Report on Stakeholder Engagement Workshops for validation of the Strategic technology roadmap for drones' skills

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Elevating the knowledge of construction professionals on the use of drones in construction

CONTENTS

CONTENTS ... 1
LIST OF TABLES ... 2
1. Summary ... 2
2. Purpose of Activity 2.2 ... 3
3. Methodological basis ... 5
3.1. Evidence base ... 6
3.2. Methodology limitations ... 7
4. Key findings ... 9
4.1. Current situation and challenges ... 9
4.2. Priority skills and competences ... 9
4.3. Gaps and weaknesses ... 10
4.4. Training priorities ... 10
5. Validation of the strategic report ... 13
5.1. Implications for the strategic report ... 13
5.2. Improvement of the strategic report ... 14
5.3. Proposed improvements ... 15
6. Discussion of identified drone skills gaps and priorities ... 18
6.1. Main skills gaps ... 18
6.2. Implications for curriculum development ... 20
7. Country sections ... 22
7.1. Italy ... 22
7.2. Spain ... 22
7.3. North Macedonia ... 22
7.4. Greece ... 23
7.5. Germany ... 24
7.6. Skills priorities validated by the workshops ... 24
8. Proposed modular training programme ... 28
8.1. Design principles ... 28
8.2. Proposed Modular Drone Training Programme for Construction and Renovation ... 28
8.2.1. Topic 1. Foundations of Drone Operations for Construction and Renovation ... 28
8.2.2. Topic 2. Drone-Based Inspection and Energy-Renovation Applications ... 29
8.2.3. Topic 3. Drone Data Processing, BIM/GIS Integration and Digital Construction Workflows ... 29
8.2.4. Topic 4. Advanced Drone Applications for Sustainable Construction ... 30
8.2.5. SPECIAL Topic. Train-the-Trainer and Programme Delivery for Drone Skills in Construction ... 31
8.3. Recommended programme architecture ... 31
8.4. Implications for next WP2, WP3 and WP4 steps ... 33

9. Conclusion.. 35

Glossary..36

ANNEX...40

Proposed Modular Drone Training Programme for Construction and Renovation....... 40

Topic 1. Foundations of Drone Operations for Construction and Renovation.................. 40

Topic 2. Drone-Based Inspection and Energy-Renovation Applications.......................... 42

Topic 3. Drone Data Processing, BIM/GIS Integration and Digital Construction Workflows 44

Topic 4. Advanced Drone Applications for Sustainable Construction...............................46

Special Topic. Train-the-Trainer and Programme Delivery for Drone Skills in Construction 47

LIST OF TABLES

Table 1: An overview of the organized national validation workshops.................. 5

Table 2: Proposed specific improvements to the strategic report on drone use..14

Table 4: Comparative maturity table - covering maturity level, priority skills, readiness gap and curriculum entry...24

Table 5: Recommended architecture of the training program................................31

Table 6: Proposed four-programme modular training programme..................... 32

1. Summary

This integrated A2.2 report consolidates the available evidence from the five stakeholder engagement workshops carried out under WP2, Activity 2.2 of the DRONE4BUILD project, with the aim of validating the strategic report on drone skills and translating workshop conclusions into actionable guidance for the next project steps. In line with the WP2 methodology, the workshops were intended not only to validate the A2.1 strategic report, but also to identify skills gaps, training priorities, and practical recommendations for the future Drone Competency Framework and curriculum design.

This final integrated version maintains the existing structure of the report while compiling the findings of Italy, Spain, North Macedonia, Greece, and Germany into one consolidated analysis. It also develops general conclusions, proposes only the minimum necessary revisions to the strategic report, and presents a modular training programme architecture comprising four training topics, each structured into basic and advanced modules, and a proposal for a dedicated programme for trainers to be developed in the frame of WP4.

2. Purpose of Activity 2.2

According to the WP2 research methodology, Activity 2.2 was designed to organise one stakeholder validation workshop in each partner country in order to assess current and future skills required for drone use in construction, identify gaps between sector needs and workforce capability, and validate the strategic roadmap developed in Activity 2.1. The methodology explicitly states that the workshop results should be merged into one report and used by the consortium to revise the strategic report where needed before moving into the competency framework and curriculum phases.

