



AN ANALYSIS OF THE REGULATORY FRAMEWORK OF COMMERCIAL AGRICULTURE UNMANNED AERIAL VEHICLES (UAVs) IN MALAYSIA

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Abstract:

The development of agriculture in Malaysia is expanding from conventional methods to the latest technology of unmanned aerial vehicles (UAVs). The potential of the operation of UAVs in the agriculture sector in Malaysia has enforced the Civil Aviation Authority Malaysia (CAAM) by the power given in the Civil Aviation Act 1969, to come out with the first directive designed specifically for UAVs in agriculture. It contains the proper guidelines and safety procedures of the said operation. This article is aimed to analyse and examine the legal framework of the Civil Aviation Directive 6011 Part II (CAD 6011 Part (II) – UAS AGR) set by the CAAM in administering the operation of UAV agriculture. As a member of the International Civil Aviation Organization (ICAO), Malaysia is obliged to develop its national regulations based on the Chicago convention and the International Standards and Recommended Practices (SARPs). This article will adopt the doctrinal research by referring to the current directive of CAAM, current laws, and regulations as enforced in Malaysia in administering the extensive operation of UAVs in agriculture. Further, this article is aimed to analyse safety, risk assessment, and liabilities *vis-à-vis* the UAV agriculture. In brief, the operation of UAVs in agriculture is a part of CAAM's mission towards the integration of manned and unmanned aircraft into the navigable airspace in line with the mission of ICAO together for the sustainability of the economy and the efficiency of the industry to cope with the development of digital and technology.

Keywords:

Agriculture, Airworthiness, Commercial, Liability, Unmanned Aerial Vehicles

Introduction

UAV is a type of unmanned flying aircraft that can navigate autonomously by a pilot from the ground or it could be a pre-program mode. The technology of UAVs day by day promotes ease to the people. Due to that, UAVs are now widely accepted in the commercial arena. The history of UAVs began in 1849 when Austrians used unmanned balloons loaded with explosives to attack the Italian city of Venice. Furthermore, during the Battle of Neuve Chapelle in 1915, the British military used aerial photography to their advantage. They were able to capture over 1,500 sky view maps of the German trench defences in the area (Sifton, J., 2012). The ability of UAVs in carrying heavy payloads leads to a wider scope of UAVs to fly and operate in the commercial arena with artificially intelligent and sophisticated sensor suites, high-definition cameras, global positioning systems, and algorithmic-driven, cloud-based software solutions that record, store, and analyse large data are at the heart of the UAV revolution (Ravich, T. M., 2018).

The conventional agricultural process has revealed the industry's complex management, which is further linked to national commodities, labour, and export and import. Conventional agriculture involves the process of soil cultivations such as seed planting, crop raising and harvesting, livestock rearing, feeding, and management; cultivation; husbandry; and farming, as well as a broader scope of import and export. The agriculture sector's bulky production to meet the national plan forces the industry to choose advanced and alternative methods of increasing production while also promoting the advancement of this era by merging technology with agriculture. Hence, the commercial UAVs may be operated to assess water conditions in fields before crop planting to determine whether drainage management is required in specific fields, as well as to assess soil health. Even during crop planting season, UAVs can be used to detect plant stress, assess plant health, population, size, and productivity, estimate crop yield, evaluate optimal harvest timing, identify invasive species and resistant weeds, identify appropriate nitrogen fertilisation levels, and optimise water usage by observing drought stress at different growth stages, as well as to quickly assess storm damage (Donaher, E. A., 2021).

Japan, an island nation in the Asia-Pacific region, has been regulating commercial and civil UAVs since the 1980s (Sheets, K. D., 2018). In late 1980, Japan deployed UAVs to spray small crop fields from the air using radio-controlled helicopters (Petty, R.V, 2018). The technology has been used in Japan's agriculture industry for more than two decades, with applications including crop spraying, fertilising, and seeding (Sheets, K. D., 2018). The development of UAV agriculture in Japan was motivated by a desire to reduce labour costs and increase efficiency in the sector. After more than 20 years of development and use, UAVs agriculture is now well integrated into society, thanks to the Japanese government's initiative and partnership with Yamaha, which built the first Yamaha unmanned helicopter with a control device in 1997 (Sheets, K. D., 2018).

