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Revolutionising Construction Oversight with Drone Technology

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***Abstract* — Site management is a management where a construction project is planned, coordinated, and supervised from start to finish and it usually requires site monitoring to be carried out. However, previous studies show that traditional site monitoring has many challenges that affect the project's progress in terms of time, safety, and efficiency. Therefore, this paper aims to establish strategies for implementing drones in construction site monitoring to enhance site management by uncovering new findings. The research objectives are to identify the challenges of traditional construction site monitoring and to recommend the strategies of drone implementation in construction site monitoring. A questionnaire survey was distributed to G7 contractor companies around Kuala Lumpur to gain their perspective related to the research objectives. The findings indicate that modern and fast-moving projects view traditional methods for monitoring construction sites as outdated, inconvenient, and not practical. Nevertheless, the positive impacts of drones seem to be acknowledged by the construction industry, such as their ability to inspect hard-to-reach areas, offer high-quality aerial images, and provide real-time data and insights. Ultimately, the paper advocates for the appropriate strategies to implement drones in construction site monitoring to improve the efficiency of site management.**

Keywords—Site management, Site monitoring, Drone, Challenges, Contractor.

I. INTRODUCTION

The construction industry is one of the most complex and resource-intensive sectors globally, often challenged by inefficiencies, safety hazards, and escalating project costs. Conventional site monitoring and management techniques, which depend largely on manual inspections and static data collection, have been ineffective in meeting the evolving requirements of contemporary construction projects [1]. The monitoring and management of construction sites have traditionally relied on manual practices, physical inspections, and paper-based documentation. While these methods have been foundational to project oversight, the dynamic and complex nature of modern construction projects has exposed their limitations. In this context, the integration of unmanned aerial vehicles (UAVs), commonly known as drones, has emerged as a promising technological innovation with the potential to transform conventional construction oversight practices. Drones offer high-resolution aerial imagery, real-time data collection, and remote monitoring capabilities that significantly enhance project visibility and operational decision-making [2]. Their ability to survey large and complex sites rapidly allows for improved safety, productivity, and resource allocation, presenting a substantial value proposition for construction managers and stakeholders. Despite these advantages, the implementation of drone technology introduces a host of new challenges, including regulatory concerns, privacy issues, data integration complexities, and workforce readiness. These issues necessitate a more profound understanding of the broader implications of drone adoption in the construction domain. This paper is aim to establish the strategies of drone implementation for construction site monitoring to enhance site management with uncovering findings.

II. LITERATURE REVIEW

The integration of unmanned aerial vehicles (UAVs), or drones, into construction site monitoring and management has garnered considerable attention recently. While scholars have explored the technological capabilities, advantages, and limitations of drones across different construction phases, considerable gaps exist in understanding the challenges of transitioning from traditional methods to a more integrated, data-driven approach that goes beyond incremental digitisation. The subsequent

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section reviews the recent challenges of traditional construction site monitoring and management.

