AN IN-DEPTH ASSESSMENT OF THE EXISTING LEGAL FRAMEWORK REGULATING UNMANNED AERIAL SYSTEMS (UAS) ACTIVITIES IN MALAYSIA

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ABSTRACT

The rapid growth of the Unmanned Aircraft System (UAS) industry, with significant increases projected for commercial unmanned aircraft, urban air mobility vehicles, cargo delivery drones, inspection drones, and hobby drones, necessitates a comprehensive approach to UAS regulations. While the Civil Aviation Authority of Malaysia (CAAM) has made strides in developing regulations for UAS operations, the current rules, mainly the Civil Aviation Regulations (CAR) 2016 are insufficient to address the challenges posed by emerging UAS technologies and their unique operational concepts. Innovations such as Advanced Air Mobility (AAM), international operations of Remotely Piloted Aircraft Systems (RPAS), swarm drones, and autonomous UAS operations are outpacing existing regulations. The aim of this study was to identify and address the shortcomings of the current regulatory framework for UAS operations in Malaysia and compared the global renowned regulatory bodies. To achieve these goals, a multi-faceted research methodology was employed. This involved an in-depth analysis of international regulatory frameworks and a comprehensive survey to gather necessary data and insights. In summary, this research presented a comprehensive and transformative approach to UAS operations in Malaysia. The findings and recommendations of this study provided valuable insights for policymakers, regulators, and UAS operators in Malaysia and other countries facing similar regulatory challenges.

Keywords: *Unmanned Aircraft System (UAS), Civil Aviation Authority of Malaysia (CAAM), Civil Aviation Regulations (CAR), risk-based approach*

1.0 INTRODUCTION

Unmanned Aircraft Systems (UAS), commonly known as drones, are rapidly advancing in Malaysia, with the country's global drone readiness ranking improving from 30th to 21st within a year. This progress highlights Malaysia's dedication to accelerating its drone technology potential, with the industry expected to contribute RM50.71 billion (USD11.45 billion) to the GDP and create 100,000 jobs by 2030 [1]. To support this growing industry, the Malaysian government introduced the Malaysia Drone Technology Action Plan 2022-2030 (MDTAP30). This plan aims to foster a conducive environment for drone technology development, establish a regulatory framework for safe and secure drone operations, promote drone adoption across various sectors, and enhance the capabilities of local drone industry players [2]. Key missions of MDTAP30 include developing a

national Unmanned Traffic Management (UTM) system, a digital drone registration portal, special drone use-case adoption in key sectors, and talent development through the accreditation of Remote Pilot Training Organizations (RPTO). The Malaysian Research Accelerator for Technology and Innovation (MRANTI) serves as the coordinating agency and secretariat for MDTAP30 [3].

In February 2008, the Malaysian Department of Civil Aviation (DCA) issued Aeronautical Information Circular 04/2008 (AIC 04/2008), requiring all UAV operators in Malaysia to comply with DCA stipulations and the Civil Aviation Regulations 1996 (CAR 1996). The DCA mandates that UAVs meet or exceed the safety and operational standards set for manned aircraft. UAVs are defined as aircraft designed to operate without an onboard human pilot [4]. As a participant in the Chicago Convention and a member of the International Civil Aviation Organization (ICAO), Malaysia adheres to the Convention's provisions and Standards. These include stipulations that unmanned aircraft cannot fly over a Contracting State's territory without specific authorization from that State [5].

On top of AIC 04/2008, the Minister of Transport introduced the Civil Aviation Regulations 2016, including Part XVI - Unmanned Aircraft System (UAS), which provides comprehensive guidelines for UAS operations in Malaysia. Regulation 140 restricts UAS operation in specific airspaces and at altitudes exceeding 400 feet unless authorized by the Director General. It also prohibits dropping objects or animals from UAS to ensure ground safety [6]. To support CAR 2016, the Civil Aviation Authority of Malaysia (CAAM) introduced the Authorization to Fly Permit (ATF) for low-risk UAS operations. This permit facilitates a streamlined process for drone operators engaged in low-risk activities, supporting compliance while amendments to CAR 2016 and a new UAS regulations framework are being developed [7]. CAAM also introduced three Civil Aviation Directives (CADs) tailored to distinct aspects of drone operations. CAD 6011 Part I addresses Remote Pilot Training Organizations, ensuring high standards of instruction and safety [8] whereas CAD 6011 Part II pertains to UAS Agricultural Operations, setting guidelines for safe and effective drone use in agriculture [9]. On the other hand, CAD 6011 Part V is designed for Special UAS Projects, providing a framework for innovative projects requiring unique considerations and exemptions [10].