The world's population is rapidly growing, with more than nine billion people predicted by 2050. By 2050, almost 70 per cent of the world's population will be living in cities, and the vast majority of them will not be able to produce their food (United Nations, 2017). Due to that, the emergency in supplying foods leads to the integration of technology with agriculture to meet the demand of the world population. A part of biotechnology, the UAV is another method to increase the efficiency of farm management which is considered crucial in securing the world demand for the future food supply. Farmers will be able to enhance yields, even more, to satisfy the demands of the world's population as UAV technology and data collection

improves (Anderson, L. T, 2015). Using UAS technology to improve farming efficiency can help farmers increase crop yield while lowering costs. The potential applications in agriculture should be at the forefront of talks as the authority and the government develops a comprehensive regulatory structure for commercial UAS usage. (Anderson, L. T, 2015).

Further in Malaysia, the integration of the Ministry of Science, Technology and Innovation (MOSTI) and the CAAM have introduced and given a mandate for the operation of UAVs in the commercial sector. In addition, on 16 September 2021, Area 57 was announced as a free fly zone for UAVs which among others are for research and development of UAVs with the paramount objective is to uphold the safety in handling the UAVs. The introduction of CAAMs' directives on agriculture shows the commitment of the government to securing the operation of UAVs in agriculture (Bernama, 2021). Agriculture contributes significantly to the Malaysian economy and national income with the total value of agricultural exports increasing from RM115.5 billion in 2019 to RM118.6 billion in 2020, with agriculture contributing 7.4 per cent to Gross Domestic Products (GDP) performance in 2020 (Mohd Uzir Mahidin, 202). Further, the National Commodity Policy (2011-2020) highlights the objective of increasing the contribution of plantation industrial commodities to the national economy and modernising and transforming the commodity industry to a more competitive and sustainable level. Thus, the use of UAVs in agriculture demonstrates a willingness of the industry to embrace this technology to maintain the policy of modernizing the industry to a sustainable level. Innovation in agriculture from biotechnology agriculture to the technology of UAVs will create a major development in agriculture. Technology is being used by farms throughout the country to reduce expenses and increase efficiency. UAV technology has progressed significantly faster than the legal structure that governs its use (Hall, P., & Rumley, R., 2017). Even though technology has been around for more than a decade, laws and regulations are continually evolving as society changes from time to time. Therefore, various potential legal issues need to be taken into consideration. Indeed, the usage of the UAV in agriculture raises concern among society especially on safety issues despite its novelty.

Methodology

This article is a combination of legal and qualitative research. The method used in this article is by analysing the legal framework of both primary and secondary sources that are relevant to commercial UAV agriculture. The data collected in this article is a content analysis where the text and the provisions of the primary sources of law and secondary sources of law are being referred to in this article. The approach of inductive analysis is inspired in this article by organizing the discussion of the relevant legal issues connected with the primary sources of laws, especially the Civil Aviation Act 1969, the Civil Aviation Regulation 2016, and Civil Aviation Directive 6011 Part II (CAD 6011 Part (II) – UAS Agriculture). Furthermore, the selective controversial legal issues are gathered in this article to analyse the relevance of the provisions of laws to the community and the effectiveness of the laws in governing the UAV agriculture thus the discussion of secondary sources of law from the cases of law and the selective author from various published articles and journals are gathered to integrate the analysis systematically and sync to the primary sources of law.

The directive for UAV agriculture is the main discussion under this analysis which was drafted by the CAAM as the subsidiary legislation under the parent law of the Civil Aviation Act 1969. Therefore the provisions and contents of the guidelines and laws shall sufficiently protect the surrounding, especially the public, property, environment as well as animals from the

unintended incidents and risks attached to the technology. The structural analysis of this article is mainly connected with the legal implications *vis-à-vis* commercial UAV agriculture, especially in safety and risk in case of negligence and the competency of the pilot or operator of the UAV. The discussion of private use of UAV agriculture is excluded from this research.

