

# **The Evolution of Remote Sensing UAVs/Drones Applications in the Urban Planning Perspectives: A Review**

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## **ABSTRACT**

Remote sensing UAVs/drones applications have changed the people view on urban and city planning. The latest technologies on remotely-sensed applications allow people to see and understand their neighborhood from above. This paper attempts to review on the evolution of remote sensing UAVs/drones application from the urban planning perspectives. Thus, the objectives of the review include the trends and issues of UAVs/drones usage in the urban area, types, and functions of UAVs/drones in the urban planning context, as well as law and regulation concerning remote sensing UAVs/drones' applications by international and local organizations. The methodology used includes literature reviews of paper articles, journals, books, website and official document related to UAVs/drones and urban planning. The findings and discussions are expected to help the professionals especially those who involve in urban planning field and encourage them to apply new and updated technological approach for smart and sustainable planning. Previous research proved that UAVs/drones have given remote sensing a new appeal for scientists, who will now be able to conduct studies in a much more flexible way and become the preferred platform for the development of remote sensing instruments and applications, especially in urban studies.

**Keyword:** UAVs/drones, Remote Sensing, Urban Planning, Applications.

## **1. INTRODUCTION**

UAVs/drones can be simply defined as robotics planes. It is also known as Unmanned Aerial Vehicles (UAV), unmanned aircraft systems (UAS) and remotely piloted aircraft (RPAs) Ivošević et al. (2015). Malaysia Department of Civil Aviation (2008) defined UAVs/drones like an airplane which is designed to function without a human pilot on board. UAVs/drones have evolved and rapidly developed over past decades mainly for military and civilian purposes. After a few decades passes, UAVs/drones are used for non-military purposes such as for atmospheric research, earth and weather observations as well as remote sensing applications (Kellington et al., 2015). Recently, its low-cost monitoring and low-impact

solutions encourage the usage of UAVs/drones in a broader context such as mapping tools for environmental monitoring.

The United States made it as a necessity to integrate Unmanned Aircraft Systems into the National Airspace System, which includes all aircraft, manned or unmanned to abide by the regulations provided by Federal Aviation Administration (Rango & Laliberte, 2010). In Malaysia, Department of Civil Aviation (DCA), Malaysian Communication and Multimedia Commission (MCMC), Jabatan Ukur dan Pemetaan Malaysia (JUPEM) and Selangor Town and Country Planning Department are among the responsible government agencies in monitoring UAVs/drones activities in Malaysia. The rules and regulations designed for UAVs/drones highlights on a few aspects that control its usage such as, the surrounding conditions, types, and size of UAVs/drones, categories of users as well as safety, privacy and security.

However, the use of robotic planes or UAVs/drones in urban planning is still in the infancy stage of development, especially in Malaysia. Recently, many research groups around the world have worked to improve the remote sensing UAVs/drones application to monitor inaccessible areas and mapping it. If remote sensing UAVs/drones were to apply vastly in various aspect especially in urban planning, there is a need to regulate laws and zones for the UAVs/drones users to comply. UAVs/drones technology used in urban areas raises important questions and concerns about public safety, privacy, and the potential implications of public and private utility and use. The regulations act as a way UAVs/drones can be utilised without violating the privacy and safety of the public as well as the natural environment and ecosystem.

## **2. THEORETICAL OF UAVS/DRONES USAGE IN URBAN AREA**

The rapidly evolved technology of UAV or drones, provide potential uses in many aspects of urban life, including in the urban planning fields. Remote sensing UAVs/drone's applications provide a superior low cost, adaptable and accurate data gathering tool for planners (Alexander & Jenkins, 2015; Colomina & Molina, 2014).

### ***2.1.Recent Issues Relating to UAVs/drones Usage in Urban Area***

Although UAVs/drones may present excellent options for accuracy assessment by providing a real-time, and high-resolution imagery of remote areas without threat to human life or the environment, they are not always ideal solutions for every situation (Kelly & Kelly, 2014). There are many issues arise from UAVs/Drones usage, especially in the urban area.

