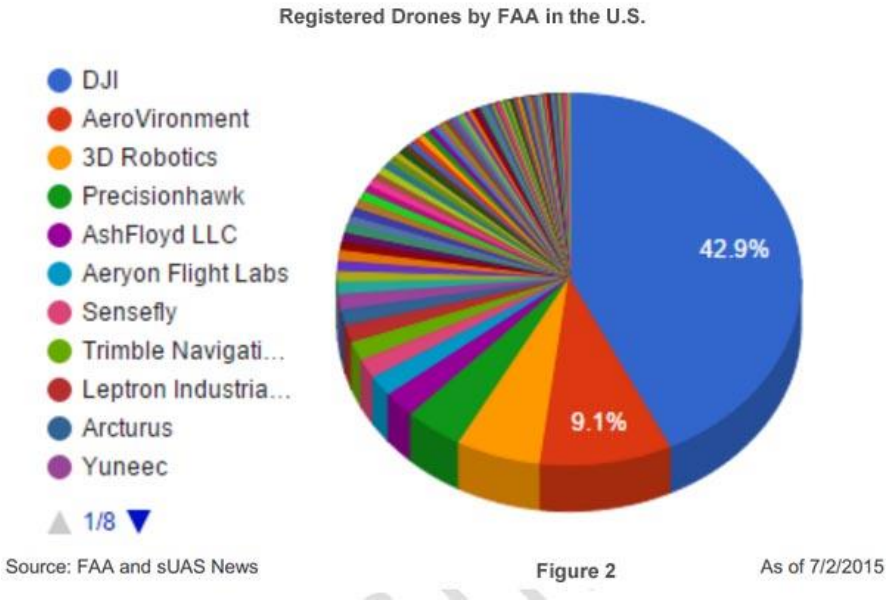

Figure 2

China is already the dominant manufacturer of consumer drones. DJI is the giant and has more than 50% worldwide market share. There are more than 400 drone manufacturers in China today, and 8 out of the 13 most popular consumer drone manufacturers in the world are Chinese.

Consumer drones are the most visible type of drones, however so far military and defence spending have accounted for the major amount of money. U.S. is still strong in this area together with Israel and Europe. China is now quickly increasing production. China has around 20 manufacturers of military drones, more or less the same number as U.S. Last year, China implemented export restrictions on military drones, with certain capabilities.

Chinese manufacturers are not so strong in developing applications for commercial drones. The commercial market segment is expected to grow fast during the coming years; a possible outcome is that Chinese manufacturers will provide the hardware and U.S. manufacturers will develop applications. [14]

3DRobotics, US

3D Robotics is an American company headquartered in Berkeley, California, that designs and manufactures commercial and recreational unmanned aerial vehicles. Specifically, it has produced consumer drones, ready-to-fly quadcopters for aerial photography and mapping, and fixed wing UAVs based on the Ardupilot platform.

3D Robotics was co-founded in 2009 by Chris Anderson (3D Robotics CEO) and Jordi Muñoz (3D Robotics President). Author and entrepreneur Chris Anderson and Mexican engineer Jordi Muñoz met online through the DIY drones´ community, which was originally started by Chris Anderson for aerial vehicle enthusiasts.

3D Robotics currently employs approx. 100 people with HQ in Berkeley and customer service in Tijuana. 3D Robotics is one of the founding members of Dronecode. [15]

AAI Corporation, US

AAI Corporation is an aerospace and defence development and manufacturing firm, located in Hunt Valley, Maryland, US. AAI was formerly a wholly owned subsidiary of United Industrial Corporation, and acquired by Textron in 2007. It currently operates as a unit of Textron Systems Corporation and employs more than 2,000 persons.

AAI's products and services include unmanned aircraft and ground control technologies; training and simulation systems; automated aerospace test and maintenance equipment; armament systems; and logistical, engineering, supply chain and operational support services. The company's customers include the United States Department of Defence (DoD) and its prime contractors, allied foreign government ministries of defence, and other United States federal agencies.

AAI is one of a limited number of companies engaged in the design and full-rate production of a successfully fielded, operational unmanned aircraft system (UAS) for the DoD. AAI first began development work on the unmanned systems product line in 1985, winning a competitive fly-off with its Pioneer Remotely Piloted Vehicle. The RQ-2 Pioneer, an unmanned reconnaissance aircraft was developed jointly by AAI Corporation and Israel Aircraft Industries.

The company's unmanned aircraft system includes the Shadow 200 Tactical UAS, which is designated RQ-7B by the U.S. Army, as well as the Shadow 400 and 600 systems. As of July 2014, Shadow systems had accumulated more than 920,000 flight hours, with more than 90 percent of those hours in support of U.S. and allied combat operations in Iraq and Afghanistan.

The company's UAS capabilities expanded with the 2006 acquisition of Australian UAS manufacturer Aerosonde Pty. Ltd. This fleet's newest model is the Aerosonde Mark 4.7 small-unmanned aircraft system.

In September 2008, AAI announced that it had teamed up with Aeronautics Ltd. to provide the Orbiter miniature UAS in selected markets.

The company's One System Ground Control Station is fielded as part of the Shadow Tactical UAS, as well as the One System Portable Ground Control Station and One System Remote Video Terminal.

On November 16th, 2009, AAI entered a 40-year exclusive license agreement with Carter Aviation Technologies concerning a possible autonomous slowed rotor/compound aircraft with potential for increased speed (250 knots) and range (1300 nautical miles) delivering 3000 pounds cargo, compared to traditional rotorcraft. It is to be based on the Carter PAV (Personal Air Vehicle).

AAI is developing an RQ-7 Shadow, also with a Carter rotor on top for vertical take-off and landing. AAI also intends to use this technology as the basis for their proposal to DARPA's (Defence Advanced Research Projects Agency) "Flying Humvee" Transformer program. [16]

CAPECON, EU

CAPECON project was a European Union initiative to develop UAVs. The project ran from May 1st, 2002 to December 31st, 2005. The total cost was 5 136 539 Euros, the EU providing towards this 2 899 992 Euros. Overall coordination of the project was via Israel Aircraft Industries Ltd (Israel Aerospace Industries). Eighteen Organisations were involved (not including Israel Aerospace Industries), six of these were academic organisations: Polytechnic University of Turin (Politecnico di Torino), Technion (Israel Institute of Technology), University of Bologna, Warsaw University of Technology, University of Naples Federico II (Universita degli studi di Napoli Federico II), and the University of Salento (Universita degli studi di Lecce), four were aerospace agencies: Instituto Nacional de Técnica Aeroespacial (Spain), Office National d'Etudes et de Recherches Aérospatiales (France), Stichting Nationaal Lucht - en Ruimtevaart Laboratorium (Netherlands), CIRA (Italian Aerospace Research Center). Other organisations involved were Agusta, Carlo Gavazzi Space S.P.A., EADS Defence and Security Systems, Eurocopter Deutschland GmbH, Eurocopter S.A.S., Swedish Space Corporation, Tadiran Electronic Systems Ltd, &, Tadiran Spectralink. [17]

DJI, China

DJI is a Chinese technology company founded in 2006 by Frank Wang and headquartered in Shenzhen, Guangdong. It manufactures commercial and recreational unmanned aerial vehicles (UAV) for aerial photography and videography. It employs around 3300 employees and had 1 billion USD in revenues in 2015.