Civil Aviation Directives: Unmanned Aircraft System Agricultural UAV Operations CAD 6011 Part (II)

The operation of UAVs in agriculture shows the prospect of the sector in sustaining the Malaysian economy. In agriculture, the UAV system is commonly used in crop scouting which allows farmers to inspect in-progress crops. (Stroud, K., 2018). Rather than having a worker stroll a field, farmers may now use UAVs to view an open spectrum at once and collect data that isn't visible to the naked eye (Grassi, M., 2014). In Malaysia, the usage of UAVs begins when Malaysia adopts the Chicago Conventions as established by ICAO, a United Nation specialized agency. Malaysia has been a member of ICAO since 7 May 1958 with the objective to set standards rules and regulations regarding international civil aviation for manned and unmanned aircraft. Malaysia has been elected to the ICAO Council in 2007 and has served on the Council for three consecutive terms (the Council States 2019-2022, ICAO, United Nations). One of the main objectives of the ICAO is to develop standards and policies connected with the aviation of manned aircraft and unmanned aircraft and the members are encouraged to establish normative standards and policies to the domestic laws. Due to that, Malaysia has inserted several provisions in the Civil Aviation Act 1969 to give effect to the Standards and Recommended Practices (SARPs) of the ICAO in managing aviation safety risks and assurance of safe operation of unmanned aircraft. Besides, the Civil Aviation Directive for Agriculture (CAD 6011 Part II-UAS AGR), has come into operation on the 1st of March 2021, by powers conferred by its parent's law of the Civil Aviation Act 1969 (Act 3) under section 24O and pursuant to Regulation 136, 141, 189 and 193 of the Civil Aviation Regulations 2016. Section 24O of the Civil Aviation Act 1969 provides the requirement of publication of directive issued under this Act by the Director General of CAAM to ensure the information contained in the directive is brought to the attention of the public. Regulation 136 of Civil Aviation Regulation 2016 which shall be read together with regulations 141 and 189, further mentions the safety procedures in handling aerial work, especially for the UAVs, whereby a prior approval and consent from the Director General of CAAM is compulsory as to affect the safety requirement. The approval and consent for permit and licence by Director General shall be properly documented with the necessary information and prescribed fees as per regulation 189. In addition, the Director General has the power to suspend, terminate and amend any licence or permit if happen information adduced contains fraud or misrepresentation, or the person has breached any terms and conditions as per the requirement of the licence or permit, or the person has breached any provision under the Act or Regulation; or the unexpected occurrences that involve death, incapacity and bankruptcy of the person or company.

This new directive lays out the standards, requirements, and procedures that individuals and operators in Malaysia must follow when applying for approval to use UAVs in agricultural operations. Agriculture UAV operations encompass dispensing any agricultural payload intended for plant nourishment, soil treatment, plant life propagation, or pest control; or engaging in dispensing 'agricultural payload' and surveillance systems directly affecting agriculture, horticulture, or forest preservation, but excluding the dispensing of live insects (Item 1.4.1.1 (a) &(b) of the CAD 6011 Part (II) – UAS AGR). The CAD 6011 Part (II) also addresses agriculture UAV operations in Malaysia, including the issuance of commercial and

private agricultural UAS Aerial Work certificates for those operations (Item 1.4.2 (a) & (b) of the CAD 6011 Part (II) – UAS AGR). The standard requirement set by the directive among others is in terms of airworthiness, competency of the operator and pilot, and the risk assessments on pre and post-operation. The non-compliance of the said directive is inevitably contravening with section 24O of the Civil Aviation Act 1969 (Act 3) and the Civil Aviation Regulation 2016 where on conviction, a person shall be liable to a fine not exceeding five thousand ringgit or imprisonment not exceeding three years or both; and further, if the non-compliance of the directive is from a body corporate, shall be liable to a fine not exceeding one hundred thousand ringgit.