The present report therefore serves two functions. First, it consolidates evidence from the national workshops into one shared project-level analysis. Second, it identifies cross-country messages and recommended revisions that should be considered by the consortium when finalising the strategic report and moving toward curriculum design and competence framework development.

Co-funded by the European Union

Methodological basis

3. Methodological basis

The Research Methodology for WP2 states that stakeholder workshops in each country should validate the strategic report findings and assess specific training needs regarding drone use, digital skills, and regulatory compliance in construction. The methodology defines the target participant profile as drone specialists, construction professionals, and VET providers, with an expected range of 15–20 participants per country, although actual participation varied across the completed workshops.

The completed workshops used different facilitation formats, including onsite discussion, online validation sessions, Kahoot-based interaction, Mentimeter polling, and satisfaction questionnaires, while maintaining a common focus on skills validation, training priorities, and curriculum implications. This common methodological direction allows the available country reports to be compared at the thematic level even where the exact data collection instruments differed.

3.1. Evidence base

The report draws on the national workshop reports from Italy, Spain, North Macedonia, Greece, and Germany, as well as the WP2 methodology and the A2.1 strategic report on drone skills. Together, the five available country reports represent 126 participants and cover a broad mix of VET providers, construction professionals, company representatives, experts, drone users, and other stakeholders.

Table 1: An overview of the organized national validation workshops

Country	Source	Date	Participants	Main contribution to the consolidated analysis
Italy	IIPLE workshop report	26/05/2026	21	Strong critique of the strategic report as too literature-driven, emphasis on interdisciplinary competence, local ecosystem differences, ROI, and train-the-trainer needs

Spain	FLC workshop report	27/05/2026	40	Rich evidence on hybrid skills, digital integration, practical modular training, trainer readiness, realistic implementation pacing, and missing competencies such as cybersecurity
North Macedonia	K&S workshop report	27/05/2026	21	Strong evidence on low current maturity, practical barriers, priority operational skills, engineering interpretation of outputs, and the need for staged, practice-oriented training
Greece	PEDMEDE and Hellenic Drones workshop reports	28/04/2026 and 15/05/2026	31	Strong evidence on practical construction-site use, SME constraints, reporting needs, role-based training, compliance, and progressive BIM/GIS integration
Germany	BBSN workshop reports	18/06/2026 and 22/06/2026	18	Strong evidence on low organisational readiness, use-case awareness gaps, foundational training needs, and very low confidence in trainer preparedness

3.2. Methodology limitations

A limitation of the methodology is that the stakeholder workshops were conducted using different delivery and feedback formats, including onsite and online sessions and various facilitation tools such as Kahoot, Mentimeter, and satisfaction questionnaires. While the workshops shared a common purpose and thematic focus, these variations reduce strict comparability between countries and may have influenced the form, depth, and granularity of participant feedback. For this reason, the integrated findings should be read as a robust thematic comparison rather than as fully standardised cross-country measurements.

Key findings

4. Key findings

4.1. Current situation and challenges

A strong cross-country message is that drones are already recognised as useful tools in construction, especially for inspection, surveying, progress monitoring, documentation, photogrammetry, and renovation-related applications such as façade assessment, roof inspection, thermal diagnostics, and energy-efficiency support. At the same time, the level of adoption remains uneven across countries and organisations: North Macedonia and Germany point to early-stage or irregular use in many settings, while Greece confirms growing relevance but uneven uptake, particularly among SMEs.

The country reports converge around several operational barriers. These include limited trained staff, weak integration into construction workflows, low digital maturity, cost and investment constraints, data-processing bottlenecks, and the complexity of aviation, safety, privacy, and data-protection regulation. Spain and Italy especially stressed that the main difficulty is not simply access to the technology, but the capacity to redesign workflows and turn drone-generated data into usable construction intelligence, while Greece and Germany highlighted SME readiness, foundational awareness, and low trainer preparedness as additional constraints.

4.2. Priority skills and competences

All five workshops confirm that drone competence in construction must be understood as a broader interdisciplinary competence, not only as a matter of piloting. The most consistently validated competence areas were piloting and operational handling, mission planning, risk assessment and safety, regulatory knowledge, understanding of drone types and sensors, photogrammetry, data processing, reporting, and BIM/GIS integration.