DJI manufactures a range of products including flying cameras (ex. Inspire and Phantom series), flying platforms, flight controllers for multi rotors, accessories for helicopters, camera gimbals (aerial, handheld) and ground stations. These products are for industrial, professional and amateur use.

According to The Economist in 2015, the company was at the forefront of the civilian-drone industry at the time. DJI, the world´s biggest producer of consumer drones, is now trying to move away from the entertainment drone market and provide drones for more specialized applications. DJI provides development kits, which will allow software developers to write their own applications for specific tasks. [18] [19] [20]

Ehang UAV, China

Ehang UAVs are a series of UAVs developed by Chinese company Beijing Yi-Hang Creation Science & Technology Co., Ltd. and have entered service in China for aerial cinematography, photography, and survey missions.

In a world first, Ehang announced new drones capable of carrying passengers. One model was shown at the Consumer Electronics Show in Las Vegas, January 2016. It is a 200 kg personal flyer controlled by a smartphone. [21]

General Atomics, US

General Atomics is a defence contractor headquartered in San Diego, California, specializing in nuclear physics. General Atomics' research into nuclear fission and nuclear fusion has also had bearing on related technologies, allowing the company to expand into other fields of research and manufacturing. General Atomics develops systems ranging from the nuclear fuel cycle to remotely

operated surveillance aircrafts, airborne sensors, advanced electric, electronic, wireless, and laser technologies.

General Atomics Aeronautical Systems produces the Predator series of remotely piloted aircrafts used in the Kosovo, Iraq, and Afghanistan conflicts. [22]

Israel Aerospace Industry (Malat), Israel

Israel Aerospace Industry (IA) is Israel's prime aerospace and aviation manufacturer, producing aerial systems for both military and civilian usage. It had 16,000 employees as of 2013. IAI is wholly owned by the government of Israel.

IAI's MALAT Division designs and manufactures Unmanned Aerial Systems (UAS's). MALAT offers a family of systems that varies in size, mission and sensors, mainly for defence-oriented customers, including multi-role tactical UAVs such as the HERON UAV.

MALAT's systems are in operational service with 50 end-users, are deployed on five continents and have accumulated over 1,300,000 flight hours.

On 13 April 2009, the Moscow Times reported that the Russian Defence Ministry had signed an agreement with Israel Aerospace to purchase $50 million in pilotless drone aircrafts. The contract reportedly includes three types of UAVs manufactured by the company. [23] [24]

Northrop Grumman, US

Northrop Grumman Corporation is an American global aerospace and defence technology company formed by Northrop's 1994 purchase of Grumman. The company was named as the fifth-largest defence contractor in the world in 2015. Northrop Grumman employs over 68,000 people worldwide. It reported revenues of $25 billion in 2012. Northrop Grumman ranks No. 72 on the 2011 Fortune 500 list of America's largest corporations and ranks in the top ten military-friendly employers. It is headquartered in West Falls Church, Virginia.

The RQ-4 Global Hawk is an unmanned surveillance aircraft (UAV) used by the US Air force. The US Army uses Northrop Grumman's RQ-5 Hunter unmanned air vehicle, which has been in operational use since 1995. The U.S. Navy uses Northrop Grumman-built aerial vehicles such as the BQM-74 Chukar, RQ-4 Global Hawk based BAMS UAS. [25]

Parrot, France

Parrot SA is a French wireless products manufacturer company based in Paris, France. Christine/M De Tourvel, Jean-Pierre Talvard and Henri Seydoux founded it in 1994.

The firm specializes in technologies involving voice recognition and signal processing for embedded products and flying robots (drones). It develops products in relationship with car telephony: Parrot chipsets (including DSP), copyrighted noise reduction and echo cancelling algorithms, Bluetooth software stack and end-user applications (Bluetooth hands free car kits).

In January 2010, Parrot introduced at CES Las Vegas the Parrot AR.Drone flying hardware piloted over Wi-Fi with a smartphone and Open API game development platform, ARdrone.org. In 2012, Parrot bought 57% of Swiss drone company senseFly as well as Swiss imaging company Pix4D. Both companies are spin-offs from EPFL. In 2014, Parrot introduced the Mini-Drones "Rolling Spider" and "Jumping Sumo" at CES Las Vegas.

In May 2014 at the annual AUVSI conference in Orlando, Parrot announced the AR Drone 3.0, code-named Bebop. Parrot also revealed the option for a Skycontroller, when purchasing the Bebop. The Skycontroller allows the Bebop Drone to fly up to 2 kilometres. [26]

Yamaha Motor Co., Japan

Yamaha Motor Company Limited is a Japanese manufacturer of motorcycles, marine products, and other motorized products. The company was established in 1955 upon separation from Yamaha Corporation (however Yamaha Corporation is still the largest shareholder with 12.21%, while Toyota Motor Corporation is the 5th largest shareholder with 3.58% of the shares, as of June 30, 2015), and is headquartered in Iwata, Shizuoka, Japan.

The company's products include motorcycles, scooters, motorized bicycles, boats, sail boats, personal water craft, swimming pools, utility boats, fishing boats, outboard motors, 4-wheel ATVs, recreational off-road vehicles, go-kart engines, golf carts, multi-purpose engines, electrical generators, water pumps, snowmobiles, small snow throwers, automobile engines, surface mounters, intelligent machinery, industrial-use unmanned helicopters, electrical power units for wheelchairs and helmets.

Yamaha is a major manufacturer of drones for agricultural applications. [27] [28]

Zipline, US

Zipline is receiving text messages from health workers. Within a few minutes a drone is despatched with the required medicine. The first real trial has started with the government of Rwanda. Zipline is delivering blood products to 20 hospitals all over Rwanda. [29]

4.4. Legislation

Figure 3

The Federal Aviation Administration in U.S. has so far prohibited most commercial drone flights over populated areas, especially crowds. That ban is a concern for many industries that want to take advantage of the technology. [113]

“Every TV station in the country wants one, but they can’t be limited to flying in the middle of nowhere because there’s no news in the middle of nowhere.” [30]

Australia

In 2002, Australia was the first country in the world to regulate remotely piloted aircrafts (RPA) with Civil Aviation Safety Regulation (CASR) Part 101. [31]

Canada [32]

France

Operators must undergo training and obtain a theoretical statement of skill level (DNC). [33]

Germany [34]

Japan

A pilotless aircraft may fly when permitted by the Minister of Land, Infrastructure, Transport and Tourism. Article 87: [35]

United Kingdom [36]

U.S.