A. Challenges of Traditional Construction Site Monitoring and Management

Many people characterise traditional construction site monitoring as slow and time-consuming due to its reliance on episodic, manual data capture and sequential reporting cycles. Across the reviewed studies, six recurring challenges emerge. Recent reviews consistently argue that these analogue routines create latency between on-site events and managerial decisions, lengthening feedback loops and masking emerging risks [3 - 4]. Even where digital tools exist, adoption is uneven and often siloed, so time savings fail to materialise at the project-system level [3]. A second, compounding challenge arises from the frequent manual analysis of image and video evidence, which is now ubiquitous on sites. The scholarly consensus is that manual visual inspection is subjective, error-prone, and difficult to scale; it also produces inconsistent labels that limit longitudinal learning [4]. Comparative reviews of computer vision progress monitoring reveal maturing algorithms, yet underline bottlenecks in dataset quality, generalisability across trades, and integration with work breakdown structures—factors that keep many firms stuck in labour-intensive review processes [5]. Third, physical inspections over large or complex sites demand significant manpower, raising cost and safety concerns. Studies highlight the persistent exposure of inspectors to hazards, travel and access inefficiencies, and their dependency on a small number of experienced personnel for quality judgements [6]. Emerging human–robot teaming and mobile sensing evidence suggests credible pathways to reduce exposure hours and increase coverage, but translation beyond pilots remains limited by skills, governance, and reliability concerns [7]. Fourth, paper-based monitoring systems remain vulnerable to loss, duplication, and version conflicts. Sector-wide surveys indicate stagnation in model-centric, data-driven workflows, with inconsistent data standards and fragmented repositories undermining traceability and auditability [3]. This fragmentation directly affects claims management, quality assurance, and regulatory compliance by eroding a single source of truth. Fifth, paper checklists and reports are operationally inconvenient. Beyond being physically cumbersome, they impede rapid cross-functional coordination (safety–quality–production) and delay corrective action because findings cannot be instantly enriched with geospatial context, as-built models, or time-stamped media [6]. Even where mobile forms are adopted, research notes a tendency to digitise the paper paradigm rather than redesign workflows for continuous data flows and analytics [3]. Finally, traditional methods struggle with rapidly changing conditions on site. The literature highlights a discrepancy between the frequency of site changes and the monitoring cycle—weekly progress meetings versus hourly production variability—which results in blind spots for rework, safety drift, and schedule slippage [4]. Vision-based and mixed-reality pipelines demonstrate potential for near-real-time situation awareness, but gaps remain around interoperability (e.g., BIM–CV–schedule), domain adaptation, and governance of AI-assisted decisions [8]. Across themes, convergence is strong on the challenges of the traditional move from incremental digitisation toward responsive, data-centric oversight that matches the pace and complexity of modern construction. The subsequent section will highlight the strategies for drone implementation in construction site monitoring and management.

B. Strategies for Drone Implementation in Construction Site Monitoring and Management

The integration of drones into construction site monitoring and management is increasingly recognised as a transformative strategy for enhancing safety, efficiency, and data accuracy. However, successful implementation requires coordinated strategies across regulatory, organisational, and technological domains. Six key themes emerge from the literature: regulatory compliance, permitting processes, privacy and liability concerns, operator training, specialised knowledge in aviation and emergency protocols, and funding for advanced drone technologies. Regulatory compliance is the cornerstone of drone implementation. Aviation authorities, such as the FAA and ICAO, require operators to comply with strict rules concerning visual line-of-sight, altitude restrictions, and no-fly zones [9]. These frameworks ensure safety but can limit operational flexibility, especially on large or hazardous sites where Beyond Visual Line of Sight (BVLOS) operations are desirable [10]. The literature converges on the necessity of compliance, yet diverges on how construction firms should navigate evolving rules while maintaining project efficiency. A clear research gap exists around adaptive governance models that can align regulatory compliance with real-world construction demands. The need for permits and approvals is closely related to the rules. Studies emphasise the need for formal authorisation from aviation bodies and project stakeholders before drones can be deployed [4]. While consensus exists that these processes are essential for accountability and legal protection, a lack of standardised procedures complicates implementation, particularly in urban areas where airspace overlaps with private property. Empirical studies rarely explore how firms negotiate these approvals in practice, leaving a gap in understanding how to streamline compliance without impeding project timelines. Privacy and liability concerns remain a contentious theme. Construction sites are increasingly digital, with drones capturing high-resolution imagery that may inadvertently infringe on personal or corporate privacy. While some firms implement rigorous documentation of pilot certifications and insurance [6], others lack formal safeguards. This divergence underscores a research gap in assessing how privacy protocols and liability frameworks impact stakeholder trust and drone adoption rates. Another important strategy is to train drone operators. In addition to piloting skills, operators must be knowledgeable in construction-specific contexts, encompassing hazard awareness and emergency protocols [7]. Recent advances in simulation training, such as VR-based systems, show potential for improving competency [5]. However, the literature diverges on whether simulation alone is sufficient or should complement field-based training. There is a lack of empirical evidence connecting training methodologies to quantifiable enhancements in safety outcomes or data precision, indicating a significant under-researched domain. Building on this, specialised training in airspace regulations, emergency protocols, and data analysis is increasingly emphasised. Operators are expected not only to navigate regulatory frameworks but also to interpret aerial data effectively for project decision-making [10]. While the literature aligns with the necessity of this skill set, studies rarely evaluate how operators balance these responsibilities under real-world conditions. This highlights a gap in understanding the interplay between regulatory knowledge, technical expertise, and decision-making effectiveness on site. Finally, funding for advanced drones and related tools remains a barrier, particularly for small and medium-sized firms. Advanced technologies such as LiDAR, thermal sensors, and AI-driven analytics promise significant benefits but demand substantial financial investment [4]. While consensus exists on the importance of adequate funding, systematic cost–benefit analyses and return-on-investment models are limited. Without these frameworks, firms find it difficult to justify their expenditures, thereby hindering their widespread adoption. In synthesis, the literature demonstrates strong convergence on the need for robust strategies across compliance, training, and funding, yet significant divergences persist in how these strategies are operationalised across firms and contexts. By addressing these gaps, we can enhance both the theoretical understanding and practical application of drones in construction site management.