Italy and Spain placed particularly strong emphasis on hybrid profiles that combine construction expertise, drone operations, and digital and data-management competences. North Macedonia likewise showed that participants value operational flying skills, but they also linked drone competence to engineering interpretation, structured mission planning, and the practical use of outputs in real construction tasks. Greece reinforced the need for practical reporting, quality assurance, and role-based progression, while Germany highlighted the need to begin with basic drone knowledge, use-case awareness, and legal/regulatory understanding before moving toward advanced data workflows.

4.3. Gaps and weaknesses

The most frequently confirmed gaps across the available reports are:

- Both basic and advanced operational skills,
- BIM/GIS integration,
- Data processing and post-processing,
- Interpretation of outputs, and
- Regulatory and safety compliance.

Spain and Italy also stressed more advanced weaknesses, including AI-supported analysis, digital workflow management, sensor integration, survey-grade positioning systems, and the ability to work in complex site conditions or GNSS-constrained environments.

Another recurring weakness concerns trainer preparedness. Spain identified the need for train-the-trainer measures because many current VET trainers do not yet have the operational and digital competences required for advanced drone education. North Macedonia reported similarly limited confidence in trainer capacity, Greece identified trainer capacity as a weak area for construction-specific delivery, and Germany recorded very low confidence in teaching staff preparedness to deliver digital competences related to drones.

4.4. Training priorities

The available reports strongly support a modular and practice-oriented curriculum model. The most frequently prioritised training themes were practical drone operation in realistic scenarios, safety and risk management, regulatory compliance, data processing and interpretation, photogrammetry, BIM/GIS integration, and construction-specific applications in renovation and inspection.

Spain and Italy added a stronger future-oriented dimension by highlighting AI, digital twins, automation, cybersecurity, sensor integration, and more flexible continuing professional development pathways. North Macedonia placed relatively greater emphasis on immediate operational and applied needs, which suggests that the future curriculum may need both core and advanced pathways to reflect different levels of market maturity across countries.

Germany has identified: practical introductory module on drones in construction; compliance and regulatory module; applied data interpretation module; progressive pathway toward technical and digital workflow competences as top training priorities.

While for Greece, a clear gap exists between generic drone-operation training and the applied competences needed in construction and renovation projects.

Validation of the strategic report

5. Validation of the strategic report

The workshops generally validated the direction and relevance of the strategic report. Stakeholders agreed that the report addresses important skill domains and aligns well with project objectives, especially regarding digitalisation, safety, data management, BIM integration, and the need for stronger competences in construction-related drone use.

The reports explicitly acknowledge that the strategic report reflects very well the status quo of drone use based on the literature review and in order to reflect more precisely the national circumstances, it should consider as additional resource the national reports with actual primary data, quantified findings from the workshops (reported in this document) including country-specific analysis. Italy genuously adopts the report while referring to national reports and clearer business cases for adoption. Spain recommended a more gradual implementation logic and clearer operational recommendations, while North Macedonia pointed to the need for more practical implementation focus, stronger engineering use-case examples, and clearer trainer-development pathways. Greece and Germany broadly confirmed the report direction and support only practical adjustments rather than major restructuring.

5.1. Implications for the strategic report

Based on the country reports, the strategic report should be revised in at least five directions.

First, it should integrate the primary findings from the workshops more explicitly, including cross-country evidence on priority skills, training needs, and barriers.

Second, it should strengthen country-sensitive interpretation, since the reports already show different levels of market maturity and different emphasis between foundational and advanced skill needs.

Third, the report should more clearly emphasize drone competence as a combination of operational, digital, regulatory, and construction-domain knowledge, rather than focusing mainly on piloting.

Fourth, it should give greater visibility to practical implementation issues such as data workflows, BIM/GIS interoperability, trainer capacity, and construction-specific use cases in renovation, inspection, energy efficiency, and infrastructure assessment.

Fifth, the final report would benefit from clearer recommendations for WP3, including modular curriculum structure, train-the-trainer provisions, and progression from foundational to advanced competences.

5.2. Improvement of the strategic report

The strongest common conclusion is that the strategic report is relevant and technically strong, and that it now requires only limited revision to better reflect validated workshop evidence. Italy expressed the strongest need for evidence-based strengthening, while Spain and North Macedonia asked for a more realistic and practical implementation logic. Greece and Germany did not call for major conceptual changes, but rather for clearer practical examples, target-group differentiation, stronger attention to national readiness conditions, and a more explicit staged progression from basic to advanced competence development.