Airworthiness and Safety Procedure

Airworthiness involves the safety measure of the suitability of any aircraft whether manned or unmanned for a safe flight with the approved certification by the relevant authority. In the case of UAVs, the airworthiness of UAVs shall meet the ability of the UAVs to fly autonomously without a pilot on board and the ability of UAVs to carry approved payloads with the control of the pilot from the ground. In the case of agriculture UAV, the CAAM does not recognize the 'privately built UAV' which such modifications do not attain the standard requirement of airworthiness that eligible for the agriculture operation and the application of the aerial work certificate (AWC) (Item 3.2.2.1 of CAD 6011 Part (II) – UAS AGR). The term 'privately built UAV' refers to a UAV assembled or manufactured for the build's use, as opposed to a UAV assembled from sets of parts sold as a single ready-to-assemble kit. The prohibition of privately made UAVs is based on the fact that the controllability and mechanical resistance of the UAV during the flight are not tested and validated, and thus the airworthiness of the said UAV cannot be determined for purposes of the operation. The Standard and Industrial Research Institute of Malaysia (SIRIM) is in charge of UAV testing, accreditation, and certification. Privately built UAVs that meet SIRIM accreditation requirements may be recognised in the Special UAV project rather than in agriculture operations.

The requirement of airworthiness in agriculture UAVs is similar to other types of UAVs where any UAV that weighs more than 20 kilograms and without fuel shall get prior authorization from the CAAM (Item 4.8.1 of CAD 6011 Part (II) – UAS AGR). Furthermore, all multi-rotor UAVs specifically designed for agriculture operations must comply with the requirements outlined in Item 4.8.2 of the Directive, which include the following: the UAV shall be designed as its intended operation set by the manufacturer and has been evaluated and accepted by the CAAM; the UAS shall have a proper Flight Manual, Maintenance Manual, and Operating Manual from the UAS Manufacturer; and the UAS shall be maintained by authorised technical personnel (ATP) appointed by the CAAM. The ATP have the qualification, and competence and is trained by the UAV manufacturer. The ATP is obliged to evaluate and inspect any modification, repair and replacement of the UAV. The ATP also shall perform the pre-flight inspection before any flight (Item 4.8.2(h) of CAD 6011 Part (II) – UAS AGR). The approval of airworthiness for a multi-rotor UAV developed for agricultural operations is based on the level of performance, limitations, and specifications of the UAV; as a result, CAAM approval is assessed on a case-by-case basis (Item 4.8.3 of CAD 6011 Part (II) – UAS AGR). This shows the airworthiness of UAVs in agriculture is depending on the types of agriculture and activities. One operation would be different from another operation and thus will impose different risks and shall be evaluated separately. The registration mark of the UAV is another feature to complete the airworthiness of the UAV. The marking of registration of UAV agriculture shall be readable and weatherproof as per Item 4.9.1(b) of the Directive.

Competency of Pilot and Operator

The operator and pilot of the agriculture UAV shall be fit and competent in conducting the operation (Item 4.1.1(a) of CAD 6011 Part (II) – UAS AGR). The requirement of fit and competent connotes the knowledge and skill of the operator and pilot in connection to the basic handling of UAVs and components in UAVs. The pilot or operator of UAVs must demonstrate aeronautic knowledge (Hall, P., & Rumley, R., 2017) by successfully passing the test and course as required by the CAAM. The Remote Pilot Training Organisation (RPTO) theoretical examination conducted by CAAM *via* online requires the applicant to pass at least 75 per cent and above as an indicator of the assessment (Item 8 of the Civil Aviation Directive-6011 Part (1)-RPTO). Apart from that, the operator and pilot of the agriculture UAVs shall have a duty to comply with rules and regulations set by CAAM and Civil Aviation Act 1969. This duty is absolute by giving a clear picture of the liability of the operator and pilot of UAVs towards the unintended accident and damage to person or property. Further, the operator and pilot of the commercial agriculture UAV are responsible for establishing the proper procedure for the agriculture operation with the safety as a paramount objective in case of manual operation, security requirements for the area of operation, unlawful interference and unauthorised access, and guidelines for minimizing nuisances to public and animals (Item 4.1.1(d) of CAD 6011 Part (II) – UAS AGR). The responsibilities of the operator and pilot of commercial agriculture UAV are greater than private agriculture UAV operation since the operation usually involves big scale operation that possibly affects the public, property and even animal. The remote operators or pilots shall comply with the directive requirement where they shall have the competency to operate in line with the certified training received by them and shall have been informed about the UAS operator's operations manual by observing and conducting the risk assessment and procedures before the operations (Item 4.1.1(f) of CAD 6011 Part (II) – UAS AGR). The directive also highlights the further strict requirement for the commercial agriculture UAV to operate on the personnel in duties of the operation to have completed on job training developed by the operator and have been informed on the manual and safety procedure of the operation (Item 4.1.1(g) of CAD 6011 Part (II) – UAS AGR). This requirement is exempted to the private AWC holder for the operation of agriculture UAV. Thus the liability under torts is extended not only to the operator or pilot and the AWC holder but it extends to the personnel in duties of the operation, where the breach of duty may liable for negligence.