The NEW Small UAS Rule (Part 107), including all pilot and operating rules, will be effective on August 29, 2016. [37]

4.5. Anti-drone Market

There have been several incidents with drones during the past years. Drones have flown onto the White House lawn, impeded more than a dozen flights battling California wildfires and been spotted hundreds of times by pilots of traditional aircrafts. Enforcement agencies, prisons and private companies are trying to find some way to protect against the new airborne threat.

A large number of companies, from aircraft manufacturing giant Airbus to tiny start-ups, are doing research in the anti-drone market. The products range from military-grade radars and lasers, to a company, which train eagles to snatch small drones out of the sky for Dutch police. Some companies have developed nets that one drone can drape over another to take them down.

Battelle tried to introduce its DroneDefender last year. But it was forced to withdraw the product because it would violate U.S. Federal Communications Commission regulations. DroneDefender jams the radio communication between the pilot and the drone.

U.S. criminal law separately prohibits use of any “destructive device” to cripple an aircraft.

FAA is working with CACI International Inc. (Consolidated Analysis Centre, Incorporated) to test the company’s drone monitor system, known as SkyTracker. CACI’s system can not only monitor drones near sensitive sites, such as the U.S. Capitol, it can also pinpoint the person flying the device by monitoring radio signals, giving police the ability to locate the perpetrator. [38]

5. Japan's Drone Market

Before a drone landed on the roof of prime minister's office (April 2015), there were many positive initiatives taken to stimulate the drone industry in Japan. Drones were regarded as toys and very few regulations existed. After the prime minister's office incident, people started to get concerned about terrorism and the possibility that drones could fall down and hurt somebody.

Drone-friendly regulations in March 2015

The Abe (prime minister) administration wanted to create a fast-track industry-friendly regulation to compete with the U.S. drone industry. Yamaha Motor Co. had developed unmanned helicopters for agricultural applications already in the late 1970s. SECOM, the largest security company in Japan, was prepared to use drones for security missions.

Abe administration asked the "Robot Revolution Realization Council" to review existing radio and civil aviation laws. Japan also opened up special zones for testing drones on a trial basis. Parts of Chiba city, just outside of Tokyo, were designated as special zones. [39]

The only aviation regulations, at that time, required drones in Japan to fly below 150 meters height and remain at least 9 km away from airports. Drones used in agriculture needed two operators, as precautions for the surrounding environment.

Japanese industry supporters dubbed 2015 as the Year One of the Era of the Drone. [40]

New regulations in December 2015

However, as a reaction on the incident with a drone, which landed on the roof of prime minister's office in April 2015, new legislations were put in place in December 2015 and March 2016. The new regulations are much stricter and ban drones with a weight of more than 200 grams, and city centres are also completely excluded for drone flying. Special approval is required.

Some people believe that the restrictions are too severe and some relaxations of the new regulations are expected.

5.1. Models/Types /Consumer Models /Business models /Military Models

Just like the global market 3 or 4 categories can be identified. Consumer models, which include pure toys and Prosumer models, Business and Military models.

Consumer Models

The world's largest manufacturer of consumer drones, DJI (from China), sees the photography sector in Japan as a very lucrative market segment. Especially from now on since the major regulations for flying drones were put in place already in December 2015.

Recently, DJI demonstrated its product Phantom 4, which has propellers, cameras, sensors and automatic tracking technology. Phantom 4 zipped around and followed a stunt bicycle-rider, successfully dodging a signboard. The Phantom 4, which has a flight range of 5 kilometres, sells for ¥189,000 ($1,800) in Japan, and $1,399 in the U.S. Its maximum speed is 72 kmh. It comes with a

"return-to-home-function", meaning it will come back safely if it loses radio contact as long as the battery life lasts.

DJI believes that Japan could be a very lucrative market because there are no major local competitors. [41]

Enterprise Models

The agricultural market is the driving force in the enterprise market segment with companies like Yamaha Motor being the leader with a track record of more than 30 years. Yamaha's drones have been used for spreading pesticides and fertilizers over agriculture land.

As more and more applications are developed, this market will grow fast. Sony has invested a majority stake in a Japanese drone company called Aerosense, mainly for enterprise applications.

In chapter 5.3, several companies, that are testing different applications for enterprise drones, are presented.

Military Models

In November 2015, the U.S. Congress approved sales of three Global Hawk drones from Northrop Gunman to Japan. Those drones will be used to monitor and deter regional threats from neighbouring countries.

Japan is going to spend 3 billion Japanese yen on drone development during the coming years. This would make Japan's investments the fastest growing drone program in the world. [42]

5.2. Size/Trends/Growth

Japan's drone markets (consumer, enterprise, military) are expected to grow fast despite all discussions about dangerous users. So far, there have been a number of incidents with consumers flying drones close to airports, official buildings etc. This has caused a lot of criticism. There is also some growing concern in Japan that drones could be used for terrorism or unlawful video recording. The government tries to control this by the recently implemented new regulations of drones and users. This has now clarified the regulation framework and the market is expected to take off quickly.

Just like in the U.S., the consumer market is now growing, but it is expected that the real growth will come in the enterprise (Commercial) market. Security firms engaged in surveillance, construction companies conducting on-site inspections, etc., will use drones.

5.2.1.Seed Planning's Market Estimate

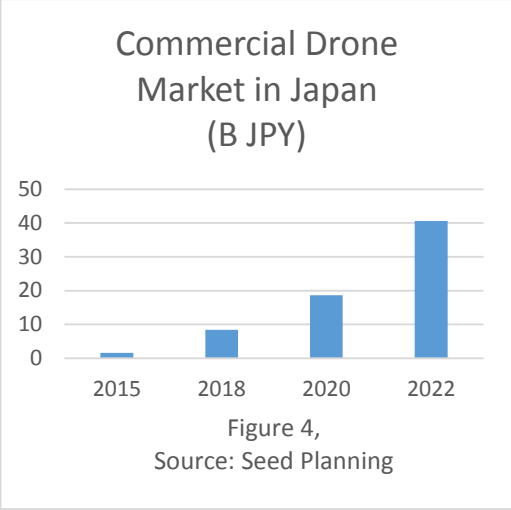

Figure 4,
Source: Seed Planning

The Japanese market for commercial drones is estimated to grow from the current (2015) 1.6 billion yen level to 18.6 billion yen by 2020, according to Tokyo-based research firm Seed Planning.