Spain and North Macedonia supported this need for refinement from a different angle. Spain accepted the report's direction, but stressed that the implementation logic and timeline should be more realistic, more gradual, and more responsive to different levels of digital maturity.

North Macedonia broadly validated the existing priorities but asked for stronger practical orientation, more visible engineering use cases, clearer staged pathways, and a closer link between drone operation and real construction decision-making.

The strategic report should place stronger emphasis on the fact that, in some national contexts, such as Germany, organisations are still at a relatively early stage of drone readiness. The report should therefore more clearly distinguish between foundational awareness and advanced digital workflow competences, and it should offer a staged progression model rather than assuming that organisations are ready for higher-level BIM-integrated or innovation-oriented applications from the outset.

Overall, Greek participants considered the strategic report to be a strong foundation for the development of the Drone4Build Competency Framework and training curriculum and confirmed that the identified skills gaps and training priorities are highly relevant to current and future market needs in Greece.

5.3. Proposed improvements

Based on the workshop conclusions, the strategic report should be improved through the minimum necessary interventions rather than a revised overall structure. In practical terms, the final A2.1 report should include a concise synthesis of national workshop evidence, a short cross-country maturity note, a more explicit prioritisation of foundational versus advanced skills, and clearer links between validated findings and the next curriculum-development steps.

It would also be beneficial to make the report slightly more explicit about immediate, medium-term, and longer-term workforce needs, since the workshops show that countries and target groups are not all ready for the same level of sophistication at the same time. The final version should therefore present the roadmap as a differentiated progression rather than a single linear model, but without changing the overall architecture of the strategic report.

The workshop conclusions support the following specific improvements to the A2.1 strategic report.

Table 2: Proposed specific improvements to the strategic report on drone use

Improvement area	What the workshops suggest	Implication for revising A2.1
Primary evidence integration	Workshop data should now be integrated with the additional findings from Greece and Germany, including validated priorities, barriers, and readiness differences.	Insert a concise evidence update in A2.1 summarising cross-country validation, without changing the report structure.
Country-sensitive analysis	National ecosystems differ in maturity, operational practice, and training readiness, but the existing structure can already accommodate this.	Update the country-sensitive interpretation with short references to SME constraints in Greece, foundational readiness gaps in Germany, and comparative maturity differences across the five countries.

Implementation realism	The roadmap should acknowledge that not all countries and target groups are ready for the same level of digital sophistication at the same time.	Adjust the wording of the roadmap to make progression from foundational to advanced competences more explicit.
Practical construction relevance	Stakeholders want more explicit use cases and links to reporting, inspection, renovation, safety planning, and site operations.	Add a limited number of practical examples and references to reporting and site-based decision-making.
Trainer readiness	Weak trainer preparation remains a recurrent concern across several countries and is clearly reinforced by Spain, Germany, Greece, and North Macedonia.	Add a short trainer-capacity note linking validated findings to curriculum delivery and train-the-trainer needs.

Discussion of identified drone skills gaps and priorities

6. Discussion of identified drone skills gaps and priorities

6.1. Main skills gaps

The available workshop reports strongly confirm the skills gap domains already identified in the strategic report, especially in operational and flight skills, technical and sensor knowledge, data processing, BIM/GIS and digital workflow integration, and business/organisational hybrid competences. The findings from all five countries further clarify the need to distinguish between foundational readiness gaps and higher-level integration gaps.

The evidence suggests that the most urgent gaps are often transition gaps between simple drone use and effective professional integration in construction workflows. At the same time, Germany makes clear that in some contexts basic awareness and use-case understanding are still real needs, while Greece shows that practical reporting, quality assurance, and role-sensitive progression are necessary to move from use to value creation.

