Educational Barriers in the Sky: Drone Regulation Challenges in Schools

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ABSTRACT

This study examines the impact of drone regulations on the implementation of drone-based learning in Malaysian schools. It focuses on requirements introduced by the Civil Aviation Authority of Malaysia (CAAM), including registration, permit approval, and operational restrictions. An exploratory qualitative approach using inductive thematic analysis was employed, involving 35 participants from government agencies, industry, and secondary schools through focus group discussions and open-ended questionnaires. Findings indicate a clear mismatch between regulatory expectations and school practices. Although regulations aim to improve safety, they impose administrative and operational constraints that limit classroom implementation. Teachers often conduct drone activities without formal approval due to complex procedures, cost, and the absence of education-specific guidelines. Key barriers include lack of differentiated standard operating procedures, restricted access to approved flight zones, low stakeholder awareness, and the absence of structured risk management frameworks. This study highlights a policy–practice gap in drone integration within education and provides empirical evidence from Malaysia. It contributes by positioning regulation as a key factor influencing technology adoption in schools and proposes the need for simplified procedures, dedicated guidelines, and institutional support to enable safe and effective implementation.

Keywords: Drone, Unmanned Aerial Vehicles (UAVs), TVET, STEM, Skills.

INTRODUCTION

Drones are no longer just recreational devices. They are becoming more familiar sight in the skies, also a powerful educational tool, especially in the fields of science, technology, engineering, and mathematics (STEM) and Technical and Vocational Education and Training (TVET) environments. Across the globe, schools and vocational institutions are exploring drone technology to enhance teaching and learning, from introducing basic aerodynamics and programming to prepare students for careers in fields like precision agriculture, surveying, logistics, and creative media. In Malaysia, this trend is gaining traction in both mainstream schools and TVET institutions, in line with the country's broader vision to strengthen future-ready skills under the Fourth Industrial Revolution (4IR) (Ministry of Education Malaysia, 2013; Ministry of Higher Education, 2021).

In Malaysia, schools have begun to explore the use of drones in both formal lessons and co-curricular programs, especially within STEM contexts. Drones are increasingly used as hands-on tools to teach concepts such as coding, programming, and digital mapping making learning more engaging and meaningful for students. There are increasingly integrated into both mainstream school programs and TVET initiatives as part of the push to develop future-ready skills in line with the Fourth Industrial Revolution (4IR) (Ministry of Education Malaysia, 2013; Ministry of Higher Education Malaysia, 2021). Educators are using drones in STEM projects, co-curricular clubs, and skills-based training.

However, as drone usage in education grows, it also intersects with a complex set of legal and regulatory requirements. In 2024, the Civil Aviation Authority of Malaysia (CAAM) introduced updated drone regulations requiring all operators, including schools, to register drones, apply for flight permits, and comply with detailed safety and operational procedures. While these rules aim to ensure safety and accountability, they have introduced new challenges for schools, especially in navigating permit fees, administrative processes, and a general lack of education-specific guidelines. This study investigates how these regulations are perceived and experienced by teachers and industry players. It also explores the current realities of drone usage in schools and the gap between policy intent and actual classroom practice. In doing so, the research aims to propose more inclusive, practical solutions for integrating drones safely and effectively in Malaysian education.

LITERATURE REVIEW

In Malaysia, the Civil Aviation Authority of Malaysia (CAAM) regulates drone operations under the Civil Aviation Regulations 2016 (CAR 2016), supported by related directives, guidance and fee provisions. Table 1 summarises the requirements relevant to educational activities.

Table 1. CAR 2016 and associated CAAM requirements relevant to schools

Aspect	Requirement or permit type	Published cost	Timeline	Operational limit	Relevance to schools
Registration	CAAM guidance addresses registration of aircraft above 20 kg when required	Not specified here	Before operation when required	Aircraft-specific	Registration and flight authorisation are separate
Standard ATF	Low-risk flight authorisation	RM250 for small unmanned surveillance aircraft, multiplied by aircraft and location units	At least 14 working days before operation. Maximum application duration: 90 days	VLOS, below 400 ft AGL, without spraying or dispensing	No general school exemption identified
Aircraft above 20 kg	ATF for the relevant aircraft category	RM1,000	Confirm applicable requirements	Subject to authorisation conditions	Outside the proposed lightweight school category
UAWC	Separate aerial-work certification route, including agricultural operations	RM800 initial application and RM500 annual renewal	Separate process	Activity-specific	Not a routine annual fee for ordinary classroom drone activities

Sources: CAAM's UAS guidance and Safety Information 01/2025. Fees derive from the Civil Aviation (Fees and Charges) Regulations 2016, rather than CAR 2016 alone.

CAAM's Safety Information 01/2025, issued on 7 February 2025, reiterated the requirement for prior authorisation, including for training operations. The notice referred to unauthorised activities identified during 2024. It did not establish that a new school-specific permit requirement began in 2024. Applications must be submitted at least 14 working days before the proposed operation, although complex applications may require longer. The notice does not identify a general school exemption. Educational purpose therefore should not be treated as sufficient grounds for exemption from authorisation. However, authorisation requirements and fee applicability must be distinguished. The published RM250 fee concerns small, unmanned surveillance aircraft, rather than all educational drones. This distinction supports the need for guidance explaining how aircraft classification and operational requirements apply to school activities.

Beyond permitting, CAR 2016 sets operational standards to protect both airspace integrity and public safety. Drone pilots must maintain direct, unaided visual line-of-sight at all times, refrain from dropping any object or animal from the aircraft, and keep prescribed separation distances from people, vessels, structures and assemblies of over 1,000 individuals (Regulations 142–143). Drones exceeding 20 kg (without fuel) are treated similarly to manned aircraft and require airworthiness certification and, in some cases, a private or commercial pilot licence. Looking ahead, CAAM has announced that a comprehensive new UAS regulatory framework in close collaboration with industry stakeholders will replace the existing CAR 2016 provisions by the end of 2025, aiming to balance innovation with safety and streamline compliance for all users (The Star, 2025).