Comparing Seed Planning's numbers with Nikkei's estimate (see following paragraph), there are some differences in the data, especially for year 2022. Apparently, Seed Planning has estimated a more aggressive growth path.

5.2.2.Nikkei AT market estimate

According to an estimate made by Nikkei BP CleanTech, the Japanese commercial drone market will grow to around 100 Billion (Billion=1000 Million) yen in 2030.

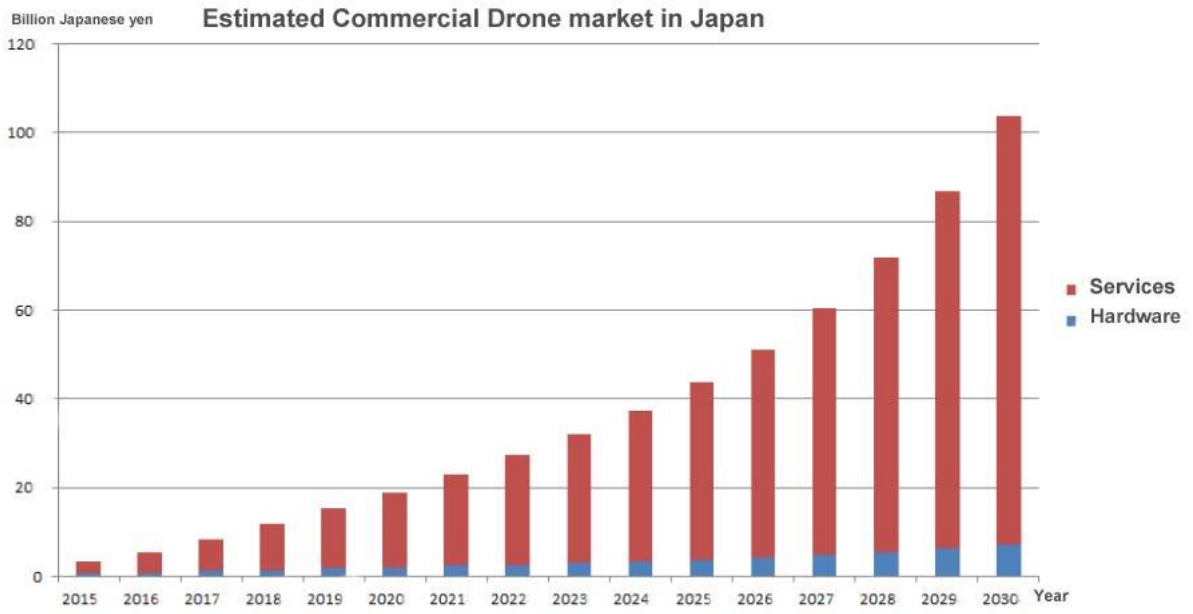

Figure 5, Source: Nikkei AT

In year 2015, the market for commercial drones was around 3 Billion Japanese yen. According to Nikkei, it will grow to 20 Billion yen in 2020, 44 Billion yen in 2025 and finally in 2030 it is expected to

exceed 100 Billion Japanese yen. Those numbers include both the hardware of the drones as well as the application services. As can be seen from the diagram, the majority of incomes are expected to come from services.

Nikkei has studied the roadmap of 173 different applications in the world and identified around 50 of those to be relevant for Japan. (See Appendix A.) The application areas are agriculture, governmental, inspection, checking, measurement, supervision, photographing, transportation, logistics, danger zone work, and traction. [43]

5.3. Experiments/Test flights

Rakuten is providing drone delivery on a Chiba golf course

Online shopping company Rakuten Inc. is enabling golfers to order snacks, beverages and golf equipment while playing a round. It is a month-long experiment at Camel Golf Resort in Chiba Prefecture. Rakuten provided this service in a golf park, since there are regulations that restrict drones from flying over crowded areas.

Rakuten and Autonomous Control Systems Laboratory Ltd. (ACSL), located in Chiba, Japan, have jointly developed the drone. [44]

Home delivery service on trial in Chiba

Chiba city is located east of Tokyo. The government has allocated a part of Chiba for trials with drones flying between condominiums, commercial facilities and parks with packages. As a next stage it is planned that drones will pick-up packages from warehouse and deliver them to Mihama Ward, 10 km away. Chiba city wants to start drone home delivery by 2020 when the Tokyo Olympic will be held. There is also a plan to ask builders of high-rise apartments building in Mihama to provide a landing area on each apartment´s balcony.

A similar trial was done in the town of Naka in Tokushima prefecture. This was a test how drones can provide better service in depopulated areas. [45]

5.4. Applications:

5.4.1. Agriculture

Japanese farmers have been using Yamaha's R-50 and RMAX unmanned helicopters to dust their crops since 1987. This is often cheaper than using full-sized helicopters. Yamaha has also set up a school to train drone operators.

Drones are also becoming an invaluable tool by farmers in several other aspects of farming, such as monitoring livestock, crops and water levels. Images, generated with a near-IR sensor, can provide detailed information on crop health, improving yield and reducing cost. There are more than 3000 drones in Japan for agricultural usage.

The agricultural application segment has already the largest market share among commercial applications in Japan. It is also expected to grow and remain among the 3 largest areas in the near future.

Office equipment maker Ricoh Co. has been testing its digital cameras on drones to monitor crop growth in field tests.

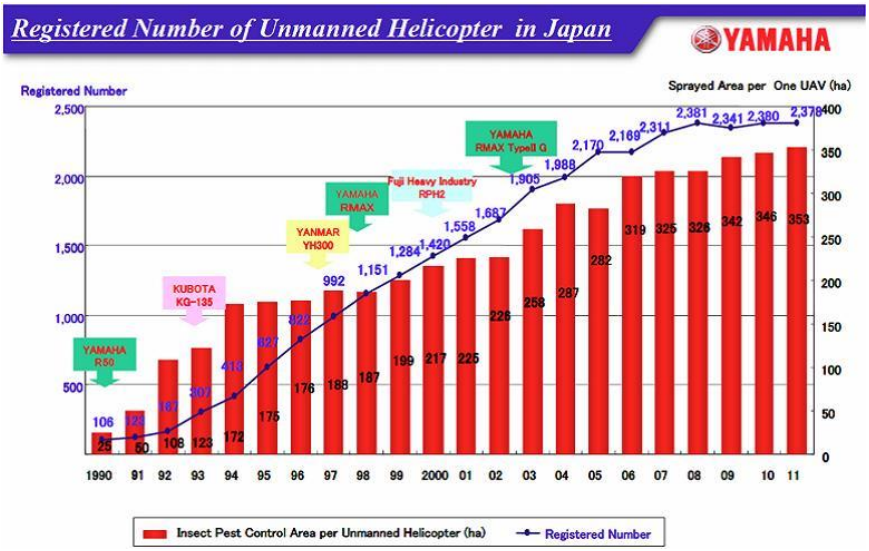

Figure 6

5.4.2. Transport

Not much is going on in this area, but Japan is trying very hard to have the driverless car ready (by) until 2020, when the Olympics will be held in Tokyo. It is reasonable to believe that the next step would be drones, which can provide passenger transport. Drones can already today carry a load of up to 150 kg. A Chinese drone manufacturer has also demonstrated a drone prototype for person transport, in Las Vegas on the CES in 2016.