Table 3: Consolidated gap domains

Gap domain	Evidence from workshops	Consolidated interpretation
Operational and flight skills	Advanced piloting, mission planning, flight preparation, risk assessment, and safety were repeatedly prioritised	Basic piloting is not enough; the sector needs operation-ready competence for dynamic construction environments
Technical and sensor knowledge	Participants highlighted drone types, payloads, sensors, maintenance, and equipment selection as important but underdeveloped	Training must cover platform selection, sensor suitability, accuracy, and maintenance for construction-specific use cases

Data processing and interpretation	One of the clearest weaknesses in all reports, especially post-processing, interpretation, and transformation of outputs into usable project information	This is the main bottleneck between drone flights and real construction value creation
BIM/GIS and digital workflow integration	Repeatedly highlighted in Spain, Italy, and North Macedonia as weak, important, and still underdeveloped	Digital integration is a core priority because, without it, drone data remains isolated and underused
Regulatory, safety, and compliance skills	Regulation, permits, SORA-related logic, safety, GDPR, and legal responsibilities were repeatedly mentioned	Compliance must remain a mandatory core domain in any future training programme
Construction-specific domain knowledge	Stakeholders noted gaps in inspection methodologies, pathology detection, rehabilitation works, site safety, and interpretation for engineering decisions	Drone competence must be contextualised in actual construction and renovation tasks, not taught as a generic aviation skill
Trainer capacity	Spain and North Macedonia both questioned whether current trainers are sufficiently prepared, and Italy called for a dedicated trainer competency profile	Educator upskilling is itself a strategic gap and requires a dedicated programme
Hybrid and organisational skills	Communication, project planning, teamwork, business case development, and interdisciplinary coordination emerged directly or indirectly in the reports	The sector needs hybrid professionals who can connect technical operations with organisational adoption and project management

6.2. Implications for curriculum development

The five country reports point clearly toward a curriculum architecture that is modular, blended, and strongly practice-based. A common core should cover piloting, mission planning, safety, aviation regulation, sensors, data collection, photogrammetry, reporting, and post-processing, while advanced modules should address BIM/GIS, AI-assisted analytics, digital twins, cybersecurity, quality assurance, construction-specific inspection workflows, and sector-specific renovation use cases.

The findings also support the development of differentiated learning pathways. Countries and target groups with lower maturity may need introductory and applied modules focused on confidence-building and basic operational competence, while more advanced ecosystems may be ready for deeper content on interoperability, automation, AI, and specialised regulatory workflows.

In parallel, trainer capacity-building should be treated as a strategic line of action, not a secondary add-on, because several reports identify educators' preparedness as a bottleneck for implementation quality. Therefore, the Train-the-Trainer Special programe will be developed and implemented in the frame of WP4.

Country sections

7. Country sections

7.1. Italy

The Italian workshop, organised by IIPLE in Bologna on 26 May 2026, brought together 22 participants in an onsite format and produced a highly analytical review of the strategic report. The report strongly validated the overall direction of the strategic work, especially its treatment of drone use as a holistic digital construction competency, while also arguing that the document needs to move from proposal-style language to a more final, evidence-based and country-sensitive strategic document.

The Italian participants emphasised regulatory complexity, poor data lifecycle management, weak workflow redesign, and the need for interdisciplinary training structures. They also provided clear recommendations for revision, such as including actual stakeholder data, adding national ecosystem comparisons, clarifying ROI and business cases for SMEs, and expanding direct recommendations for WP3 curriculum design.

7.2. Spain

The Spanish workshop, organised online by Fundación Laboral de la Construcción in Madrid on 27 May 2026, gathered 40 participants and generated the largest available evidence base among the current reports. It confirmed that drones are increasingly valued in construction, but stressed that their effective use depends on digital integration, hybrid professional profiles, stronger trainer capability, and modular practical training approaches.

Spain placed strong emphasis on BIM/GIS integration, data interpretation, AI, digital workflows, cybersecurity, environmental constraints, and more realistic implementation pacing. It also highlighted the need for flexible continuing training and train-the-trainer measures, making the Spanish report particularly important for shaping curriculum architecture and delivery methodology.

7.3. North Macedonia

The North Macedonian workshop, organised by K&S in Skopje on 27 May 2026, recorded 21 participants and offered useful evidence from a context where drone use in engineering appears less mature. The workshop showed that many participants still do not use drones in their work, but it also provided clear priorities regarding the skills and conditions needed to increase uptake in practice.

The strongest messages from North Macedonia concern the need for practical hands-on training, stronger attention to engineering interpretation of outputs, better data processing capacity, clearer use-case examples, and more confidence in trainer preparedness. This report is especially valuable for understanding entry-level barriers and foundational curriculum needs that may also be relevant in other lower-maturity environments.