In Malaysia, drone operations are regulated by the Civil Aviation Authority of Malaysia (CAAM) under the Civil Aviation Regulations 2016 (CAR 2016). These regulations apply equally to recreational and commercial drone users. To legally operate a drone, there are requirement to obtain CAAM authorization at least 14 working days before a drone flight applies to all Unmanned Aircraft System (UAS) or drone operations in Malaysia, regardless of whether they are commercial, recreational, or for other purposes. This requirement was formalized and communicated to the industry in early 2025, particularly in February 2025. Applications typically require additional documentation such as permission from the landowner of the take-off location, and special clearances for sensitive operations, such as aerial mapping or filming in restricted areas like Putrajaya (CAAM, 2025). A permit valid for up to 90 days costs RM250 for drones weighing 20kg or less, while heavier drones incur a fee of RM1000. These regulations apply uniformly, including educational activities and recreational flights.

Feedback from industry players indicates dissatisfaction with the 2024 CAAM regulation updates, particularly regarding mandatory registration and associated permit fees (The Rakyat Post, 2025). Concerns over the cost of permit applications were already raised in earlier research, with educators and small operators warning that high fees could hinder the growth of drone usage in education and small businesses (Mohd Yunus & Techanamurthy, 2023; Zolkepli, Zainudin, & Salleh, 2023). This concern has become more pressing with the introduction of the RM250 permit requirement in 2024. Although these regulatory measures are designed to enhance safety and accountability, stakeholders advocate for a more balanced regulatory framework that recognizes educational and small-scale drone usage as low-risk activities (Hassan, Ismail, & Ahmad, 2023). There is a clear need for engagement between regulatory bodies and industry stakeholders to refine existing policies, aiming to foster a more conducive environment for the development and integration of drone technology within Malaysia's educational and industrial sectors (Mohd Yunus & Techanamurthy, 2023; Malay Mail, 2022).

Operational Limitations

Global UAV operations are governed by standards from bodies like Civil Aviation Organization (ICAO), the European Union Aviation Safety Agency (EASA), the United States Federal Aviation Administration (FAA), Japan's national UAV standards, and the Civil Aviation Authority of Malaysia (CAAM), crucial for applications such as chemical plant inspections. Operational limitations vary significantly: CAAM, for instance, prohibits flights in Class A, B, C, or G airspaces and airport traffic zones. Night flight regulations differ; ICAO permits it with lighting, EASA with a green flashing light, and FAA with lighting features. Conversely, LBA restricts night flights to UAVs under 5kg, MLIT prohibits them, and CAAM lacks specific night flight regulations. The carriage of dangerous goods is permitted by ICAO with authorization and by CAAM with approval, EASA allows it for certified categories, while LBA and MLIT prohibit it. Maximum flight altitudes also diverge: 400ft for ICAO, FAA, and CAAM; 120m for EASA; 100m for LBA; and 150m for MLIT. Understanding and adhering to these region-specific operational limitations is vital for ensuring safe and legal UAV deployment.

Administrative Requirement

Operating Unmanned Aerial Vehicles (UAVs) necessitates adherence to administrative prerequisites, primarily registration and flight authorization, which vary significantly across global aviation authorities like ICAO, EASA, FAA, LBA, MLIT, and CAAM. Registration criteria often depend on UAV weight, sensor presence, and operational purpose. For instance, LBA mandates registration for UAVs over 249g or those under 250g

equipped with a camera, while MLIT requires it for all UAVs, and CAAM for those exceeding 20kg, also requiring an airworthiness certificate. Prior authorization is crucial for specific airspaces (e.g., FAA's Class B, C, D, E) or restricted zones (MLIT), and for heavier UAVs (e.g., LBA's >5kg category). Thorough assessment of local authorization and potential airworthiness certification requirements is imperative for regulatory compliance and to prevent legal issues.

Operator Qualification

Safe and lawful UAV operation requires competency appropriate to the aircraft and operating conditions. Minimum age and certification requirements vary across regulatory systems. The International Civil Aviation Organization (ICAO) provides model regulations for national adaptation rather than imposing a universal minimum age for all drone pilots. Under the European Union Aviation Safety Agency (EASA) framework, the general minimum remote pilot age for open and specific operations is 16, subject to exceptions, including qualified direct supervision. In the United States, applicants for a Federal Aviation Administration (FAA) Part 107 Remote Pilot Certificate must be at least 16. In Malaysia, Civil Aviation Authority of Malaysia (CAAM) Civil Aviation Directive (CAD) 6011 Part I specifies a minimum age of 18 for RCoC-B and its additional modules, and 16 for A2 RCoC.

Certification requirements also depend on the operation. The EASA framework includes training and competency requirements for relevant open-category operations, alongside requirements for specific and certified operations. Germany's Luftfahrt-Bundesamt (LBA) provides an online training and examination pathway for the EU A1/A3 competency certificate. The FAA distinguishes Part 107 certification from the Recreational UAS Safety Test (TRUST) pathway. Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) administers an unmanned aircraft remote pilot certification system, although certification is not mandatory for every flight. Similarly, CAAM competency requirements should be interpreted according to the applicable operational category.

Training pathways combine regulatory knowledge with operational preparation. First-time FAA Part 107 applicants undertake an aeronautical knowledge examination, while certificate holders complete recurrent online training. Transport Canada's Advanced Operations certification requires an online examination and a flight review. These examples demonstrate the need to distinguish certificate eligibility, training requirements and supervised participation.