As of today, it is a very small market and is expected to remain small during the coming 5-year period.

5.4.3. Parcel Delivery

Parcel delivery by trucks is a big market in Japan, and 3 major companies are fighting for the business. It is fast and low priced. The next step will of course be parcel transport by drones. At the moment, several companies are carrying out tests in a part of Chiba outside Tokyo, which has become a special area for drone field trials. There are also some test-condominiums built for providing off-loading places for parcel drones. Already today some of the parcel delivery companies guarantee a 60 min delivery, within major cities. This could probably be reduced further as a result of the competitive game.

Even if there is a big need (36 million parcels annually), there are many technical and safety problems, why it is unlikely that this market will take off during the coming 5-year period.

However, there is some positive thinking about using drones within warehouses to move parcels around. This is seen as more likely to happen earlier. There are 4700 warehouses in Japan with around 80 000 forklifts.

Home delivery to elderly in rural areas

The tests were mainly targeted at elderly residents who have difficulties going shopping. A drone carrying such food items as bread and milk flew for about 500 meters at an altitude of around 50 meters over crop fields. On its way back, the drone was loaded with eggs and equipment designed to measure the impact of take-offs and landings.

The tests were conducted in the town Naka in Tokushima Prefecture, which is designated as a special zone that seeks to revitalize its economy through drone usage. [46]

5.4.4. Utilities

Telecommunication

Nippon Telegraph and Telephone (NTT) has developed drones to be used for recovery work and inspections in the event of a natural disaster.

The drones can carry wires for emergency repairs of communication facilities. Equipped with cameras, they can also check the conditions of damaged equipment in devastated areas. The drones helped prepare for repairing cables after powerful earthquakes hit Kyushu in April 2015. [47]

Pipelines

Yamaha is now looking to adapt its drone technology for patrolling the nation's borders and for checking oil and gas pipelines.

5.4.5. Surveying

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in Japan has conducted drone tests for maintenance check-up at inaccessible and dangerous sites. It is expected that this kind of applications for drones will be widely used already from now.

This is an area, which is expected to grow from almost nothing in 2015 and become one of the three major applications in 2020.

5.4.6. Construction

Also, construction companies will use drones to carry materials to construction sites. According to the ministry, around 12 000 new construction sites are started annually.

An Italian company, Siteco Informatica S.R.L has developed an airborne image data collection system, Sky-Scanner that can deliver high quality images at relatively low cost. The Japanese construction-consulting firm ASCO-DAITA immediately purchased a system for environmental engineering. [48]

5.4.7. Real Estate

Terrain analyses and surveys based on aerial images from satellites have been used to survey the land for potential new real estate. Japan's 2nd land observation satellite named "Daichi 2nd" is being

used for disaster monitoring and continental crustal changes. More specific and detailed data can be obtained if created in combination with drones.

5.4.8. News Media, Advertisement

Drones used for advertisement

MicroAd Inc., a Tokyo-based online advertising company, has developed a service called Sky Magic to produce sound-and-light extravaganzas. Drones illuminated with LED lights can project logos, words, shapes and pictures in spaces above large-scale events.

The company has developed a system to automatically synchronize the movements of drones and illuminations in time with music. Each drone is equipped with 660 LED lights. The company is targeting formation flying by more than 100 drones for large-scale outdoor events. [49]

5.4.9. Film Production

Aerial image shooting with drones for movies, TV programs and TV advertising at low cost is becoming popular.

Drone fees are around 100 000 JPY but the cost for a plane or a helicopter will be several hundreds of thousands of yens. There are already a few hundred program-studios and local broadcasters using drones in film production.

Drones and Cherry Blossoms

Senboku in Akita Prefecture, which boasts the cherry trees in its Kakunodate district, is one of several areas nationwide designated as special zones where the use of drones for public purposes is allowed. This is intended to encourage economic revitalization.

City authorities plan to put together drone footage optimized for smartphones to promote tourism, and to use the drones to guide arborists when they prune the trees. [50]

5.4.10. Disaster recovery

In the event of a disaster, drones can provide quicker information gathering than by overland transportation.

Drones can also be used to monitor what is happening in an emergency before police or security guards arrive. Security companies like SECOM have developed such a drone.

Fukushima reactor buildings

A drone was developed during 2015 to survey the inside of the reactor buildings of Fukushima No. 1 plant. Autonomous Control Systems Laboratory Ltd., a university-based (Chiba university) venture headed by Kenzo Nonami, developed the drone. The drone used lasers to detect and avoid obstacles in flight and was able to replace batteries without the help of an operator.

The six-propeller drone was equipped with a camera, an instrument to measure radiation levels, and a dust collector. The aircraft was different from conventional drones in that it can detect walls and other obstacles by laser, even when inside a reactor building, where GPS would not work and where

radiation doses may be too high for humans. The information gathered during a survey flight is converted into three-dimensional data in real time, enabling the production of images of damaged walls and dangling piping, for instance. [51]

Kikuchi Seisakusho in Fukushima has also developed drones, which can check-up areas, which are decontaminated with radioactivity.

5.4.11. Security

SECOM has already launched a service for small businesses that includes having a surveillance drone that can take photos of an intruder when an alarm is alerted.

SECOM believes that this kind of security drones will be used at the 2020 Tokyo Olympics.

Japan scrambled fighter jets after an unidentified drone flew near a small island owned by Tokyo that is at the centre of a bitter territorial dispute with China. Japan's Air Self-Defence Forces sent an unspecified number of jets to the area of the Senkaku Islands. The ministry said it did not know the origin or nationality of the unmanned aircraft, which did not enter Japanese airspace. [52]

5.4.12. Anti-drone

Under the latest revisions in December 2015 to the Civil Aeronautics Law, if a drone enters a restricted zone, such as an airport, police will try to find the person controlling it and issue a verbal warning. If the user continues flying the drone, the unit will mobilize its large drone to counter it. [53]

Tokyo police have conducted an anti-terrorism drill, including the seizure of a suspicious drone by using an interceptor drone, ahead of the Tokyo Marathon in 2016.