Furthermore, the inherently global nature of UAS operations requires a nuanced understanding of international best practices. Organizations like the International Civil Aviation Organization (ICAO), the European Union Aviation Safety Agency (EASA), the Federal Aviation Administration (FAA), various regional Civil Aviation Authorities (CAAs), and the Joint Authorities for Rulemaking on Unmanned Systems (JARUS) have been instrumental in shaping the regulatory landscape. Their experiences, insights, and evolving frameworks offer valuable benchmarks and potential models for Malaysia's UAS regulatory development.

The CAR 2016 in Malaysia, which were developed when UAS technology was less advanced, are now struggling to keep up with the complexities of modern UAS applications. The deviation has led to significant concern in areas crucial for the industry's growth and safety. The rapid development of UAS capabilities, particularly in areas like Advanced Air Mobility (AAM), swarm drones and autonomous flight, has exposed the limitations of existing safety and security protocols. The current framework's inability to adapt to these advancements could hinder innovation and investment in Malaysia's UAS sector. The increasingly global nature of UAS operations further the need to align Malaysia's regulations with international standards to foster collaboration and avoid being left behind in the global UAS ecosystem.

In conclusion, given these intricacies and the relentless pace of technological progress, it is essential to undertake a comprehensive reassessment of Malaysia's UAS regulatory framework primarily CAR 2016. Therefore, this research aims to explore these complexities and bridge existing gaps especially . The ultimate goal is to position Malaysia as both a harmonious contributor to global UAS advancements and a proactive leader in innovation and safety within the dynamic UAS landscape.

2.0 METHODOLOGY

The methodology utilized in this study is incorporating various analytical elements to conduct a comprehensive examination of the subject matter. At its foundation, the methodology relies on a qualitative review of literature. This particular aspect involves a deep dive into a wide array of articles, research papers, and primary source documents relevant to the topic. The goal is not only to gather information but also to critically analyze it, discerning underlying patterns, obstacles, and possibilities. By comparing Malaysia's regulations with those of prominent international aviation organizations, the author can pinpoint differences, similarities, and best practices.

This research is built upon a comprehensive qualitative analysis of relevant literature. This thorough examination includes the detailed study of numerous articles, research papers, and authoritative documents concerning UAS. The primary goal of this qualitative review is not just to collect information but to thoroughly analyze and investigate the intricacies, examining ideas, approaches, difficulties, and possibilities linked to UAS system design and program requirements. This intensive exploration of literature helps in grasping the historical backgrounds, current standards, and emerging trends in the realm of UAS. Furthermore, the study presents the research questions that drive the study. To explore these inquiries, a thorough search was performed using precise keywords relevant to the subject. The keywords are essential for a comprehensive evaluation of Malaysia's UAS regulations because they cover the entire scope of UAS operations, from technology to regulations and operational aspects. The subsequent Table 1 lists all the keywords that underpin this research.

Table 1: Research keywords

Unmanned Aircraft System	Drone	Unmanned Aerial Vehicle	Regulations	Aviation
Civil Aviation	Civil Aviation Authority	Civil Aviation Directive	Aeronautical	Visual-line-of-sight
Airworthiness	UAS Geo-location	Autonomous	Enforcement	Beyond-visual-line-of-sight
Research Methodology	Aerodrome	Data Privacy		Remotely Piloted Aircraft System

The initial phase of the selection process involved a comprehensive search of academic databases and libraries to identify a broad range of potential sources. This was followed by a preliminary screening, where titles and abstracts were skimmed through to eliminate any clearly irrelevant articles. Upon completion of this initial filtering, a more detailed evaluation was conducted, where in the full text of the shortlisted articles was thoroughly analyzed. To provide a clear overview of the selection guidelines, Table 2 presents the selected criteria chosen for screening the articles.