Within Malaysian education, Mohd Yunus et al. (2025) identified Structured Training, Drone Handling and Safety, and School Governance among the constructs supporting a school drone ecosystem. Their findings support consideration of operator preparation alongside instructional resources and institutional responsibilities. For schools, this means preparing teachers to supervise activities, assess sites and respond to emergencies, while providing students with age-appropriate instruction under the conditions applicable to the activity.

Challenges in Drone Usage in Malaysian Schools

Currently, there are no official guidelines from the Ministry of Education (MoE) governing drone usage in schools. In most cases, if a teacher wants to use a drone, they simply fly it in an open area or whenever the need arises, often without going through any formal process mandated by CAAM. Yet, operating drones is not a casual activity, it involves safety concerns, regulatory compliance, and technical skills that warrant more structured oversight and support.

Public Perception and Acceptance

Unmanned Aerial Vehicles (UAVs) around school compound can be hampered by community concerns related to privacy, safety, and potential misuse. Fears surround accidents involving crashes, colliding, or jeopardizing equipment, aircraft, and personnel. Unauthorized UAV activity near critical infrastructure, by malicious actors or hobbyists, raises alarm. The possibility of privacy and information security breaches through on-board cameras and sensors further compounds anxieties (Serafinelli, 2022). Overcoming these hurdles requires fostering a culture of trust and understanding through open communication. Public education and engagement

are key, ensuring transparent explanations of the technology's benefits and challenges. Establishing clear and robust protocols for UAV operations and reporting procedures, alongside unwavering adherence to principles of transparency, accountability, and responsibility, will be crucial in building community trust and enabling the safe and ethical integration of UAVs around chemical facilities.

Successfully integrating UAV technology in schools necessitates a skilled workforce equipped with diverse expertise. Effective operation demands training in UAV flight mechanics, navigation principles, and communication protocols, alongside familiarity with hardware and software across various platforms and payloads (Staroletov et al., 2019).

Developing this diverse skillset necessitates tailored training and upskilling programs. Online courses, workshops, simulations, and certifications can equip the workforce with relevant knowledge and practical experience. Training programs should be customized to cater to specific roles, be it UAV pilot, technician, engineer, or analyst. Additionally, regular updates and refreshers are vital to keep pace with evolving technology, standards, and regulations.

METHODOLOGY

This study adopted an exploratory qualitative approach to examine expert perspectives on integrating drones into Malaysian schools. Data were analysed inductively using thematic analysis, guided by Braun and Clarke (2006), to identify and interpret patterns of meaning across participants' accounts. The analysis focused on perceived needs, contextual enablers and barriers to school–industry collaboration in drone-related educational activities. The qualitative findings informed the identification of components for a proposed collaborative framework.

Participants and Sampling

The study used purposive sampling to recruit participants with relevant knowledge and direct experience in drone-related educational or industrial activities. A total of 35 informants participated in the qualitative phase. Participants were organised into two groups according to their professional backgrounds and data collection methods, as detailed below:

Table 2: Number of Participants and Background Based on Group (A and B)

Group	Number of Participants (n)	Participant Background	Description
A	19	•Drone industry professionals	High-level stakeholders with expertise in drone technology, policy, and higher education. Participated in Focus Group Discussions (FGD) to provide strategic and policy-level insights.
		•Malaysian Sport Aviation Federation (MSAF) representatives	
		•Ministry of Youth and Sports (KBS) representatives	
		•Ministry of Education Malaysia (KPM) officers	
		•Ministry of Higher Education (KPT) representatives	
		•Local university academicians	
B	16	Secondary school teachers from various disciplines (e.g., STEM, TVET)	Educators with direct classroom experience, offering practical perspectives on drone usage in schools. Participated through open-ended questionnaires.

This two-group sampling allowed for the collection of a broader spectrum of insights: strategic and policy-

level considerations from Group A, and ground-level pedagogical and infrastructural perspectives from Group B. Such diversity ensured a well-rounded exploration of the components necessary for a comprehensive drone ecosystem in schools.

Data Collection Methods

Two qualitative methods were employed, tailored to the background and availability of participants:

Focus Group Discussions (FGD):

Group A, comprising experts from the drone industry, relevant government ministries, and higher education institutions, participated in semi-structured FGDs. These discussions were guided by open-ended questions aligned with the study's objectives, encouraging deep, interactive exchanges on strategic and policy-level concerns such as infrastructure, governance, training, and inter-agency collaboration.

Open-Ended Questionnaires

Group B, consisting of secondary school teachers, responded to open-ended questionnaires containing similar exploratory questions. This method enabled educators to reflect on and share their experiences and views in written form, particularly regarding the implementation of drone-related activities at the school level.

Both data collection methods sought detailed accounts of participants' perspectives and experiences to support an inductive thematic analysis of drone integration in Malaysian schools. Specifically, the qualitative inquiries aimed to uncover current practices and challenges surrounding drone-related activities in schools, shedding light on what is presently happening within the educational context. In addition, the data sought to explore the rationale for why schools require support from the drone industry particularly in terms of training, access to technology, and the provision of relevant resources. Beyond this, participants were encouraged to reflect on the roles and responsibilities of the drone industry in ensuring its sustainable growth, particularly its contribution to nurturing student interest, developing future competencies, and creating structured career pathways. These multiple layers of insight were essential in informing the development of a comprehensive and sustainable collaboration framework that integrates perspectives from both the educational sector and industry stakeholders.