The interceptor, introduced by the Metropolitan Police Department last month (in August 2016), is about 1 meter in diameter and is equipped with a net measuring about 3 meters long and 2 meters wide to capture suspicious drones. A special unit of the riot squad operates it.

The Tokyo police currently have only one interceptor but plan to add another. The first was introduced following the discovery of a suspicious small drone on the rooftop of the building housing the prime minister's office in April 2015. [54]

6. Main Players in Japan

6.1. Japanese Manufacturers/Suppliers

There are 16 major companies that are producing/supplying drones in Japan such as Autonomous Control Systems Laboratory, Yamaha Motor (Motors), Hirobo, DJI Japan, Blue Innovation, Kikuchi (Kikuchi Seisakusho), NSi Moka, enRoute, Luce Search, Nisohken, Sohgo Security Systems, Asco, Komatsu, Fuji-imvac, NTT East, and Sony.

Autonomous Control Systems Laboratory (ACSL)

ACSL is a spinout from Chiba University in Japan, established in 2013. ACSL utilizes the world-leading autonomous control technologies developed at the laboratory of Professor Kenzo Nonami at Chiba University since 1998. ACSL is engaged in R&D, manufacturing, sales and building solutions for industrial drone applications. With its proprietary technologies made and developed in Japan, ACSL aims to take the lead to the new industrial revolution of the global skies. [55]

Blue Innovation

Blue Innovation Co., is a Japanese company, founded in 1999, that provides civil engineering services using drones, mainly to government institutions, construction companies and advertising firms for purposes like shooting commercials and monitoring beaches for disaster prevention.

Blue Innovation has partnered with Japan's Advanced Telecommunications Research Institute International, a research body in Kyoto prefecture with private sector backing, to develop drone control systems. One system includes a security application to ensure that drones can only be activated by authorized users, and could fly by autopilot inside buildings for inspections, deliveries and security purposes. [56] [57]

Chuo Electronics Co.

The Tokyo-based company makes systems that enable drones to fly without human control.

Defence Ministry

The Japanese and Israel defence authorities have recently agreed on starting joint research on drones for military surveillance. The Japanese agency also wants to conduct joint studies on unmanned attack planes and fighters. It is expected that Japan will provide sensor technology to Israel. [58]

DJI Japan

DJI Japan is the Japanese sales organisation of DJI with HQ in China. DJI is the worldwide leading manufacturer of consumer type drones. [59]

enRoute

enRoute Co., Ltd., is a company specialized in development and manufacturing of industrial drones, specialized in areas such as measurement, surveillance, inspection, security, environmental research and agriculture. The company was established in 2006 in Saitama-ken, Japan.

Hitachi Maxell is developing lightweight lithium ion batteries in cooperation with enRoute for drones. [60] [61]

Fuji-Imvac

Fuji-Imvac is a company, which originally was specialized in vacuum equipment. Recently the company has added RC model planes and UAVs. [62]

Fujitsu

Fujitsu has developed a drone with wheels. The drone is used for inspection of the underside of bridges, and the wheels will keep the drone on a fixed distance from the bridge. By using this method together with a high-definition camera, it is possible to find cracks as small as 0.2 mm. In Japan there are 700 000 bridges over 2 m high, which need to be inspected every 5 years in accordance with government regulations. [63] [64]

Hirobo

Hirobo Electric Corporation is a Japanese RC model company best known for their line of high-quality radio controlled helicopter models, both glow-fuel powered and more recently, electric-powered. Its parent company is Hirobo Limited, established 1949 in Hiroshima.

Hirobo continues to be a leader in helicopters of all price ranges, including coaxial-bladed indoor Sky Robo helicopters in both radio controlled and tethered configurations.

Hirobo manufactures unmanned helicopters for agricultural and industrial use. [65]

Kikuchi Seisakusho

Kikuchi Seisakusho is a mid-size company located outside of Tokyo in the suburb of Hachioji. The company started production of drones in 2015 and claims that they are the first company in Japan to mass-produce drones for surveillance. The plant is located near the crippled Fukushima No 1 nuclear plant, which needs drones to measure radiation levels. [66] [67]

Komatsu

Komatsu is the world's second largest manufacturer of construction machinery, such as forklifts and bulldozers.

Komatsu has developed a system called SmartConstruction, which will scan a customer's jobsite with drones and 3D laser scanners, as well as a stereo camera installed on the operator seat of the earthmoving equipment being used on the site. The gathered data will be combined into a comprehensive survey of the site. Soil classification and buried objects will be included in the site

research. That data will then be transmitted to machines and the machines are able to operate by themselves. [68]

NSi Moka

NSi Moka Co. Ltd., develops and sells multi-copters. The company was founded in 2009 and is based in Haga, Tochigi prefecture. Besides developing own drones, the company has also a partnership with the Chinese company DJI. The company has also a school for drone pilots. [69] [70]

NTT Group

NTT Group is "the old PTT in Japan" and consequently the largest telecom operator in Japan. It has developed a number of different drones for applications, such as surveying and inspection, but also more unique applications such as cable laying. [71]

Ricoh Co

Ricoh's cameras are very popular to use together with drones. Small, wide angle and high tech. [72]

SECOM Co.

SECOM Co. claims to be the first security company in the world to use unmanned aircrafts for security services. Equipped with a security camera and light-emitting diode lights, the drone will take images of suspicious-looking individuals and automobiles. The company expects the service to be used at large-scale factories and commercial facilities. [73]

Sony Corp.

Sony has created a new venture, called Aerosens that uses drones to capture images and other data for business purposes. Aerosens is making drones that can fly over a predetermined geographical area and take high definition footage that will be uploaded into the cloud for analysis. Sony's partner in this joint-venture is a Japanese robotics and automation company called ZMP.

The joint-venture will not sell any drones, but instead Sony Corp. plans to offer commercial drone services targeting the construction, logistics and agriculture industries from the first half of 2016.

Sony believes that it is difficult to expect growth from smartphones alone and therefore the company is looking for new applications like this one. [74] [75]

Yamaha Motors

Yamaha Motors Company Limited is a Japanese manufacturer of motorcycles, marine products such as boats and outboard motors, and other motorized products. The company was established in 1955 upon separation from Yamaha Corporation, however Yamaha Corporation is still the largest shareholder with about 12% of the shares. Yamaha Motors is headquartered in Iwata, Shizuoka, Japan. The company conducts development, production and marketing operations through 109 consolidated subsidiaries as of 2012.