7.4. Greece

The PEDMEDE face-to-face stakeholder engagement workshop held on 28 April 2026 with 16 participants confirmed the overall relevance and usefulness of the WP2 strategic report on drone skills. Participants validated the main skill areas and confirmed that drone-related competences are increasingly relevant for construction and renovation, particularly for inspection, monitoring, documentation and safety-related applications.

The Hellenic Drones stakeholder engagement workshop, held on 15 May 2026 with 15 participants, confirmed the overall relevance of the WP2 Strategic Report on Drone Skills and validated the key findings related to the use of drones in the construction and renovation sector. Participants agreed that drones are increasingly being recognized as valuable tools for inspections, surveying, progress monitoring and documentation activities, particularly in situations where safety, accessibility and efficiency are critical.

In both workshops, the discussions highlighted that the main challenge is no longer the operation of drones themselves, but the ability to transform collected data into actionable information that supports construction decision-making. Participants identified data processing, photogrammetry, BIM/GIS integration, regulatory compliance, and construction-specific operational planning as priority areas for future training. They also stressed the need for practical, modular and role-based learning pathways tailored to the realities of SMEs and construction professionals with limited prior experience in drone technologies.

Overall, participants considered the strategic report to be a strong foundation for the development of the Drone4Build Competency Framework and training curriculum and confirmed that the identified skills gaps and training priorities are highly relevant to current and future market needs in Greece.

7.5. Germany

The German validation workshop held on 18 and 22 June 2026 confirms that drone-related competences are relevant to the construction sector, but it also shows that many organisations are still at an early stage of adoption and capability development. Participants prioritised foundational knowledge on drone types, use cases and regulations before more advanced technical or data-processing competences. The results also reveal weak organisational readiness and very limited confidence in trainer preparedness, which means that the future Drone4Build curriculum should follow a staged, practical and highly accessible progression model in the German context.

Recommendations for curriculum development: The future curriculum for Germany should begin with practice-oriented introductory content on what drones are, where they can be used in construction, and what value they can create in concrete use cases. The next step should cover legal and regulatory obligations, followed by interpretation of drone data, and only then more advanced topics such as specialised sensors, BIM-related processing or further digital workflows. A train-the-trainer element is also recommended, given the very low confidence score regarding teaching staff preparedness to deliver digital competences related to drones.

7.6. Skills priorities validated by the workshops

The workshops not only identified gaps but also clarified which competences should be treated as top priorities for the consortium's training response.

Italy framed these priorities at a systemic level, insisting that future skills models must integrate technical, digital, regulatory and soft skills into one unified, construction-oriented competence system.

Spain highlighted regulations, safe piloting, risk management, BIM/GIS, data interpretation, photogrammetry, operational planning, hybrid profiles and cybersecurity as essential priority areas.

North Macedonia prioritised piloting, mission planning, safety, drone types and sensors, photogrammetry, and practical work with drones, while also highlighting engineering interpretation and data analysis as important weak points.

Greece added strong validation for construction-site drone operation and safety planning, sensor selection and data capture, regulatory and privacy compliance, and the communication of findings through practical technical reports, while highlighting applied data interpretation, BIM/GIS integration, quality assurance, and trainer capacity as weaker areas.

Germany highlighted basic drone knowledge, legal and regulatory framework conditions, and data interpretation as the most immediate priorities, while indicating that advanced processing and technical specialisation should follow later in the learning pathway.