.3 Data Analysis

Each dataset was analysed together using thematic analysis. Preliminary codes were generated, grouped into categories, and developed into distinct themes. All FGD transcripts and questionnaire responses subjected to the following analysis stages:

i. Initial (Open) Coding: Line-by-line coding to identify and label emerging concepts.
ii. Focused Coding: Grouping of similar codes into thematic clusters.
iii. Axial/Theoretical Coding: Linking themes and subthemes to form conceptual categories and frameworks.

This structured analytical process supported the development of the educational drone ecosystem model and ensured that the themes reflected the participants' real-world experiences and priorities.

RESULTS AND DISCUSSION

This section presents the qualitative findings on regulatory and operational issues associated with integrating drones into Malaysian schools. The findings cover regulatory oversight, operating procedures, school guidelines, risk management, enforcement, awareness, flight locations and drone sports. Figure 1 summarises these findings and their associated codes. Sections 4.1 – 4.10 present supporting participant quotations and discuss their implications for school drone activities.

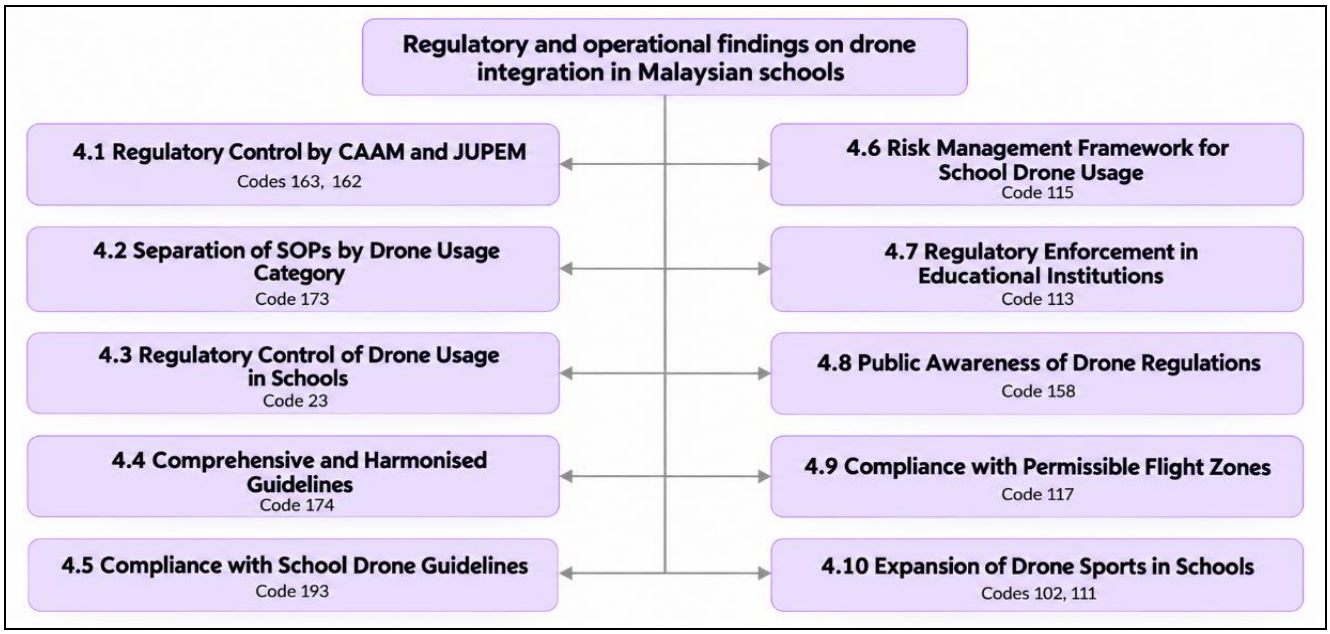

Figure 1. Overview of qualitative findings and associated codes on drone integration in Malaysian schools.

The findings highlight participants' concerns about regulatory requirements and the practical support needed for school drone activities. The following subsections examine each area through the corresponding codes and participant quotations.

Regulatory Control by CAAM and JUPEM

Participants discussed regulatory oversight by CAAM and JUPEM in relation to drone activities. Under Code 163, participants referred to aircraft classification and described sport drone operations as subject to commercial drone rules. Under Code 162, their concerns focused on camera use, mapping and flights over sensitive locations. Table 3 presents the supporting quotations.

Table 3: Regulatory Oversight by CAAM and JUPEM Based on Expert Perspectives

Code	Quotation
Code 163:	Quotation 1:
Regulation and Compliance with Drone Safety Measures by CAAM (Civil Aviation Authority of Malaysia)	"The Civil Aviation Authority of Malaysia (CAAM) classifies drone operations into several categories based on the drone's weight, purpose, and equipment."
	Quotation 2:
	"Currently, sport drones follow commercial drone rules."
Code 162: Regulation and Compliance for Drone Usage by JUPEM (Department of Survey and Mapping Malaysia)	Quotation 1:
	"Regulation of JUPEM: they are concerned with outdoor use because of the camera."
	Quotation 2:
	"Kids apply unauthorized mapping that may compromise national security or border integrity."
	Quotation 3:
	"Flying the drones over restricted areas such as military zones, infrastructure, or administrative buildings."

These accounts indicate a need to clarify agency responsibilities and the requirements applicable to different school activities. The statement that sport drones follow commercial rules represents a participant's perception

and should be distinguished from verified regulatory provisions. For schools, practical guidance should explain when flight authorisation, mapping approval or other clearances apply.

Separation of Standard Operating Procedures (SOP) by Drone Usage Category

Under Code 173, participants advocated differentiated procedures for sporting and commercial drone activities. They referred to arrangements involving aviation authorities and aero-modelling organisations in other countries as examples of category-specific oversight. Table 4 presents these perspectives.