Yamaha Motors have one division, which manufactures Industrial-use unmanned helicopters, mainly used for agricultural applications. [76]

6.2. Foreign Suppliers in Japan

U.S: Amazon.com, Google X, MIT, 3D Robotics, Infatics, Helico Aerospace Industries, PXY NANO, Precision Hawk, Game of Drones, Trace, Squadrone System, GoPro, Ehang USA, Hobbico, SkyDio、Airware, CyPhy Works

Germany: Definetz, Height-Tec, Service Drone

France: Renault, Parrot SA, Sense Fly

China: DJI Technologies, Hubsan Technologies

Britain: ZANO, Torquing Group,

Switzerland: Pix 4D

DJI

DJI from China is the world's largest drone maker, if the numbers of drones sold are counted. The company mainly manufactures drones for entertainment and low-end commercial usage. Besides drones DJI also makes the cameras mounted in the drones.

Also in Japan DJI is probably the largest supplier of drones. The company do not want to publish any numbers, but half of the drones, registered with the Japanese government for special permission, are from DJI. DJI has expanded its sales value in Japan from 2011 by three times.

DJI is also providing training courses and special insurances for drone pilots. [77]

7. Governmental Regulations

7.1. Ministries and Other Organisations in Charge of Legislation:

MLIT, The Ministry of Land, Infrastructure, Transport and Tourism

The Ministry of Land, Infrastructure, Transport and Tourism is in charge of planning and enforcing aviation regulations. The civil aeronautics law governing aviation contains a provision on unmanned aircrafts, including multi- copters, and drones that are subject to the law. [78]

MIC, The Ministry of Internal Affairs and Communication

The Ministry of Internal Affairs and Communications is responsible for telecommunications. A certain frequency band has already been allocated for controlling unmanned helicopters for agricultural applications. The band for multi-copters is 2.4GHz. [79]

METI, The Ministry of Economy, Trade and Industry

The Ministry of Economy, Trade and Industry is in charge of the drone manufacturing industry. The Aircraft Manufacturing Industry Act specifies that anyone who wants to manufacture aircraft needs to obtain permission from the ministry. However, the amendment of 2014 made it possible to manufacture drones up to 150kg without permission. [80]

The Forestry and Fisheries Aviation Association

The Forestry and Fisheries Aviation Association issues operator's licenses to fly unmanned helicopters used for spraying agrochemicals. It also holds safety operation classes.

The Japan Agricultural Aviation Association

The Japan Agricultural Aviation Association under the auspices of the Ministry of Agriculture, Forestry and Fisheries of Japan, sets standards governing the use of unmanned helicopters for agricultural applications, including pilot training and aircraft registration.

Ministry of Defence (MoD)

The Defence Minister is in charge of developing military drones, and development is under way at the ministry's research and development institute. [81]

7.2. Regulations for Usage

Before a drone landed on the roof of the prime minister's office in April 2015, Japan regarded drones as toys and allowed them to fly freely at altitudes of up to 150 meters except near airports. The attitude changed quickly after this incident. There were also a number of other incidents, which made the government to set up a committee to review the legislation.

Drones landed on prime minister's office in April, 2015

A drone carrying a small amount of radioactive caesium was found on the roof of the prime minister's office. This caused the authorities to increase security and demand regulations of drone flights.

DIJ has announced that it will add the prime minister's office and the Imperial Palace to the GPS list of non-flight zones. [82] [83]

New regulations for the flights of drones and other unmanned aircrafts

On December 10th, 2015, the new Civil Aeronautics Law Was implemented. The new law bans flights of drones weighing 200 grams or more in crowded residential areas, at altitudes 150 meters or more above the ground, and near airports. The transport ministry can grant operators exceptions on a case-by-case basis.

The designation "crowded residential areas" covers large parts of areas in major cities, including all of Tokyo's 23 wards. This means operators will be severely restricted from flying drones and even toy aircrafts in such areas.

The restrictions also require operators to keep their aircraft at least 30 meters from people, buildings and cars, and ban them from locations where large crowds are present, such as at festivals and exhibitions.

Violators may be punished with a fine of up to JPY 500 000.

The law will permit the use of drones for emergency purposes, such as manhunts and search of land by ambulance staff and the Self-Defence Forces.

The government meanwhile is working out more detailed rules to promote the industrial use of drones, with plans to expand their applications in pesticide spraying and the inspection of civil engineering projects. [84] [85]

Criticism of the new law

Some people think the new law is too severe, regulating toys as light as 200 grams and ban those drones to be used in most urban areas. Hobbyists and children need to get an approval 10 days in advance. So it is not possible to go out flying when the weather is good. The government should implement special non-restricted areas for drones. [86]

Japan enacts more laws to regulate drones

During March 2016, the Diet enacted a new law banning drones from flying over important facilities such as the Prime Minister's Office while giving police the power to destroy drones if necessary.

The original law implemented on December 10th, 2015 was seen as insufficient to deal with possible terrorist attacks using drones, as it failed to empower law enforcement authorities to destroy them.

Key facilities over which drone flights will be banned include the Imperial Palace and facilities where important foreign dignitaries are staying. [87]

First case of person charged with flying a drone without approval from the police

Japanese prosecutors have looked into a case where a studio photographer used a drone to take a photo of a school building for the annual schoolbook. This is the first case brought to prosecutors after the new law was implemented on December 10th, 2015. The photographer knew he needed permission, but thought it would be ok for just a few minutes. However, he lost the drone and contacted the police. [88]

7.3. Import Tariffs

Goods imported into Japan are subject to Customs duty and consumption tax. In addition to consumption tax, certain other internal taxes (liquor tax, tobacco tax, etc.) are also applicable to dutiable imported goods.

The consumption tax (VAT) was increased to 8% in April 2014 and originally planned to be increased to 10% in October 2015. Due to Japan's economic situation, however, the Abe government has decided to delay the tax increase to 10% until April 2017.

In 2007, the average applied Customs duty for all goods imported to Japan was 1.8 percent. Specifically, 10.1 percent for agricultural products, 4.6 percent for fish and fish products, and 1.7 percent for wood, pulp, paper and furniture. [89]

The Customs duties for Electrical Equipment, Aircrafts and Photographic Instruments are in most cases zero and consequently no import duty, but of course the Consumption Tax has to be paid when goods are brought into Japan. [90]

8. Key Success Factors, Main Challenges and Opportunities

The drone market in Japan is still under development, and it is expected that it will change much once the legislation is (has) improved. Today, there is a weight limit of 200g. So even the toy market is highly restricted by this limitation. Anyone, who wants to play with a drone with a weight of more than 200g, has to apply 10 days in advance. Also for flying in a park in a big city, a similar approval is required. Regulations will most likely be modified to allow for more spontaneous playing with drones.

Anyway, the toy market does not seem to be any good opportunity for European SMEs. The reason for this is that toy drones, at the moment, are just a novelty and the general public will lose interest in playing with drones. Of course there will always be a small and reliable market of hobbyists, but Chinese makers such as DJI etc., have already captured this segment with excellent products.