Table 2: Selected criteria for articles' screening

Criteria	Action
Direct Relevance to Dissertation Objectives	Include
Non-Academic Publications	Exclude
Peer-Reviewed Articles	Include (If Any)
Date Range	No later than 8 years
Methodological Soundness	Include
Incomplete Data	Exclude
Unrelated Topic	Exclude
Non-English Studies	Exclude

Based on the research objectives, most information can be sourced from the websites of relevant authorities, such as CAAM, EASA, FAA, JARUS, and ICAO. These sources are considered high-quality as they are the official and valid sources for regulations and formal documents in the aviation industry. For example, EASA offers a comprehensive document library containing regulations, type certificates, acceptable means of compliance, and guidance materials for aviation authorities, industry professionals, job applicants, and the media. National civil aviation bodies like CAAM and FAA, along with joint organizations such as JARUS, provide invaluable resources for industry professionals. These online repositories include governing acts for aviation practices, comprehensive regulations for operators and airlines, directives detailing specific aviation-related instructions, circulars guiding regulatory processes, and official notices for streamlined communication from authorities. Such resources are crucial for reinforcing standardized and safe operations within the aviation sector. Additionally, this study leverages established research libraries, including the UiTM Digital Library, Google Scholar, and the IEEE Library, to procure research papers, journals, and publications published within the last 5 to 8 years from the commencement of this research. This time frame was chosen because the UAS industry, along with its regulatory guidelines, is relatively new. Significant technological advancements and the maturation of regulatory requirements have occurred during this period, making it ideal for study and insights. In the final phase of sourcing information, traditional search engines, particularly Google, are used to capture current developments. This approach aims to gather the latest trends, news articles, up-to-date statistics, and pertinent information directly related to the research questions. Using search engines in this way provide cs a holistic understanding, ensuring the research remains relevant and informed by the most recent advancements and discussions in the field. Table 3 tabulates the online resources employed in the study.

Table 3: Online Resources

Organization	Online Resource
Civil Aviation Authority of Malaysia (CAAM)	https://www.caam.gov.my/resources/publications/
International Civil Aviation Organization (ICAO)	https://www.icao.int/publications/Pages/default.aspx
Joint Authorities for Rulemaking On Unmanned Systems (JARUS)	http://jarus-rpas.org/publications/
European Union Aviation Safety Agency (EASA)	https://www.easa.europa.eu/en/home
Federal Aviation Administration (FAA)	https://www.faa.gov/uas/resources/policy_library

3.0 RESULTS AND DISCUSSION

3.1 Comparative Analysis of Aviation Regulatory Bodies

The comparative analysis in this research resulting on several pivotal aviation regulatory bodies: CAAM, ICAO, EASA, FAA, and JARUS. Each of these organizations holds significant influence in the global aviation landscape and has played a key role in shaping the regulatory environment for UAS operations. The Civil Aviation Authority of Malaysia (CAAM) is the national aviation regulatory body responsible for overseeing and ensuring the safety and integrity of all aviation activities in Malaysia. As the principal regulator, CAAM ensures that civil aviation operations and infrastructure in Malaysia meet international standards set by bodies such as the International Civil Aviation Organization (ICAO). For Unmanned Aircraft Systems (UAS), CAAM has proactively established guidelines and regulations tailored to the specific needs and challenges posed by these systems. Recognizing both the potential and risks of UAS, CAAM has implemented measures to ensure the safe integration of drones into Malaysian airspace, covering aspects from pilot certification to operational restrictions. These efforts reflect CAAM's commitment to fostering innovation while ensuring the safety of all airspace users and the general public [7].

As a specialized agency of the United Nations (UN), the International Civil Aviation Organization (ICAO) plays a central role in setting global standards for aviation safety, security, efficiency, and environmental protection. ICAO's guidelines influence national UAS regulations and establish foundational practices and procedures across the vast technical spectrum of aviation,

including UAS operations [11]. The European Union Aviation Safety Agency (EASA) is a key regulatory body that develops shared safety and security standards for aviation across European Union nations. Its significance in the UAS domain is profound. EASA was one of the first authorities to draft and introduce comprehensive risk-based approach regulations for the use of UAS in civil operations. Its initiatives serve as a model for many countries, offering a blend of innovative thinking and safety considerations [12-13].

The Federal Aviation Administration (FAA) of the United States has long been recognized as a leader in aviation regulation. Given the extensive UAS activities within the U.S., the FAA's rules and guidelines on UAS operations are among the most comprehensive and forward-thinking. Their experiences, challenges, and solutions provide invaluable insights for countries looking to refine their own UAS regulatory approaches [14]. JARUS, which stands for Joint Authorities for Rulemaking of Unmanned Systems, is a coalition of international civil aviation authorities. Its primary mission is to harmonize and formulate recommendations for the operation of Unmanned Aircraft Systems (UAS) within the civil environment. Acting as a cooperative nexus for its member countries, JARUS facilitates mutual cooperation and knowledge sharing [15].