#### ***2.1.1 Safety and Security***

In this paper, the issues on Safety and Security do not only focus on the people living in the urban area or any parties affected by UAVs/Drones usage but also includes the safety and security aspect of drone users, the equipment, licensing, training and maintenance. The aspect of UAVs/Drones usage sometimes being neglected by users probably due to the cost and lack

of awareness and this community is facing a global problem and should strive towards attaining a global solution (Kelly et. al.,2014). The most important part is to create awareness of the community with efforts by all global stakeholders in UAV/Drones applications. International synchronization of rules and regulations about the use of drones in the urban airspace to ensure the aspect of safety and security can only be achieved if there is continued contact, co-ordination and co-operation between all the stakeholders involved.

### *2.1.2 Privacy*

Recently, many types of UAVs/drones became widely available due to affordable prices and stable flight performance. UAVs/drones can capture the scene from different points of view, and can get close to targets which as a result, they can collect private personal data. This situation alerts a new dimension to issues around privacy and calls for appropriate privacy protection solutions (Bonetto et al 2015). Moreover, the domestic use of UAVs/drones by law enforcement has become a popular topic in the U.S leading to the establishment of FAA Modernisation and Reform Act of 2012. The act fixed that the FAA must integrate the unmanned aircraft systems which include UAVs/drones into the national airspace by September of 2015. Due to this matter, some organisations have expressed concern over the possibility that thousands of UAVs/drones will be crowding the skies, and the risk of improper safeguard on aerial surveillance (Mcneal, 2014).

The domestic use of UAVs/drones by law enforcement is likely to prompt privacy debate. It can be a valuable tool in certain kinds of operations by the law enforcer where they are liable to use UAVs/drones in tactical operations and to view public spaces clearly. Nonetheless, the Legal experts say they will have to obtain a warrant to spy on private homes. (Kohn, 2016) designs a city that is UAVs/drones-proof. He argues that a town that's impermeable to the newest instruments of war not be just a novelty, but it is a necessity. On the other hand, the potential for hijacking a UAVs/drones has already been realised among hobbyists and enthusiasts, and as UAVs/drones become commercially accepted. There will be a need for secure communications between the UAV and ground control. This security issue may require either, or both, a semiconductor and software solution. The issue should be addressed before the commercial market expands and the potential dangers arise (Hoy, 2015).

## **2.2. UAVs/Drones Used in Urban Areas**

Many remote sensing applications have benefited from the use of drones due to the cost of the mission, the need for quick response or even the fact that observations need to be carried out in an environment that may be dangerous or inaccessible to an individual. Many types of research have been done with the adoption of UAVs/drones with remote sensing techniques. The studies includes archaeology (Agapiou & Lysandrou, 2015), monitoring vegetating area (Salamí, Barrado, & Pastor, 2014), 3d modelling and tree species cataloguing in a park area (Gini et al 2012) and rangelands studies. Other studies include using this application for post-disaster management. In Japan, UAVs/Drones are used as part of farm equipment and for

environmental conservation purposes like tree plantation and orang-utan habitat distribution (Chen, Shioi, Montesinos, & Koh, 2014).

In the urban area, Hermes 900 is one example of high-endurance UAVs/drones with longer flying time that being use to patrol stadium for national events such as World Cup 2014 and in-coming Olympic Games 2016 (Pool, 2016). UAVs/drones modern machinery that can be selected for a broad range of applications to improve the way we work, play, and live. For example, UAVs/drones are used in Singapore today for diverse applications ranging from emergency operations, research, to urban planning and design (Authority, 2016). Bonetto et al., (2015) inventively studied the use of UAVs/drones for surveillance in the urban area, e.g. car park, and recreational park with the Crowdsourcing method. Crowdsourcing-based evaluation of privacy trade-off in video surveillance has shown good consistency with laboratory-based studies. The crowdsourcing methodology benefits from a large number of participants and can be performed efficiently and at a relatively low cost with drone applications. Nonetheless, there is some evidence that the use of UAVs/drones is gaining traction among law enforcement agencies responsible for public security. Some countries began using UAVs for surveillance, like law enforcer in Brazil used UAVs in special urban operations such as tracking a top drug kingpin (Pool, 2016)