Table 4: Need for Separation of SOPs by Drone Usage Category

Code	Quotation
Code 173: Separation of Standard Operating Procedures (SOP) for Drones Based on Their Intended Use	Quotation 1:
	"Currently, what happens worldwide is that sport and commercial operations are being separated."
	Quotation 2:
	"They have government bodies like CAA; within that, there are Aero Modelling clubs and organizations actually governing their sport drones."

The quotations suggest a preference for procedures that reflect the purpose and operating conditions of drone activities. They do not establish a universal international practice or demonstrate that such arrangements can be transferred directly to Malaysia. For educational activities, differentiated procedures would require consideration of aircraft characteristics, site conditions, supervision and applicable regulatory requirements.

Regulatory Control of Drone Usage in Schools

Under Code 23, participants expressed support for school drone activities subject to appropriate oversight and compliance with relevant requirements. One quotation proposed weekend scheduling to avoid disrupting lessons, while another emphasised the need for control. Table 5 presents these responses.

Table 5: Control and Governance of Drone Operations in Schools

Code	Quotation
Code 23: Regulatory Control of Drone Usage in Schools	Quotation 1:
	"It will not interfere with anything as long as certain rules and regulations by agencies and programs are followed, and it does not disrupt classroom time. It must take place on weekends."
	Quotation 2:
	"It is very good but there needs to be control."

These responses highlight the importance of coordinating drone activities with school routines and assigning supervisory responsibilities. Weekend scheduling represents a participant's recommendation rather than an established requirement. Schools could consider suitable scheduling arrangements according to the activity's educational purpose, available facilities and supervision needs.

Development of Comprehensive, Harmonised Guidelines for All Levels

An industry participant called for standardised modules and guidelines under Code 174. Teacher responses also identified a need for practical supporting materials, including handling manuals, flight guides, videos, safety brochures and information on drone regulations. Table 6 presents these accounts.

Table 6: The Need for Comprehensive and Harmonised Guidelines Across Educational and Industrial Contexts

Code	Quotation
Code 174: Development of Comprehensive, Harmonized Guidelines for All Levels	Quotation 1 (Drone's industry player):
	"Standardized modules and guidelines—so we will dive into what kind of modules and guidelines are required."
	Quotations (School Teachers) – Need for Printed and Non-Printed Supporting Materials:
	• Quotation 1: "Yes. A manual for drone handling and flight."
	• Quotation 2: "Yes – slides, reading materials, videos, etc."
	• Quotation 3: "Yes – supporting materials such as a Drone Flight Guide."
	• Quotation 4: "Yes – safety brochures."
	• Quotation 5: "Yes – a module on drone usage."
	• Quotation 6: "Yes – reading and distribution materials."
	• Quotation 7: "Yes – flight modules, drone regulations, and laws."
	• Quotation 8: "Not sure."

The responses indicate demand for guidance in several formats to support drone instruction and operation. They do not demonstrate that all teachers agreed that official guidelines were absent. The response "Not sure" indicates uncertainty. A coordinated resource package could address these needs through operating instructions, teaching materials and clear references to applicable requirements.

Compliance with School Drone Guidelines

These responses under Code 193 addressed the availability of school drone guidelines. The quotations in Table 7 express uncertainty or report that guidelines were unavailable, alongside recognition of their necessity.

Table 7: Perceptions of the Need for Drone Operation Guidelines in Schools

Code	Quotation
Code 193: Compliance with Drone Usage Guidelines in Schools	Quotation 1:
	"Not sure. But school need such guidelines"
	Quotation2:
	"None. But school need it"

These responses suggest a gap in participants' access to, or knowledge of, relevant guidance. They do not establish that formal policies are absent across Malaysian schools. The practical implication is to clarify which documents schools should use, where staff can obtain them and how the requirements apply to educational activities.

Development of a Risk Management Framework for Drone Usage in Schools

Under Code 115, participants raised concerns about authorisation and the protection of children and operators during school drone activities. One quotation linked unauthorised operation with potential danger, while another referred to procedures specified by regulators. Table 8 presents these concerns.

Table 8: Perspectives on the Development of a Risk Management Framework for Drone Usage in Schools

Code	Quotation
Code 115: Development of a Risk Management Framework for Drone Usage in Schools	Quotation 1:
	"It is quite critical: if we put it in school and it is illegal, it endangers children and operators"
	Quotation2:
	"The regulator says if you want to fly, this is what you need to do."

The accounts connect regulatory compliance with operational safety and support clearer allocation of responsibilities. A proposed school risk management process should address hazard identification, assessment of likelihood and severity, control measures, supervision and incident response. These components represent recommendations informed by the findings. The quotations alone do not constitute a developed or validated risk management framework.

Enforcement of Regulations in Education Institutions

Under Code 113, one participant described conducting programmes quietly because of concern about regulatory enforcement. Table 9 presents this account, which reflects hesitation about conducting drone activities openly.

Table 9: Concerns Regarding the Enforcement of Drone Regulations in Educational Institutions

Code	Quotation
Code 113: Enforcement of Drone Usage Regulations in Education Institutions	Quotation 1: "My main concern is more on regulation. We hold programs but have to do them quietly. Afraid the regulators will find out."

This account suggests uncertainty about approval procedures and possible regulatory consequences. It does not establish that the activities breached regulations or indicate how widespread this practice was. Clear application guidance and access to regulatory advice could help organisers address uncertainty before conducting school programmes.

Public Awareness of Drone Usage Regulations

Under Code 158, participants identified regulatory awareness and parental engagement as areas requiring attention. One response proposed a regulatory awareness programme, while another anticipated challenges involving parents. Table 10 presents the supporting quotations.