One of its significant achievements is crafting standardized regulations, recommendations, and guidelines for the safe incorporation of UAS into global airspace. JARUS is recognized for generating and disseminating guidance materials on UAS certification, operations, licensing, and safety. With the rapid technological evolution of UAS, JARUS remains agile by continuously updating its regulatory recommendations to ensure they are both relevant and effective. The organization values collaboration and often engages with industry stakeholders, ensuring the formulated regulations are both practical and implementable. Representing a vast segment of the international civil aviation community, the recommendations set forth by JARUS are widely accepted and respected [15].

3.2 Thematic Comparison Analysis of UAS Regulations

Thematic comparison analysis of UAS regulations forms the basis for identifying similarities and discrepancies across international UAS regulatory frameworks. This analysis highlights the importance of adapting and tailoring these regulations to suit Malaysia's specific operational contexts and requirements. While international guidelines offer valuable insights into UAS safety, certification, operational limitations, and risk management, they may not fully encompass Malaysia's distinct challenges. Therefore, the approach should include a detailed review of these regulations to pinpoint areas necessitating localization and customization.

Table 4 presents a chronological overview of the evolution of UAS regulations in Malaysia, detailing key regulations and guidelines introduced or implemented over time. These regulations and guidelines form the framework governing unmanned aircraft systems (UAS) operations within the country. By studying this history, it becomes feasible to identify any gaps and deficiencies in the regulatory framework that could affect the support and effective management of UAS operations in Malaysia.

Table 4: Summary of UAS Regulations History in Malaysia [16-18]

Year	Regulations / Applicable Guidelines	Description
Pre-2016	AIC 04/2008 and CAR 1996	a. UAV operators must adhere to DCA's stipulations and CAR 1996. b. UAVs defined as aircraft functioning without an onboard human pilot. c. Weight-based certification and permits required. d. Malaysia, as an ICAO member, must authorize any unmanned flight over its territory. e. Cross-border operations require specific authorization

Year	Regulations / Applicable Guidelines	Description
Post-2016	CAR 2016, Part XVI - Unmanned Aircraft System	a. Regulation 140 restricts UAS operation in specific airspaces. b. Regulation 141 mandates authorization for aerial work. c. Regulation 142 for Small Unmanned Aircraft (SUA) emphasizes visual contact. d. Regulation 143 restricts SUSA operations in designated areas. e. Regulation 144 requires authorization for UAS > 20 kg. f. Formal application process for Director General's authorization.
Post-2016	Authorisation to Fly Permit (ATF)	a. Introduced for low-risk UAS operations. b. Temporary measure for compliance and support to low-risk operators
Post-2021	CADs 6011 Part I, II, and V	a. CAD RPTO: Ensures high training standards for remote pilots. b. CAD Agri: Focuses on safe UAS use in agriculture. c. CAD SUP: Framework for unique UAS projects. d. CAD SUP covers BVLOS operations, carriage of Dangerous Goods, R&D, and projects requiring CAAM support.

Table 5 offers a succinct comparison of Regulations 140 to 144 of CAR 2016, focusing on their essential provisions and objectives. These regulations delineate critical guidelines and constraints governing UAS operations in Malaysia, encompassing aspects such as safety protocols, operational criteria, and regulatory compliance mandates.

Table 5: Summary of UAS regulations in civil aviation regulation 2016 [5]

Regulation	Description
Regulation 140	Restricts UAS operation in specific airspaces (Class A, B, C, or G), within an aerodrome traffic zone, and at altitudes exceeding 400 feet above the earth's surface without explicit authorization from the Director General. Prohibits the dropping of objects from the UAS to ensure ground safety.
Regulation 141	Requires authorization from the Director General for the use of UAS for aerial work, such as photography, surveying, or inspections. Ensures these activities are conducted under aviation authority supervision to promote safety.
Regulation 142	Pertains to Small Unmanned Aircraft (SUA) and mandates that the person in charge must operate the aircraft safely while maintaining direct, unaided visual contact to monitor its flight path and avoid collisions.
Regulation 143	Prohibits the operation of Small Unmanned Surveillance Aircraft (SUSA) over designated areas, within certain proximities of designated areas, large gatherings, vessels, vehicles, structures, or individuals without the Director General's authorization. Protects privacy and public safety.
Regulation 144	Requires specific authorization from the Director General for the operation of any UAS weighing more than 20 kilograms (excluding fuel). Ensures larger UAS adhere to safety and regulatory standards.