The AWC is issued according to Regulation 136 of the Civil Aviation Regulation 2016 as a compulsory requirement for the operation of UAV agriculture, subject to the CAAM's approval (Item 3.1.3 of CAD 6011 Part (II) – UAS AGR). The activities and operations of UAV agriculture shall be notified to the nearest agriculture department or agency. Further, the mode of operation could be executed by a pilot or operator who is employed or by contract for service to engage and to assign the UAV operation safely. This shows the approved diversity of commercial agreements *vis-à-vis* to the agriculture UAV. The AWC operation can be extended to private agriculture operations and commercial agriculture operations (Item 3.2.1 of CAD 6011 Part (II) – UAS AGR). Further, the commercial holder of AWC is subject to the annual inspection and review of the operation manuals, logbook, and audit upon renewal of the said certificate (Item 3.10.1 of CAD 6011 Part (II) – UAS AGR) by the CAAM within four months before the expiry of the certificate (Item 3.10.2 of CAD 6011 Part (II) – UAS AGR). The audit will be conducted by the CAAM to ensure and demonstrate the AWC holder and the UAVs are complied with the UAV Regulation in conducting the agriculture operation. In case of non-compliance with the UAV, Regulation is found while the audit process took place, the operator

would be notified for such non-compliance that renders the operation would be suspended, revoked or terminated (Item 3.10.8.1 of CAD 6011 Part (II) – UAS AGR). The safety issues of the UAV may affect the non-compliance decision and the operation of agriculture shall always highlight a good practice procedure and avoidance of hazards to uphold the safety of the public and property (Item 3.10.8.2 of CAD 6011 Part (II) – UAS AGR).

The remote pilot or operator has a duty under the law not to operate the UAV while under influence of substance or alcohol, or while unfit to perform the duty because of injury or sickness. This is to ensure both the physical and state of mind of the pilot or operator is fit and can make the best judgement for the operation. The remote pilot or operator further shall evaluate pre-flight, during and post-flight requirements as per the directive. The pre-evaluation that remote pilot or operator shall comply among others are; Obtaining an updated Notice of Air Mission (NOTAM) in regards to the area of operations; ensuring that the operating environment is compatible with the authorised or declared limitations and conditions; ensuring that the UAV is in a safe condition to complete the intended flight safely, and if applicable, checking if the direct remote identification works properly; and ensuring that the information is accurate (Item 4.10.1.1(c) of CAD 6011 Part (II) – UAS AGR). Moreover, during the operation of UAV agriculture, the pilot or operator shall ensure that the flight is within the authorised declared limitation areas and geographical zones and shall avoid any risks and collusion to manned aircraft, public, property, animals and the environment. The operator and pilot have to be familiar with the operation's location. The operator and pilot shall check any possible conditions and obstacles that may affect the flights and design possible emergency and alternative routes to avoid the obstacles. Therefore, an appropriate survey shall be conducted in such an area of operation. The weather condition also is a paramount procedure in the operation of agriculture UAVs as such winds, rains and thunderstorms may affect and cause failure to the operation and pose risks to the surrounding. The pilot and operator of the UAV agriculture further must wear appropriate Personal Protective Equipment (PPE) while operating especially in dispensing pesticide or substance that involves chemical payload. This is compulsory in line with the Occupational, Safety and Health Act 1994(OSHA 1994).