III. METHODOLOGY

The data was gathered in various ways and from various sources. Data collection for this study utilises a quantitative technique using an online survey with a questionnaire that has been sent through platforms such as email, WhatsApp, Telegram, and others. The survey's respondents comprise the G7 contractor companies in Malaysia. The survey was disseminated to targeted respondents situated within Kuala Lumpur to gain their perspective related to the research objectives. By focusing on this geographical area, this study aimed to gather insights from a representative sample of professionals actively engaged in Malaysia's construction sector. Table I shows the population of respondents for this study will be selected from a total of 1,815 G7 contractor companies registered and operating in Kuala Lumpur, Malaysia. These companies represent the highest grade of contractors recognised by the Construction Industry Development Board (CIDB) Malaysia, typically undertaking large-scale and technologically advanced construction projects. Kuala Lumpur has been chosen as the primary area of study due to its status as the nation's capital and its dense concentration of active construction projects. The city is also a hub for innovation and development, making it more likely to discover contractor companies that have already integrated drone technology into their site monitoring processes. The corresponding sample size needed to achieve a representative and reliable dataset is 317 respondents. The data are then tabulated and analysed using frequencies frequency and descriptive analysis methods. In the Likert Scale, the respondents were given the options of 5 scales of level of agreement, which are 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The questionnaire had three primary sections: Section A: Demographic Information, Section B: Challenges of Traditional Construction Site Monitoring and Management, and Section C: Strategies for Drone Implementation in Construction Site Monitoring and Management.

Table I. Population of respondents.

	Population (N)	Required sample (n)	Returned
G7 Contractors Registered with CIDB	1815	317	89

This study analyses the 89 questionnaires returned from the survey, representing 28% of the overall sample size. According to [11], a response rate between 20% and 30% is considered adequate for questionnaire-based research within the construction industry. This level of participation enhances the reliability of the findings and reinforces the validity of conclusions drawn from the survey results.

IV. RESULTS AND DISCUSSION

The returned questionnaire indicates that the majority of respondents are most likely to apply UAVs to infrastructure projects. The implementation of UAVs is significant in infrastructure works such as roads, overpasses, bridges, and railways. Infrastructure-type projects often are large open areas, making them perfect candidates for drone-based aerial surveys mapping and inspections using fixed-wing or hybrid UAVs, which is a natural fit.

Table II identifies six variables that pose challenges to traditional construction site monitoring and management. There are several challenges faced under this section and it can be seen that the highest-ranked challenge is that paper-based checklists and reports are inconvenient to manage. The study indicates that many site workers may find it difficult to carry and handle physical documents during their regular site monitoring. Carrying multiple forms, drawings, or inspection sheets around a large site is impractical for workers who need to move quickly and multitask. This challenge is considered valid, as it is consistent with past research [12], as they have mentioned in their study. The second primary issue is the manual analysis of images and videos. Most survey respondents concur that this difficulty consumes a significant amount of time and hinders progress. These challenges may arise due to the rigorous human performance, decision-making, and hours of concentration required for this process, which necessitates careful, repetitive monitoring and inspection by humans. This issue appears to be consistent with the findings of past research referenced in [13]. Other major challenges agreed upon by the respondent are the need for a lot of manpower during physical inspections. These findings seem to align with past research [14], suggesting that traditional methods are labour- intensive. In reality, traditional monitoring, particularly in large construction projects, can be exhausting, time-consuming, and costly due to the need for regular updates. High labour requirements can also further slow the decision-making process, as it takes time to gather, verify, and report information manually. Hence, it gains concerns among the respondents. In addition, the struggle to keep up with rapidly changing site conditions also shows concerns among the respondents. These results are in line with past research by [12] and [15], who state that paper documents cannot adapt to rapidly changing situations and struggle to show connections between activities and their effects in real-time updates. This study indicates that this variable can pose a significant problem, particularly for large and dynamic construction projects where conditions change rapidly and timely updates are essential. Some respondents also pointed out that paper-based systems can possibly lead to data loss and misplacement, which is similar to past research by [16] and [17]. These results indicate that the respondents may have experienced this incident before; thus, it raises concerns if these data are lost or misplaced before the data collected are keyed into the system. Worryingly, it can cause delays and confusion. Following that, the respondents agreed that traditional methods are generally slow and time-consuming, which shows consistency with past research [18], [19] and [20]. Several factors contribute to these issues. Therefore, this study has reinforced the Malaysian construction industry, where conventional practices struggle to keep up with the fast-paced demands of technology adoption in construction projects.