### **3. CONTEXT OF URBAN PLANNING**

Urban planners and other city personnel are often tasked with the difficult job of renovating a section of the city. With aerial UAVs/drones photography, the photo and video of the block or area that is to be renovated can be precisely captures. In the urban planning context, the rapid response imaging using UAV/UAVs/drones has received much attention as well which has been demonstrated by road accident simulations, Pedestrian Detection on TUD-crossing Image Sequence (Chen et al., 2014), traffic monitoring as well as zoning and land use planning (Alexander & Jenkins, 2015). The authors also listed some UAVs/drones applicability in urban area such as Window Cleaning UAVs/drones, Fog Dissipation, Power Grid Monitoring, Site Inspector UAVs/drones, Fully automated paid parking system UAVs/drones, Autonomous Infrastructure Mapping and Evaluation Robot, Coupling of UAVs/drones with Public Buses, UAE Falcon to allocate accidents, UAVs/drones used for organ transportation in emergency cases, Sky Net Delivery Catchment System, UAVs/drones for Planting 1 Billion Trees a Year, and lastly drones used to scan and probe lakes, rivers for emerging pollutants and threats.

Schroyer, (2014) in his journal listed several UAVs/drones applications such as Agriculture for weed management, UAVs/drones assist in disaster management such as Fukushima Disaster in 2011 and post-hurricane mapping in the Philippines in 2014. Urban planning in Albania using UAVs/drones application for running the smart city in 2014, and demand for infrastructure as well as detecting illegal dumping site potential to affect the environment negatively. Some stated that a difficulty in gaining cloud-free scene at the

region from satellite platforms. It can be solved by using aerial imagery as an effort for introducing an economical method of remote sensing data; which only requires UAV/Drones to be used with a digital camera to provide near-time data. The results indicated that the drones with a high-resolution digital camera could reduce the time and cost of images acquisition for LULC mapping.

The Singapore Urban Redevelopment Authority is currently exploring the use of aerial images captured by UAVs to create 3D digital models of heritage building and sites in the city areas. The process is done using a technique called photogrammetry, which is the science of making measurements from photographs (Authority, 2016).

#### **4. DRONES LAW**

In the United States, the airspace above 700 feet is restricted under federal regulations, only the airspace 30 feet from the ground surface considered as part of individual property rights. Property owners can sell the airspace ownership through a transfer of development rights. According to Hoy, (2015), the U.S. Congress has ordered the Federal Aviation Administration (FAA) to put into effect a plan to allow commercial UAVs/drones in the U.S. airspace in 2015 while The European Union has a similar deadline set for 2018. However, a different situation is a practice in Malaysia where the land owner fully own both the airspace and the underground within the owned land as stated in Section 75B, National Land Code 1965. Due to this situation, the Legal consideration in the exercise of the powers on UAV/Drones operations in Malaysian Airspace stated that there are two categories of Unmanned Aerial Vehicles comprise of civil aircraft and state aircraft. As previously mentioned, UAVs/drones operating in Malaysia falls under “Malaysia Aircraft” which means it must fulfil the safety and operational standards as the manned aircraft.

##### ***4.1. Analysis Inter Countries***

Among countries in Europe, France, has the largest number of drone operators which is over 1,600 registered companies. Due to that, France has one of the most advanced laws on the use of civilian drones. Paris, the capital city of France, is zoned as a restricted area for flying. Any illegal use of a drone in this city will cause a maximum of five years' jail and €75,000 (USD 84,400) fine. The French law also prohibits small citizen drones from sensitive areas such as nuclear facilities, which are protected zone that extends at the 2.5km radius and a height of 1,000m (MLV Drone, 2015).

Transport Canada is the agency that controls the Canadian air space. The agency has set a clear line for UAVs/Drones between “commercial use” and “recreational use”. The recreationally used aircraft which is under lighter regulations which require being less than 77.2 pounds in weight, must be individually owned and non-profit-seeking. Aircraft which do not meet this criterion are officially considered as “unmanned aerial vehicles for commercial

use” and require Special Flight Operations certificates. The certification requires a very strict process that includes a detail list of specifications. For example, a UAV can meet the three model aircraft standards listed above, but if it is also attached to a small camera, then the UAV defined by the category of an “unmanned aerial vehicle” under the law.

Currently, in Mexico, no regulations are affecting UAVs/Drones users. The government also uses UAVs for various purposes from detecting drug-dealing activity to university research (Mexico Moves to Regulate Use of Drones, 2015). Brazil has become a leading player in UAVs/Drones usage for South America. On the national level, the country is spending intensely in UAVs/Drones usage to patrol its borders (Agencia Nacional de Aviacao Civil, 2015). In 2013, a company, XMobots, has been permitted to fly the first civil drone for the purpose of monitoring Jirau dam (Stochero, 2013).