Safety and Risk Assessment

The principle of *res ipsa loquitur* is applied in aviation due to the nature of the flying object and is considered an excessive-hazardous and dangerous activity (Cox v. Nw. Airlines, Inc., 1967). While the underlying Bernoullian and Newtonian concepts behind powered flight were never substantially questioned, the early interaction between humans and flying machines was clearly hazardous (Ravich, T. M., 2015). The accidents and incidents of manned aircraft were the turning point for the legislator to provide the human involvement in securing the safety even though the artificial intelligence (AI) of the technology exists. The safety requirements and manuals are considered the blueprint of safety procedures coupled with the technology. The safety policy established for the operation of UAV agriculture must meet similar safety standards as manned aircraft to maintain safety as the primary consideration and avoid greater risk to persons, properties, vehicles, and vessels in airspace or on the ground.

The UAV agriculture operation shall be only for outdoor operation and further indoor operation is prohibited under the directives (Item 1.4.3 of CAD 6011 Part (II) – UAS AGR). This Item highlights a clear prohibition for UAVs to fly in the indoor agriculture which is built with the structures and buildings. Greenhouses and indoor farming are excluded from the operation of agriculture UAVs. The rationale behind this prohibition is to avoid possible UAV collision

with structures and even the public where escape spaces are limited. The operation further employs the principle of ‘see and avoid’ as similar to the principle of manned aircraft of ‘detect and avoid’. The importance of keeping the UAV within the line of sight is to provide reasonable protection to the surrounding (Sheets, K. D., 2018). As such the operation of the agriculture UAV mostly is the visual line of sight (VLOS) operation in the prescribed arrangement of scale meter. The VLOS operation is an operation of a UAV in which the operator or pilot can directly see the said UAV and within the visual contact with the operator or pilot. Agriculture UAVs usually involve a limited scale of a parameter as per the wide area of the farm, unlike delivery UAVs that involve the beyond the line of sight operations (BVLOS). Due to that, the directive further mentioned the operation of agriculture UAV could be either VLOS or BVLOS (Item 4.1.1(p) of CAD 6011 Part (II) – UAS AGR), however, the Civil Aviation Directive 6011 Part (V) - Special UAS Project (CAD 6011 (V) –UAS SUP) shall be observed by the operator and pilot if the operation involves BVLOS. Ultimately, all operation for the agriculture UAV is limited in Class G of airspace and must be conducted beyond the 9.26 kilometre from the aerodrome with a limited vertical line of altitude of the airspace below 400 feet from the surface of the land with the restriction not to fly the UAV closer to person, vessel, vehicles and building at distance range 50 meters (Item 4.1.1(n) of CAD 6011 Part (II) – UAS AGR). In conjunction with that, the operation of the agriculture UAV must be insured to cover the liability of the holder and operator against the third party claim (Item 1.10.1 of CAD 6011 Part (II) – UAS AGR). Unmanned vehicle insurance premiums may rise as a result of safety concerns (Anderson, L. T, 2015). In Malaysia, VStream Revolution Sdn Bhd is the pioneer in the insurance industry for UAVs which includes VLOS and BVLOS operations (Technode Global, 2022). Insurance considerations will include accidents and damage caused by drone distraction, interfering with other aircraft, privacy, cybersecurity, and intellectual property (Stroud, K., 2018). According to ICAO Annex 13, an accident is defined as an occurrence associated with the operation of an aircraft that, in the case of an unmanned aircraft, occurs between the time the aircraft is ready to move with the purpose of flight and the time the aircraft comes to rest at the end of the flight and the primary propeller is shut down, resulting in harm to a person, or the aircraft retains damage or structural failure, or the aircraft is missing or completely inaccessible. For example, spray drift, or the inadvertent spraying of pesticides or herbicides to adjoining landowners' property, is one liability problem (Stroud, K., 2018). This could also consider an unintended interference and occurrence that is associated with legal implications from the operation of the agriculture UAV but may be covered under the insurance.