Table II. Challenges of traditional construction site monitoring and management.

No.	*Challenges of Traditional Construction Site Monitoring and Management*	*Mean*	*Std. Deviation*	*Rank*
1.	Traditional site monitoring methods are a slow and time-consuming process.	3.83	0.661	6
2.	Traditional site monitoring usually requires images and videos to be manually analysed.	4.09	0.577	2
3.	Physical inspections on large sites require significant manpower.	3.96	0.601	3
4.	Paper-based monitoring systems are at risk of data loss and misplacement.	3.87	0.726	5
5.	Paper-based checklists and reports used in traditional monitoring are inconvenient to manage, as they need to be carried around.	4.15	0.873	1
6.	Traditional site monitoring methods struggle to address rapidly changing conditions on-site.	3.92	0.727	4

The second study objective was achieved, as indicated in Table III of the ranking table, where most respondents agreed that several important strategies are necessary for the successful implementation of drones in construction site monitoring. The two highest-ranked statements were that, first, privacy and liability concerns must be managed through proper regulatory compliance, and second, necessary permits and approvals must be obtained before using drones on site. This result shows that legal issues are a top priority for the respondents. In the construction industry, drones operate not only in physical space but also in regulated airspace, which means failure to comply with aviation laws can lead to legal penalties, project delays, or even site shutdowns. Therefore, acquiring the appropriate authorisations before drone deployment ensures that companies operate within legal boundaries and avoid costly consequences. Similarly, privacy and liability concerns are becoming more significant as drones can record images, videos, and sensitive data. Construction sites may be near homes or public places, and if companies don't have clear rules about how to collect, store, and use data, they could accidentally break privacy laws or raise ethical issues. By addressing these issues through proper legal frameworks and policies, companies are not only following the law but also protecting themselves from liability and building credibility with clients, stakeholders, and the public. This is consistent with past research [21]. Thirdly, the strategy emphasises that drone operators should be trained in airspace regulations and emergency protocols, indicating strong agreement among respondents. The survey shows that technical competence is viewed as a key pillar in the successful implementation of drone technology on construction sites. Simply acquiring drone equipment is not sufficient without skilled operators who understand the operational environment and safety guidelines. Therefore, operators must be fully aware of where and how they are permitted to fly drones to avoid potential legal breaches or safety incidents and know how to analyse data collected from drone flights. This shows consistency with past researchers [21] and [22]. Furthermore, there are two variables which are comprehensive training for drone operators and adequate funding for drone equipment, which indicates a strong endorsement of the importance of funding both human resources and drone technology. Comprehensive training can ensure that drone operations technicians, operators, pilots, and the support staff who will collaborate with the drone operators involved in a project have the same amount of knowledge and skill as a baseline of competency. This same baseline will lead to a fair amount of consistency and efficiency when using drones across the various teams and different construction projects. Training of drone operational personnel will also minimise the potential for operational errors when on a busy construction site with numerous moving parts, where coordination is crucial. This conclusion is consistent with past researchers [21], [22] and [23]. On the same note, adequate funding of drones and compatible tools like GPS, mapping software, and data-processing platforms is essential to have good-quality drones, as well as the support material that could lead to cutting down on operational time, increased data accuracy, and longevity and sustainability of the drone system. This information is consistent with past research by [24] and [25]. Hence, the appropriate funding and training predicate that if full use of drone technology is to be successful, both the technical capability of the drone operator and the quality of the tools being used need to work together, which is to say that not considering one without the other would lead to diminished potential and likelihood of operational success. It also shows the industry's foundational knowledge that drone use is not just about drones but about ensuring the workforce is technically capable of drone use. Additionally, even though some strategies require fewer resources, such as adhering to aviation regulations, they are still important.