However, in the United Kingdom, the UAVs/Drones laws are similar to the current policies of the United States of America. The laws are more like guidelines than a comprehensive set of regulations. Currently, CAP 722 claims jurisdiction over UAVs/Drones use in the United Kingdom. The legislation divides the use of UAVs/Drones into two groups which both groups require permits. The weight limit of the UAVs/Drones cannot surpass 20.7kg for it to be considered as a “small unmanned aircraft” (Castella, 2014).

Australia and New Zealand that share the same law, however; New Zealand does not require identification requirement. The Aviation Industry Association of New Zealand has planned legislation on UAVs/Drones, but the suggestion is apparently more of a non-restrictive manual for UAV use than anything. An “unmanned aircraft system” is Australian terminology for a UAV used for profit-seeking “air work,” but such commercial use only requires some easily available identification. Otherwise, the UAV is a “model aircraft, flown for sport & recreation and education,” according to the Civil Aviation Safety Authority. Model aircraft are completely hands-off in terms of regulation

Singapore Air Navigation Order requires permits to be attained for flying a drone within 5km of an airport or air base. The same requirement applies for flying a drone higher than 61m above the average sea level. An application to conduct aerial photography from a camera-mounted drone must also be submitted to the Civil Aviation Authority of Singapore (CAAS) (Civil Aviation Authority of Singapore, 2015). The new regulation basis stipulates that users need a permit to fly a drone that weighs more than 7kg, as well as for commercial purposes. Specialised services like surveying, aerial advertising or the discharge of any substance from the drone will also require a permit. In addition, security-sensitive locations and special event areas - for instance, at the upcoming SEA Games - will be gazetted as “protected areas” and those without a permit will not be allowed to fly drones or take aerial photographs of these regions (Chan, 2015). A list of security-sensitive areas where such aircraft are not authorised to fly without a permit, like the Istana, will be published.

In Malaysia, it is the policy of Malaysia Department of Civil Aviation that Unmanned Aerial Vehicles must meet or surpass the operational and safety standards as the manned aircraft. Thus, Unmanned Aerial Vehicles operations must be safe as manned aircraft as to not cause or create any harm towards a persons or property in the air or on the ground (Department of

Civil Aviation, 2008). The civil UAVs/drones which not exceed 20kg are prohibited in controlled airspace or within aerodrome traffic zone without permission of air traffic controller. Operators must receive authorisation from the Department of Civil Aviation before flying a UAV.

#### *4.3 Aspect the Drones Law and Regulations*

Most countries imposed the laws and regulations on UAVs/Drones concerning a few important aspects which are safety, security and privacy. All of the mentioned aspects are applicable to all main components in UAV/Drones application which are; the users, the UAVs/Drones and the air space. The type of users defines on what kind of drones they are using and skill in handling the equipment. The types of users and equipment also justify user's ability to fly in different types of airspace without neglecting the safety requirement as to avoid causing disturbance to any parties. Some country has very specific area in term of regulation on air space where the drone are prohibited, restricted and allowed to fly. Some countries outline the zoning for the drone, which in this case, identify the type of land use and its activity varies crucial before the drone zone could be implemented. Some zones are fixed, such as buildings and gathering square. But there is a country that very detail in defining the airspace. The temporarily prohibited area, for example, are not fixed, it is based on events and occasions that held in that particular area in some certain timeframe. There are pros and cons come along with UAV technology, but with best-designed guidelines and zoning for its applications will give more positive impacts and open to new findings in urban planning in particular, and reduce the negative impacts and a grey area in legislation statutes.

## **5. CONCLUSION**

Drones are a highly adaptable technology that is constantly changing in innovative ways to provide greater utility. This tool provides planners with a source of unique aerial data by which they can better inform the client and public. Drones are also relatively inexpensive, providing access to data and information which was previously cost prohibitive for many planning tasks; such as with satellite technologies. Therefore, due to both the adaptability of the technology and the low cost of drones compared with alternatives, the utilisation of drones in urban planning provides one of the most cost-efficient data collection and transport task utility tools of our time. If Malaysia is able to come out with a comprehensive drone zoning for urban planning purposes and progressively address the issues surrounding the remote sensing drones applications, then this technology can help to plan for, and monitor progress towards sustainable urban development.

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