Apart from that, the requirement of night operation for agriculture UAVs highlights that the remote pilot or operator shall complete 15 to 25 hours of flight operations in the area proposed to enhance the safety features of the night operation (Item 4.4.1 of CAD 6011 Part (II) – UAS AGR). This shows the visibility of night operation is dependent on the flight experience during daylight. The logbook and flight activities shall be filled up for record-keeping to record and calculate the flight operation. Moreover, other strict conditions for the pilot or operator of the agriculture UAV shall complete at least three agriculture UAV flights with minimum 10 minutes of each flight together with one dispensation operation during 90 days to ensure the competency and recency of the pilot and operator in handling the operation (Item 4.1.1(g) of CAD 6011 Part (II) – UAS AGR). The continuous skills in handling the agriculture UAVs are measured within 90 days which is considered reasonable for the Malaysian agriculture sector that usually will take 90 days up to a maximum of 120 days per session of the plant and crops. However, because paddy fields typically take 120 days to plant, the 90-day timeframe for the recency criteria for agricultural UAV operation might fail the pilot and operation.

Another safety procedure in terms of privacy also is highlighted in the directive where any recorded data and image which contains unidentified individual and private person are captured by the agriculture UAVs will be subject to the Malaysian Personal Data Protection Act 2010 (Item 1.9.1 of CAD 6011 Part (II) – UAS AGR). The seven principles of personal data protection are protected for purpose of agriculture operation. Moreover, the provision of trespass also is highlighted under the directive for the protection of private property where the UAV operator shall aware of the limit of the operation and not encroach on other's airspace and land while operating the UAV (Item 1.9.2 of CAD 6011 Part (II) – UAS AGR). This is considered the responsibility and liability of the operator in conducting the agriculture UAV to know the boundaries of airspace as attached to the surface of the land to avoid trespass issues. Agricultural UAVs, like all small UAV commercial operations have restrictions on where they may fly and what operations they can undertake (Stroud, K., 2018). The easiest way to set boundaries of airspace in agriculture UAV operation is by determining as according to the high of tress or even the as per trench of the farm and the crop boundaries. All operations of agriculture UAVs shall effectively observe the prescribed radio spectrum approved by the Malaysian Communication and Multimedia Commission (MCMC) to avoid harmful interference that might occur to the manned aircraft and for safety reasons. The radio spectrum is the range of frequencies and wavelengths of electromagnetic radiation. The rationale behind this approach for UAVs is that spectrum bandwidth is used by a variety of electrical devices, and capacity is limited (Stroud, K., 2018). The policy block as to the radio spectrum is a part of the licensing scheme *vis-à-vis* the approval of UAV permits for the agriculture operation.

The usual operation of UAV agriculture involves the dispersion where the payload of the UAV shall only carry substances listed by the Department of Agriculture (DOA) (Item 4.10.1.1(e) of CAD 6011 Part (II) – UAS AGR). If the UAV agriculture carries pesticide, it shall be a Lembaga Racun Makhluk Perosak (LRMP) approved and registered pesticide. This is to ensure the safety of the public, animals and the environment are protected and the operation of agriculture UAV will not impose nuisance to the surrounding. The directive further provides the provision on the Emergency Response Plan (ERP) (Item 4.7.3 of CAD 6011 Part (II) – UAS AGR) which here contains the guidelines and procedures that shall be taken in response to the emergency and unexpected events besides to mitigate risks and impacts to the public, property and environment.

The importance of maintenance in any mechanical vehicle including UAVs is the ultimate success of safety requirements. In conjunction with that, the accountable manager (AM) is introduced in the directive with the job scope among others are to ensure all maintenance procedures and activities can be financed accordingly as per the standard required by CAAM (Item 4.2.3 of CAD 6011 Part (II) – UAS AGR). Apart from that, the safety manager (SM) is also responsible for the implementation of maintenance and shall have adequate knowledge and experience *vis-à-vis* the operation of agriculture UAVs to ensure the safety procedures and requirements are in line with the laws. Maintenance provision is another safety procedure mentioned in the directive whereby the classified the maintenance into the maintenance of the UAV and maintenance in terms of training for the staff connected to the operation with proper qualification (Item 4.1.1(j)(1) of CAD 6011 Part (II) – UAS AGR). Further, the CAAM is also aware of the noise pollution that might be caused by the UAV agriculture thus the maintenance of UAVs shall include minimizing the aircraft noise and emissions especially if the area and locality of the operation concerned are close to the public and residential area.