Table III. Strategies for Drone Implementation in Construction Site Monitoring and Management.

No.	***Strategies for Drone Implementation in Construction Site Monitoring and Management***	***Mean***	***Std. Deviation***	***Rank***
1.	Adhering to aviation regulations is a must to ensure safe and legal drone operations on construction sites.	4.53	0.545	6
2.	Necessary permits and approvals must be obtained before using drones on construction sites.	4.62	0.594	2
3.	Regulators must effectively manage privacy and liability concerns related to drone use during site monitoring.	4.62	0.533	1
4.	Organisations need to provide comprehensive training for drone operators to ensure their safety and effective use.	4.54	0.565	5
5.	Drone operators should be trained in airspace regulations, emergency protocols, and data analysis.	4.57	0.541	3
6.	Adequate funding should be allocated to purchase advanced drones and related tools.	4.54	0.658	4

V. CONCLUSION

This paper presents the initial objective findings, highlighting the most significant challenges identified by respondents, which include the inconvenience of paper-based checklists, manual analysis of images or videos, labour intensity, the struggle to address rapidly changing conditions on-site, and the fact that paper-based monitoring systems are at risk of data loss and misplacement. The second objective of the study highlights key strategies for implementing drones in construction site monitoring, which include privacy and liability concerns related to drone use that must be effectively managed through regulatory compliance during site monitoring; obtaining permits and approvals before using drones on construction sites; drone operators should be trained in airspace regulations, emergency protocols, and data analysis; adequate funding should be allocated to purchase advanced drones and related tools; and the organisation needs to provide comprehensive training for drone operators. This research contributes to knowledge by extending and improving the implementation of drones in site monitoring and management, ultimately enhancing safety management. The authors also acknowledge that the survey design needs to be expanded and further tested to strengthen its credibility. Nevertheless, the current results are preliminary and should be interpreted with caution. Additional findings are anticipated as the research continues to progress.

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Nur Alia Munirah: Conceptualization, Data Curation, Formal Analysis, Investigation, Mohd Esham: Methodology, Validation, Visualization, Shahela: Writing–Original Draft Preparation, Norazlin: Supervision, Farhan: Writing–Review & Editing.

CONFLICT OF INTERESTS

No conflict of interests was disclosed.

ETHICS STATEMENTS

Our publication ethics follow Research Ethics Committee (REC) of Universiti Teknologi Mara (UiTM) guideline.

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DATA AVAILABILITY STATEMENT

No available.

REFERENCES

[1] W. Zhou, J. Whyte and R. Sacks, "Construction Safety and Digital Design: A Review," *Automat. Construct.*, vol. 80, pp. 79–92, 2017.

[2] S. Siebert and J. Teizer, "Mobile 3D Mapping for Surveying Earthwork Projects using An Unmanned Aerial Vehicle System," *Automat. Construct.*, vol. 41, pp. 1–14, 2014.

[3] *Digitalisation in construction report 2023*, Royal Institution of Chartered Surveyors, 2023.

[4] R. Samsami, "A Systematic Review of Automated Construction Inspection and Progress Monitoring (ACIPM)," *Civil Eng.*, vol. 5, no. 1, pp. 265–287, 2024.

[5] A. Pal, J. Yang and I. Brilakis, "Automated Vision-based Construction Progress Monitoring: A Review," *Develop. Built Environ.*, vol. 14, pp. 100148, 2023.

[6] E. I. Daniel, A. Eirug, V. Okorie and P. X. W. Zou, "The Use of Digital Technologies in Construction Safety: A Systematic Review," *Buildings*, vol. 15, no. 8, pp. 1386, 2025.

[7] S. Halder, E. Oh and S. Kim, "Construction Inspection and Monitoring with Quadruped Robots: A Human–Robot Teaming Approach," *J. Build. Eng.*, vol. 72, pp. 106503, 2023.