3.3 Gaps in Current UAS Regulations in Malaysia

One of the most significant problems in UAS regulation is related to Beyond Visual Line of Sight (BVLOS) operations. Although The FAA recognizes the transformative potential of BVLOS flights but acknowledges the need for rigorous regulatory oversight. This includes addressing safety concerns, coordination challenges, and the development of standards for BVLOS operations [19]. In contrast to the more general approach to BVLOS operations in CAR2016, which simply requires authorization from the Director General for such flights, CAD 6011 (II) offers a more structured pathway for BVLOS approvals. It explicitly directs operators seeking BVLOS approval to refer to CAD 6011 (V) - SUP, suggesting a dedicated framework for evaluating and authorizing these complex operations. This signals a shift towards a more permissive and structure approach to BVLOS, acknowledging its potential benefits for various applications, including agriculture. Compared to other regulatory authorities like the EASA and the FAA, which have the established comprehensive BVLOS frameworks. CAD 6011 (II) represents a step in the right direction for Malaysia. However, it still lacks the detailed requirements and specific operational guidelines presents in those frameworks, indicating room for further development and refinement to fully enable safe and scalable BVLOS operations in Malaysia.

Beside the BVLOS operations, CAR 2016 falls short in addressing the specific needs of cargo or goods delivery compared to EU and the U.S. It lacks explicit provision for cargo limitations and operational procedures for UAS deliveries. Furthermore, it lacks provisions for payload limitations, cargo securing and jettisoning and the transport of dangerous goods by UAS. This creates unclear direction and potential safety risk, hindering the growth and innovation of the UAS industry in Malaysia. In contrast, the EU's regulatory framework, established through Commission Delegated Regulation (EU) 2019/945 and Commission Implementing Regulation (EU) 2019/947 provides a more comprehensive and structured approach to UAS operations, including BVLOS flights and cargo delivery. It addresses payload limitations, cargo securing, dangerous good transport, operational procedures and UAS Traffic Management (UTM) integration, ensuring that UAS cargo operations are conducted safely and efficiently [12][13]. In addition ICAO's manual on Remotely Piloted Aircraft Systems (RPAS) offers guidance on various aspects of RPAS operations, including cargo transport. It emphasizes the important of securely attaching cargo to the RPA and outlines considerations for the safe transport of dangerous goods by air. It also provides guidance on operational flight planning for RPAS, including considerations for cargo transport such as payload limitations, weight and balance and emergency procedures.

When it comes to privacy and data protection, the FAA advisory circular 107-2A emphasize the importance of respecting privacy during UAS operations [19]. It advises operators to review state and local privacy laws and to consider the impact of their operations on individuals' privacy. Meanwhile, regulation in the EU, require operators to comply with the General Data Protection Regulation (GDPR) when processing data. The GDPR sets strict standards for data collection, storage and use ensuring that individuals' privacy rights are protected. CAR 2016 does not explicitly address crucial aspects such as data collection and storage, privacy impact assessments, transparency and consent. Although CAD 6011 (II) indicating some level awareness of data protection principles, their specific application to UAS operations remain unclear. To sum up, the gaps and other deficiencies identified was summarized in Table 6. These gaps can be used to improve the regulatory framework for UAS operations in Malaysia, emphasizing safety, efficiency, and promoting responsible drone use.

Table 6: Identified gaps in supporting UAS operations in Malaysia [19-21]

Gap Area	Description
Beyond Visual Line of Sight (BVLOS)	Lack of clear guidelines for BVLOS operations, which are crucial for various industries.
Cargo or Goods Delivery	Absence of specific regulations for cargo or goods delivery by drones, a growing industry segment.
Airspace Integration	Need for comprehensive guidelines for seamless integration of UAS into controlled airspace.
Privacy and Data Protection	Limited coverage of privacy and data protection concerns related to UAS operations.
Training and Certification Standards	Gaps in defining training requirements, certification standards, and ongoing competency assessments.
Emergency Response and Contingency Planning	Lack of detailed guidance on handling emergencies during UAS operations.
Insurance Requirements	Absence of explicit requirements for liability insurance coverage for drone operators.
Enforcement and Penalties	Need for clear mechanisms for enforcement and penalties for violations.
Public Awareness and Education	Emphasis on public education and awareness about safe UAS use in common drone usage areas.
International Coordination	Alignment with international standards to facilitate international drone operations and coordination.

4.0 CONCLUSION

The primary research objective was to conduct a comprehensive evaluation of the current regulatory framework governing Unmanned Aircraft Systems (UAS) operations in Malaysia. This evaluation focused on assessing how well Malaysian regulations align with international standards and their effectiveness in adapting to the evolving landscape of UAS technologies and associated operational risks. Through thorough exploration and analysis, this objective has been successfully achieved, providing a foundational understanding of Malaysia's regulatory environment for UAS operations.

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