In addition, the operation of agriculture UAV shall strictly observe that substance or material carried by payload is not to dispense and subsequently create hazard over person and property on the surface of the land (Item 4.1.1(l) of CAD 6011 Part (II) – UAS AGR). In case the payload of the agriculture UAV carries pesticide for the operation, it shall be approved and registered under the Pesticides Act 1974 (Item 4.1.1(m) of CAD 6011 Part (II) – UAS AGR). Any pesticide which is not listed under the Act is presumed to be prohibited and most likely to create a hazard to the public and property. Although pesticides could expose dangers and hazards to the public, animals, environment and even property so long the operation of agriculture UAV is in line with the requirement set by the DOA and CAAM, the operation is presumed to be safe and according to the Pesticides Act 1974. The restrictions in the Act and by the DOA on the registered pesticide approved by the Board are a shred of conclusive evidence that the pesticide is safe to use for the industry. The maximum take-off mass (MTOM) has been set by the Directive to up to 150 kilograms. This is a part of a pre-defined risk assessment that the operator and pilot should notice. The maximum speed of flight also is determined at 35 knots if the UAV carries payloads with a weight less than 75 kilograms and 25 knots for the UAV with payloads weight between 75 kilograms to 150 kilograms.

Recommendation and Conclusion

The UAV in agriculture will become an indicator of the production and demand of the food industry. The revolution and technology of UAVs in Malaysia are now expanding with the introduction of the Civil Aviation Directive for Agriculture embarks on the acceptance of the industry and farmers to UAVs. While technological barriers continue to exist, policy considerations are currently the most significant impediment to UAV use in agriculture and other industries. (Stroud, K., 2018). It can be presumed that the technology of UAVs replaces the conventional method of farming to improve the efficiency in production and farm management. Along with the farm management through UAVs, it definitely could make the most significant impact on the Malaysian economy. Farmers in the Muda Agricultural Development Authority (MADA), for example, have switched to using new agricultural technologies of UAVs to do fieldwork in paddy fields. (Noorazura Abdul Rahman, 2019). The work of fertilising and spraying pesticides, which used to take nearly a month using the conventional method, can be reduced by fifty per cent using the UAVs. Although directive by CAAM for agriculture use is considered guidelines for the operator and pilot in handling the UAV, the government may grant a moratorium or cooling period for the usage of UAVs in the agriculture sector to encourage other farmers and investors to trade in this industry. Besides, the public will be aware of the importance of UAVs in the industry and thus may caution the public about the safety and hazard connected with the operation. Further, the indicator of competency test of the pilot or operator of the UAV agriculture is not mentioned in the Directive, therefore the pilot and operator shall score at least eighty per cent on the test. By analogy, this test is like other motor vehicle competency tests where the applicant is required to obtain at least 84 per cent for a passing score. This is to show the safety of the public is in the right hands of the remote pilot or operator of UAVs. As the civilian and commercial use of UAVs becomes more common, new laws will be needed to assure that this technology is used safely. The development of UAVs in agriculture is a game-changer for farmers to integrate technology with the conventional method of farming in line with the development of digital technology nowadays. Although there is a significant lag in commercial UAVs agriculture in Malaysia, the introduction of the Civil Aviation Directive for Agriculture shows the government's initiative to put the agriculture industry to the next level and create a route for its development with paramount consideration of the safety of the public, animal, property and

environment. It can be concluded that Malaysia has fulfilled its international obligations as an ICAO member by providing a comprehensive directive for UAV agriculture in accordance with the objectives of ICAO to uphold the standard and recommended practices of international aviation to the domestic law.

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