Table 10: Public Awareness and Perception of Drone Usage Regulations in Educational Contexts

Code	Quotation
Code 158: Public Awareness Regarding Drone Usage Regulations	Quotation 1: "Regulatory awareness program."
	Quotation 2: "The biggest challenge we foresee is not going to be outsiders, but the parents of primary to tertiary students."

These responses support communication that explains the purpose, supervision and operating arrangements of school drone activities. However, the quotation about parents does not specify their concerns or demonstrate

that they refused permission for participation. Further interpretation should draw on the surrounding transcript rather than assume the reasons for parental hesitation.

Compliance with Safe Zones (Fly Zone Area)

Under Code 117, a participant identified the need for a database explaining where drones may be flown. This account highlights access to location-specific information as a practical concern when planning activities. Table 11 presents the relevant quotation.

Table 11: Compliance with Safe Zones for Drone Operations in Educational Settings

Code	Quotation
Code 117: Compliance with Safe Zones for Drone Flights (Fly Zone Area)	Quotation 1: "That regulatory awareness, knowing where to fly requires a certain database so that we can disseminate information, and so on."

The quotation supports clearer information about permissible flight locations. An accessible database could assist planning, while site assessment would address local hazards, operating boundaries and the presence of uninvolved people. These are proposed responses to the information need identified by the participant. A permissible location should not automatically be treated as suitable for every school drone activity.

Introducing Drone Sports Broadly in Schools

Under Code 102, a participant reported difficulties organising drone competitions. Under Code 111, another account described AKSADRON's intention to standardise modules, guidelines and operating practices for clubs. Table 12 presents these perspectives on expanding school drone sports.

Table 12: Efforts and Challenges in Expanding Drone Sports at the School Level

Code	Quotation
Code 102: Specific Regulations for Drone Sports in Competitive Leagues	Quotation 1: "That is why we face many problems organizing competitions."
Code 111: Collaboration with AKSADRON (National Drone Sports Excellence Academy)	Quotation 1: "What AKSADRON intends to do: they are standardizing the module, the guideline, the standard of practice. As a center of excellence, it is the best practice to run the club."

The competition quotation identifies an organisational difficulty but does not specify its causes. Its interpretation therefore requires reference to the surrounding transcript. The AKSADRON quotation describes an intended contribution to standardisation, rather than evidence that the resources have been completed or implemented. Together, these accounts suggest a potential role for collaboration in developing practical resources for school clubs and competitions.

Summary of Qualitative Phase Findings

The qualitative findings identified regulatory and operational concerns relevant to drone integration in Malaysian schools. Across Sections 4.1–4.10, six related areas summarise participants' perspectives:

1. Regulatory requirements and agency responsibilities (Codes 163, 162). Participants discussed aircraft classification, perceived similarities between sporting and commercial requirements, and concerns involving cameras, mapping and sensitive locations. These accounts indicate a need to clarify how agency requirements apply to school activities.

2. Differentiated operating procedures (Codes 102, 173). Participants advocated procedures suited to sporting activities and reported difficulties organising competitions. References to overseas arrangements reflected participants' perspectives rather than evidence of a universal international practice.

3. School guidance, resources and coordination (Codes 23, 111, 174, 193). Responses highlighted school oversight, standardised modules and practical supporting materials. Some responses expressed uncertainty about available guidelines or reported their absence. These accounts do not establish that official documentation is absent across Malaysian schools.

4. Uncertainty about regulatory enforcement (Code 113). One participant described conducting programmes quietly because of concern about enforcement. This account indicates hesitation about conducting activities openly, without establishing how widespread the practice was or that the activities breached regulations.

5. Risk management and supervisory responsibilities (Code 115). Participants linked authorisation and compliance with concerns about protecting children and operators. These perspectives support the development of a school risk management process, although the study did not validate such a framework.

6. Regulatory awareness and flight-location information (Codes 158, 117). Participants called for awareness activities, identified parental engagement as a concern and proposed a database explaining permissible flight locations. These responses support clearer communication and access to location-specific guidance, rather than demonstrating uniformly low awareness.

Together, these findings inform proposals for clearer school procedures, coordinated guidance, accessible flight-location information and defined safety responsibilities. The following recommendations translate these identified needs into proposed actions for educational and regulatory stakeholders.