[8] R. M. I. Anwar, J. Park and M. Bhandari, "Mixed Reality in Building Construction Inspection and Monitoring: A Systematic Review," *Infrastructures*, vol. 9, no. 9, pp. 159, 2024.

[9] *Regulations of Unmanned Aerial Vehicles, In Regulation Of Unmanned Aerial Vehicles.* International Civil Aviation Organization, 2022. https://en.wikipedia.org/wiki/Regulation_of_unmanned_aerial_vehicles.

[10] V. K. Reja, J. Kim and S. Lee, "Computer Vision-based Construction Progress Monitoring: A Review," *Automat. Construct.*, vol. 136, pp. 104108, 2022.

[11] A. Akintoye, C. Black and E. Fitzgerald, "An Analysis of Success Factors and Benefits of Partnering in Construction," *Int. J. Proj. Manage.*, vol. 18, pp. 423-434, 2000.

[12] Y. Chen and J. M. Kamara, "A Framework for using Mobile Computing for Information Management on Construction Sites," *Automat. Construct.*, vol. 20, no. 7, pp. 776-788, 2011.

[13] A. Pal and S. H. Hsieh, "Vision Based Construction Site Monitoring: A Review from Construction Management Point of View," in *20th Int. Conf. Construct. Appl. Virt. Real.*, pp. 44 – 55, 2020.

[14] M. Kopsida, I. Brilakis and P. A. Vela, "A Review of Automated Construction Progress Monitoring and Inspection Methods," *Proc. 32nd CIB W78 Conf. Construct. IT*, Eindhoven, 2015.

[15] A. N. Harun, E. Bichard and M. N. M. Nawi, "Traditional vs Technological Based Surveillance on Construction Site: A Review," *Appl. Mechanic. and Mater.*, vol. 735, pp. 247-252, 2015.

[16] B. A. Weber, H. Yarandi and M. A. Rowe, "A Comparison Study: Paper-Based versus Web-Based Data Collection and Management," *Appl. Nurs. Res.*, vol. 18, pp. 182–185, 2004.

[17] A. R. Zulkifli, N. A. Yahya, E. A. Azmi and J. Md Diah, "Site Inspection Practice in Construction Projects in Kuala Lumpur, Malaysia," *Adv. Civil Eng. and Sci. Technol. AIP Conf. Proc. 2020*, pp. 1-7, 2018.

[18] T. Tasaki *et al.*, "A GIS-based Zoning of Illegal Dumping Potential for Efficient Surveillance," *Waste Manage.*, vol. 27, no. 2, pp. 256-267, 2007.

[19] M. Wang, C. C. Wang, S. Sepasgozar and S. Zlatanova, "A Systematic Review of Digital Technology Adoption in Off-Site Construction: Current Status and Future Direction Towards Industry 4.0," *Buildings*, vol. 10, no. 11, pp. 204, 2020.

[20] R. Hussamadin, G. Jansson and J. Mukkavaara, "Digital Quality Control System—A Tool for Reliable On-Site Inspection and Documentation," *Buildings*, vol. 13, pp. 358, 2023.

[21] T. A. Gyamfi, K. O. Adjei and S. O. Bonney, "Strategies to Improve Building Construction Sustainability Through Utilization of Drones in the Building Construction Sector," *Proc. Comput. Sci.*, vol. 236, pp. 209–216, 2023.

[22] J. M. Nwaogu, Y. Yang, A. P. C. Chan and X. Wang, "Enhancing Drone Operator Competency within the Construction Industry: Assessing Training Needs and Roadmap for Skill Development," *Buildings*, vol. 14, pp. 1153, 2024.

[23] T. A. Whitehead, "Training and Development: Investing in Employees Through Assessment," *Scholar Chatter*, vol. 3, no. 1, pp. 1-6, 2022.

[24] O. Parmaksiz and G. Cinar, "Technology Acceptance Among Farmers (2023): Examples of Agricultural Unmanned Aerial Vehicles," *Agronomy*, 13, pp. 2077, 2023.

[25] D. Vumbaca, "Drone Startups: A Research on The International Ecosystem and on The Determinants for Attracting External Funding," *Master Thesis*, *Politecnico Milano*, pp. 1-58, 2021.