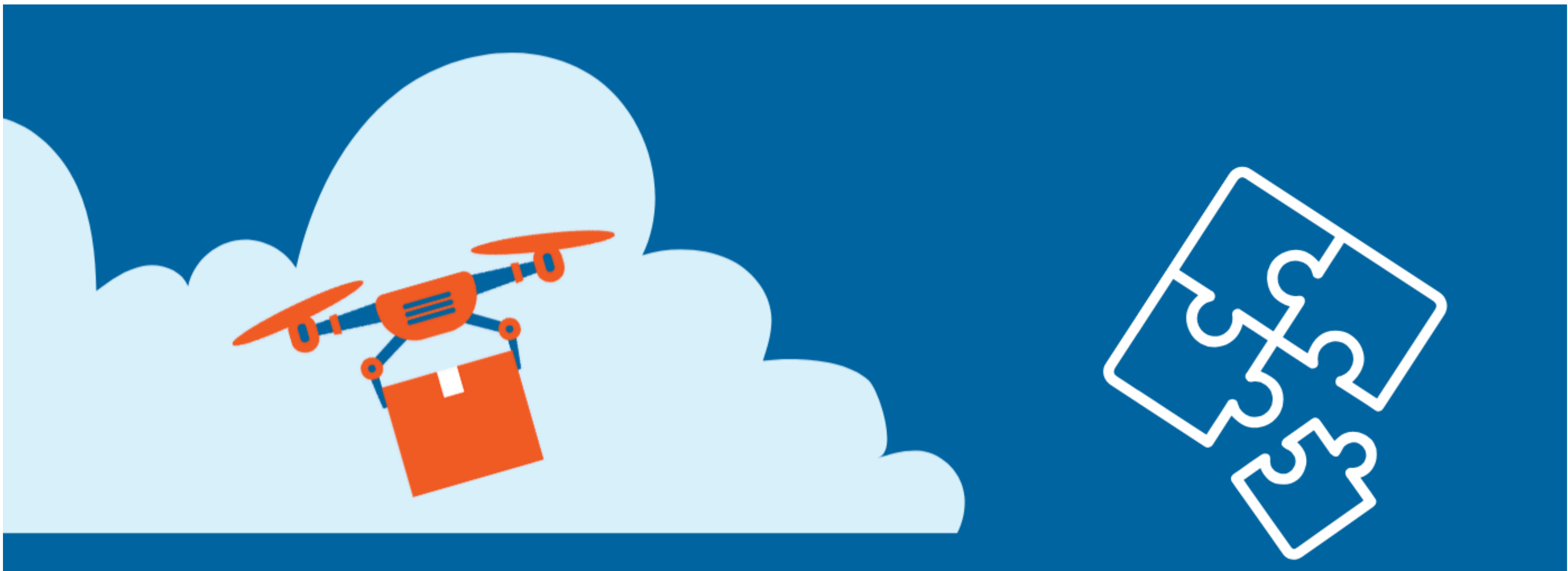
Taken together, the workshop evidence suggests that the consortium should prioritise four clusters:

- safe and compliant operations,
- digital data workflows,
- construction-domain applications, and
- trainer/hybrid capability development.

Table 4: Comparative maturity table - covering maturity level, priority skills, readiness gap and curriculum entry

Country	Maturity level	Priority skills	Readiness gap	Curriculum entry point
Italy	Medium to advanced	Interdisciplinary competence, regulatory compliance, data lifecycle management, workflow redesign, ROI/business cases	Need to move from literature-driven understanding to more evidence-based and country-specific implementation	Start with advanced foundational analysis, then move to workflow integration and business-case-oriented modules
Spain	Medium to	BIM/GIS	Stronger	Start with

Country	Maturity level	Priority skills	Readiness gap	Curriculum entry point
	advanced	integration, data interpretation, AI, digital workflows, cybersecurity, hybrid profiles, train-the-trainer	implementation pacing and trainer capability are needed; digital integration remains a key bottleneck	modular applied training, then progress to digital workflows and advanced integration
North Macedonia	Low to medium	Piloting, mission planning, safety, drone types and sensors, photogrammetry, engineering interpretation	Basic adoption is still limited; practical barriers and confidence gaps remain high	Start with introductory, hands-on modules focused on awareness, basic operation, and practical use cases
Greece	Medium	Inspection, monitoring, documentation, reporting, photogrammetry, BIM/GIS integration, compliance, role-based training	Main gap is turning drone data into actionable construction intelligence; SME readiness and trainer capacity also need strengthening	Start with applied construction-site use, then progress to reporting, data processing, and BIM/GIS integration
Germany	Low to medium	Basic drone knowledge, use cases, regulations, data interpretation, staged progression, trainer readiness	Organisations show early-stage readiness and very limited confidence in trainer preparedness	Start with introductory awareness and legal/regulatory basics before advanced data workflows



Proposed modular training programme

8. Proposed modular training programme

8.1. Design principles

The workshop conclusions support a curriculum model that is modular, progression-based, and flexible enough to respond to different levels of prior knowledge and national maturity. Rather than proposing one single course for all audiences, the findings suggest a modular architecture that can converge toward four differentiated training programmes serving different profiles and levels of complexity.