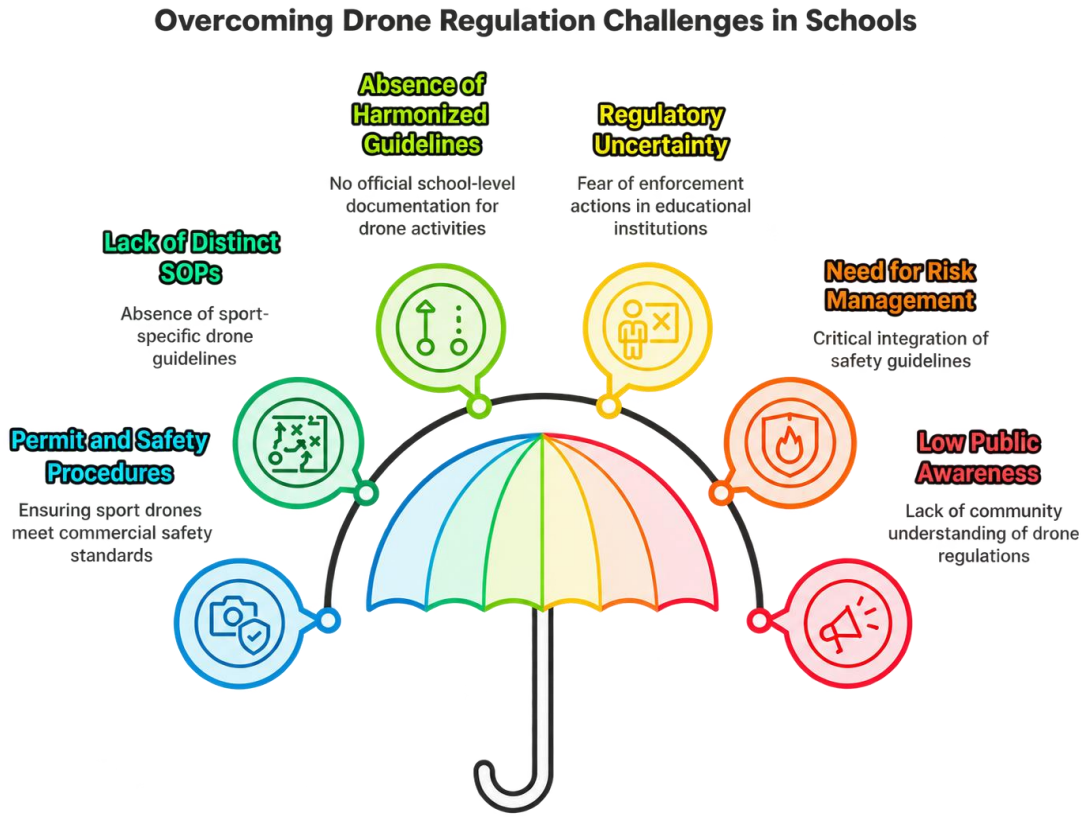

Figure 2: Summary of regulatory and operational challenges associated with drone integration in schools.

Figure 2 summarises the concerns identified in participants' accounts, including regulatory uncertainty, operating procedures, supporting resources, awareness and safety responsibilities. These findings suggest that schools need clearer guidance and practical support for planning drone activities. They inform the following recommendations on policy coordination, educational modules, stakeholder communication and a proposed school risk management process.

RECOMMENDATIONS AND FUTURE DIRECTIONS

Recommendations

The qualitative findings inform four areas of recommendation: differentiated operating procedures, educational resources, risk management and awareness, and teacher preparation. These proposals require regulatory assessment and pilot evaluation before implementation.

Regulatory Differentiation for Education

MOE and CAAM should jointly evaluate an education-specific operating pathway for supervised, non-commercial school activities. A candidate low-risk category would cover drones below 250 g, including batteries and payloads, flown below 30 m above ground level, within an assessed school compound, during daylight and within visual line of sight. These thresholds are proposed eligibility conditions and do not independently establish acceptable risk.

For eligible activities, the agencies should assess a simplified notification process through MOE instead of individual ATF applications. This would require a formal CAAM authorisation or exemption mechanism. Until implementation, schools would remain subject to applicable approval requirements. Fee reductions or waivers could also be considered to address participation costs, subject to the relevant approval process. Joint guidelines should distinguish routine instructional flights, sporting activities and operations outside the proposed category. They should specify supervision, aircraft suitability, operating boundaries, separation from uninvolved people and emergency procedures. Competitions involving different equipment or operating conditions would require separate assessment.

Table 13 translates the proposed education-specific operating category into operational conditions, risk controls and assigned responsibilities. These provisions require MOE–CAAM review and pilot evaluation before adoption.

Component	Proposed operating condition	Risk control	Proposed responsibility
Aircraft eligibility	Aircraft below 250 g, including battery and payload, for non-commercial educational activities	Verify operating mass and suitability. Fit propeller guards where compatible	Trained supervising teacher
Flight limits	Below 30 m AGL, within the assessed school compound, during daylight and within VLOS	Apply a lower ceiling where site conditions require it. Stop flights approaching operating boundaries	Supervising teacher
Site suitability	Use an assessed and designated flight area	Check airspace restrictions, obstacles, roads and public access. Apply geofencing where supported, alongside physical boundaries	School coordinator, with competent aviation support
Participant	Separate the operating	Establish an exclusion area.	Supervising teacher

protection	area from uninvolved people	Prohibit overflight of uninvolved people and stop operations following intrusion	and designated support staff
Competency and supervision	Teacher demonstrates relevant knowledge and practical supervisory skills	Complete the proposed competency programme. Permit student operation only under direct supervision	MOE–CAAM working group to define competencies, school management to assign staff
Pre-flight readiness	Aircraft, batteries, controls and weather are suitable	Complete an aircraft-specific checklist. Defer flights following defects or unsuitable weather	Supervising teacher
Risk assessment	Record hazards, likelihood, severity, controls and residual risk	Proceed only when residual risk meets agreed acceptance criteria. Reassess after changes	Supervising teacher, reviewed by school coordinator
Notification and approval	Use simplified MOE notification only under a formally established CAAM mechanism	Record activity, location, aircraft and supervising teacher. Follow applicable approval procedures outside the category	School coordinator, MOE and CAAM within their agreed roles
Emergency response	Establish procedures before the activity	Brief participants on loss of control, boundary breach, injury and battery-fire response	Supervising teacher and school emergency team
Privacy and records	Collect only information required for the educational activity	Define permissions, access and retention arrangements. Maintain flight, maintenance and incident records	Teacher coordinator and school management
Post-flight review	Inspect equipment and record incidents or near misses	Suspend defective equipment and document corrective actions before reuse	Supervising teacher and school coordinator

The proposed SOP links each operating condition to a control measure and an accountable role. The mass and height thresholds are candidate criteria for evaluation, rather than evidence that all qualifying flights present acceptable risk. Pilot findings should guide revisions to site requirements, teacher competencies and oversight arrangements.

Development of Harmonised Educational Resources

Ministry of Education (MOE) should coordinate an accessible “Drone in Education” toolkit containing:

- Aircraft-specific handling instructions, pre-flight checklists and emergency procedures.
- Illustrated guidance on batteries, maintenance and spectator management.
- Curriculum-aligned lesson plans and responsible data-collection activities.
- Videos, slides and printable materials explaining supervision and regulatory procedures.