The enterprise (commercial) market is more interesting as it requires more than just hardware. It requires knowledge about complete individual applications and solutions; something that takes time and efforts to build up. This is a much more interesting market for European SMEs. It is to develop software support for specific applications in the drones and the supporting systems. According to the market forecasts made by Nikkei AT Clean Tech, in chapter 5.2.2, the revenues from hardware are very small. The majority of revenues come from the system and the services that are provided by the drones.

Nikkei is also expecting the market to grow in the future, and by 2030 the market for commercial drones is estimated to be worth about 100 Billion Japanese Yen that will correspond to about 8,200 drones. This is a significant growth from 500 units in 2015!

In order to achieve those numbers there are many challenges such as technical, legal and social ones that have to be cleared. The technical requirements, for instance, are faster speed, longer distances and higher payloads. The ultimate goal is to provide a “taxi-service” by drones. Nikkei believes that drones will be able to carry humans in year 2025. [91]

The military drone market will continue to grow during the coming years, but not as fast as the commercial drone market. The Japanese Ministry of Defence is developing its own drones; however, the ministry is open to new and attractive products from abroad. Traditionally, this market is not very cost-focused.

9. Importers & Related Organisations

The Japan UAV Association (JUAV)

Four companies (Fuji Heavy Industries Ltd., Kawada Industries, Inc., Yamaha Motor Co., Ltd and Yanmar Agricultural Equipment Co., Ltd.) that have been involved in developing, manufacturing and utilizing unmanned helicopters, formed an Unmanned Helicopter Consortium in 2002. But there are no common rules governing applications outside of the agricultural field, which have been expanding

over the past few years. Because of that, rather than continuing to expand the Unmanned Helicopters Consortium, the Japan UAV Association (JUAV) was formed as a new organization.

Regular Corporate Members (In order as of admission, Jan 2016):
Fuji Heavy Industries Ltd., Yamaha Motor Co., Ltd., Yanmar Agricultural Equipment Co., Ltd., Kawasaki Heavy Industries, Ltd., Mitsubishi Heavy Industries, Ltd., Hirobo Limited, Hitachi Co., Ltd, NEC Corporation, GH Craft Ltd., Fuji Imvac Inc., NIPPI Corporation, Xenocross Co., Ltd, X-TREME COMPOSITE JAPAN.LLC, GEOSURF CORPORATION, Futaba Corporation, TOKYO AIRCRAFT INSTRUMENT CO., LTD., Kanematsu Aerospace Corporation, Autonomous Control Systems Laboratory Ltd., Canon Marketing Japan Inc., TAJIMA MOTOR CORPORATION [92]

JUIDA, Japan UAS Industrial Development Association

JUIDA is organising the Japan Drone 2017 exhibition. Also providing the "Sorapass" which is a platform including support for drone makers and users. The platform includes maps over non-flying areas etc. [93] [94]

10. Important Trade Fair and other events

In May 2015, the first international drone expo took place in Makuhari Messe, Japan, with 50 companies participating. Although a relatively small expo, occupying a minor site at the convention centre, it was packed, showing high interest among the public. The fact that drones have made media headlines recently might have stirred interest.

Cutting-Edge IT & Electronics Comprehensive Exhibition (CEATEC) 2016
Oct. 4- 7, 2016, Makuhari Messe, Tokyo. [95]

Japan Drone 2017,
March 23-25, 2017, Makuhari Messe, Tokyo. [96]

International Drone Expo 2017
April 19-21, 2017, Makuhari Messe, Tokyo. [97]

11. Summary and Recommendations

As this report has shown, the drone market is still at a very early stage. Legal and social issues are still under discussion; and drones are still regarded as toys in many countries. However, the enterprise or commercial market has started to grow, and after some years will become the dominant market segment, exceeding revenues from the consumer and military market.

The hardware is a small part of the total business; instead the major revenues will come from the service businesses, which primarily come from application development. Today's drones still have some limited hardware performances in terms of speed, distance and payload, however with improvements in those areas the number of possible applications will expand dramatically.

Battery technology is an important area to achieve improvements of those three parameters. Charging stations may possibly become a complement to battery improvements. The drone industry will benefit from improvements in battery R&D for other applications, such as computers, mobile telephones and electrical cars. Better hardware will allow more and more new applications.

The application market for drones is enormous, and it is very difficult for large companies to develop this kind of diverse applications in an efficient way. In the future, there will be many small entrepreneurial companies working in collaboration with large end-users to develop specialized drones.

It may be drones for the police to find stolen cars in the traffic, or it may be drones for large building owners to clean the windows.

This kind of specialized applications will be an attractive market for European SMEs that have developed new applications in collaboration with European companies. Initially, it is expected that most applications will be developed within the areas described in Appendix A, but later it will develop well outside those areas. There is basically no limit.

Many applications will also require a complete system, not only the software in the drones, but also systems which control customer interfaces and optimise the utilisation of a number of drones.

There will also be opportunities in providing training schools for drone operators. Especially initially when the legislation in EU is not yet identical in all EU member countries.

Areas, which can be opportunities for European SMEs:

- Battery improvements
- Charging stations
- Software development for specialized applications
- Complete systems for special applications
- Training of drone pilots for EU

Being entrepreneurial and flexible, European SMEs have great opportunities in Japan.

Appendix A: Application areas for Drones in Japan.

This list of drone's applications areas is produced by Nikkei AT Clean Tech, and it is the base for their market study. [98]

Agriculture, Forestry and Fishery
Pesticide Spraying
Crops management
School of fish inspection

Inspection Tour, Inspection
Rivers, Dams
Highways
Electrical power Lines
Petroleum terminals
Chemical complex
Shipyards
Thermal and Nuclear Power Stations
Very large Solar panels
Bridges and Tunnels
Volcanic eruption
Earthquakes

Search and Rescue
Maritime
Mountain and forests

Work in Danger Zone
Accident prevention in Nuclear Power plants
Factories
Construction sites
Disaster sites
Fire sites
Work on outside of skyscrapers

Measurement and Observation
Airspace and Map Information
Traffic volume
Weather
Ocean
Atmosphere
Radioactivity
Environment
Stalactite cave and caves

Filming and Shooting
Movies, TV and News
Sport events
Promotional videos
Documentary

Shipping and Logistics
Delivery
AED shipping
Emergency shipping

Others
Radio base stations for emergency usage
Advertisements
Attractions

Security & Guard
Border
Maritime
Coast
Drug management
Traffic management
Event management
Building and Factory management
City security

Disaster Protection
Flooding and Tsunami
Forest Fires

Hobby

Appendix B: Literature & Web Links

[1] https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle
[2] http://ngm.nationalgeographic.com/2013/03/unmanned-flight/horgan-text
[3] http://dronelife.com/2016/01/14/will-china-dominate-the-drone-market/
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