Resources should be available in downloadable and printed formats for schools with limited connectivity. Collaboration with higher education institutions, industry organisations and organisations such as AKSADRON could support resource development, teacher workshops and equipment-sharing arrangements. Any designated support centres should have defined responsibilities, staffing and funding.

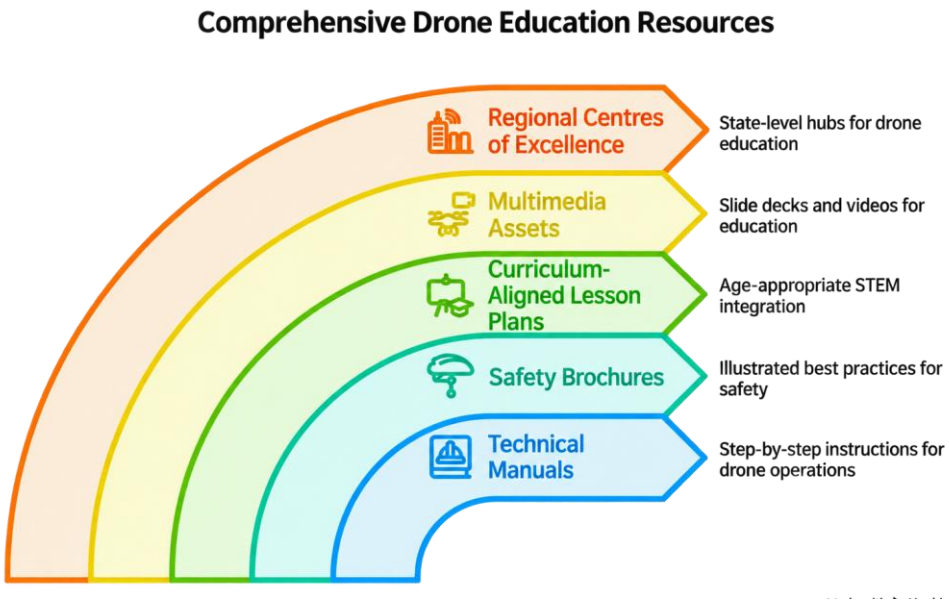

Figure 3. Proposed components of a coordinated drone education resource toolkit.

Risk Management, Flight Zones and Community Awareness

Schools participating in the proposed pathway should use a documented risk assessment process. This should include hazard identification, likelihood and severity assessment, selection of controls, residual-risk review and a decision to proceed or defer the activity. Responsibilities for supervision, emergency response and incident reporting should be assigned before flight. Potential controls include propeller guards, operating-area boundaries, separation from uninvolved people and geofencing where supported. Geofencing should supplement site assessment and active supervision. Schools should review assessments after incidents, changes in equipment or changes in operating conditions. MOE and CAAM should coordinate a database of assessed school flight locations, consulting JUPEM and other relevant authorities where required. Entries should identify operating conditions, restrictions and review dates. Schools without suitable grounds should have access to shared assessed facilities. Parent and staff briefings should explain activity objectives, supervision, privacy arrangements and emergency procedures. Their frequency should reflect programme needs rather than an untested fixed schedule.

Teacher Competency and Student Preparation

MOE and CAAM should develop a school-focused teacher competency programme, provisionally termed “RCoC-B lite”. This is a proposed label rather than an existing qualification. Its scope, assessment and recognition would require CAAM agreement. Training should address applicable regulations, aircraft handling, site assessment, pre-flight checks, emergency response, responsible data collection and pedagogical integration. Practical assessment should establish teachers’ ability to supervise the proposed operating category. Training duration and refresher requirements should be determined through competency analysis and pilot evaluation. Students should complete age-appropriate preparation in flight principles, safety, responsible data collection and supervised practice. Schools may recognise completion through an educational achievement record, which would not replace any applicable aviation competency requirement.

Future Directions

Regulatory and Operational Validation

Future research should assess the proposed operating category through consultation with MOE, CAAM, relevant agencies, teachers and technical specialists. Expert review or a Delphi study could evaluate eligibility conditions, notification arrangements and supervisory responsibilities. International comparisons should focus on provisions relevant to school operations and their transferability to Malaysia.

Pilot Implementation across School Settings

A pilot should include urban and rural schools with different facilities, resources and access to training. Evaluation should examine site suitability, implementation costs, administrative processing, teacher competency and participation. Local conditions should guide adaptations rather than assumptions that all schools face similar constraints.

Safety and Governance Evaluation

Pilot research should assess the usability of risk-assessment tools, incident-reporting procedures and flight-zone controls. Evaluation should include incidents, near misses, compliance and reporting completeness. An MOE–CAAM working group could coordinate implementation and review evidence before deciding if additional governance structures are necessary.

Pedagogical Impact and Sustainability

Longitudinal and comparative studies should examine spatial reasoning, data literacy, STEM engagement and teacher practice using appropriate measures. Research should also assess equipment maintenance, staff turnover, costs and continued participation to determine the conditions needed to sustain school programmes.

CONCLUSION

Adopting UAVs in Malaysian schools promises to enrich STEM education through hands-on learning, spatial analysis, and project-based inquiry. However, rigid, commercial-oriented regulations, the absence of tailored SOPs, and a lack of harmonized resources create significant obstacles. This chapter proposes a comprehensive strategy involving regulatory differentiation, resource development, enhanced risk management, stakeholder collaboration, and targeted training. By undertaking these reforms and pursuing the outlined research agenda, Malaysia can cultivate a safe, innovative, and pedagogically valuable drone ecosystem transforming regulatory challenges into opportunities for educational advancement.

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