This structure is also consistent with the logic of the strategic report, which distinguishes immediate, medium-term, and longer-term workforce development needs and emphasises the importance of hybrid drone-data-BIM roles, advanced digital integration, and train-the-trainer capacity-building. A modular approach, therefore, enables the project to create common building blocks while still producing differentiated learning pathways.

8.2. Proposed Modular Drone Training Programme for Construction and Renovation

This modular programme translates the validated findings from the five national workshops into four training topics, each consisting of a basic (X.1) and advanced (X.2) module. It builds on the original proposal while strengthening staged progression, construction-site relevance, data processing, BIM/GIS integration and trainer capacity, in line with the curriculum needs identified in Italy, Spain, North Macedonia, Greece and Germany.

8.2.1. Topic 1. Foundations of Drone Operations for Construction and Renovation

Module 1.1 – Basic Drone Systems, Use Cases and Sensors in Construction

- **Learning focus:** core drone components, platform types, basic payloads and sensors; typical construction and renovation use cases (site inspection, roof and façade assessment, progress photos, simple surveying); basic limitations and suitability of drones for different tasks.
- **Target groups:** construction workers, site technicians, supervisors, managers needing operational awareness.

Module 1.2 – Advanced Safe Piloting, Mission Planning and Regulatory Compliance

- **Learning focus:** pre-flight planning, site-specific risk assessment, emergency procedures, GNSS and environmental constraints, flight in active construction environments, European and national rules (EASA categories, local permits, privacy, insurance and liability), role-specific responsibilities.
- **Target groups:** operational drone users in construction, safety coordinators, company representatives responsible for compliance.

8.2.2. Topic 2. Drone-Based Inspection and Energy-Renovation Applications

Module 2.1 – Basic Building Inspection and Defect Detection Using Drones

- **Learning focus:** planning and executing façade and roof inspections, documenting existing conditions, progress monitoring and measurement support; simple defect detection methods; preparation of clear, practical technical reports for engineers, contractors and clients.
- **Target groups:** inspectors, site managers, engineers, SME contractors starting to use drones for inspection tasks.

Module 2.2 – Advanced Thermography and Energy Performance Assessment

- **Learning focus:** thermal imaging principles, configuration of thermographic payloads, detection of thermal bridges and envelope defects, energy-efficiency diagnostics, inspection of PV installations, case studies for renovation and climate-mitigation strategies.
- **Target groups:** energy-audit specialists, retrofit teams, consultants working on renovation and building-pathology analysis.

8.2.3. Topic 3. Drone Data Processing, BIM/GIS Integration and Digital Construction Workflows

Module 3.1 – Basic Photogrammetry, Mapping, Quality Checks and Reporting Outputs

- **Learning focus:** image management, creation of orthomosaics, point clouds and simple 3D models; basic quality-control principles; exporting and using outputs in reports, drawings and simple decision-support tools.

- **Target groups:** operational users responsible for data capture and first-level processing, technicians supporting engineers and site managers.

Module 3.2 – Advanced BIM/GIS Integration and Digital Construction Workflows

- **Learning focus:** importing drone data into BIM and GIS environments, model alignment and georeferencing, interoperability between tools, collaborative data workflows, advanced analytics (including selected AI-assisted methods), and using processed outputs for planning, supervision and asset management. Attention is given to cybersecurity, data protection, and quality assurance of digital deliverables.
- **Target groups:** BIM/GIS specialists, digital construction profiles, engineers and project managers in more digitally mature organisations.

8.2.4. Topic 4. Advanced Drone Applications for Sustainable Construction

Module 4.1 – AI-Assisted Inspection and Emerging Technologies

- **Learning focus:** To prepare learners to implement drone-enabled innovation strategies supporting sustainable construction and renovation projects.
- **Target groups:** VET trainers, in-company trainers, experienced practitioners beginning to teach drone use in construction.

Module 4.2 – Drone Project Management for Sustainable Renovation

- **Learning focus:** design of progression paths from foundational to advanced topics, use of simulators and case-based learning, updating content for emerging technologies (AI-assisted inspection, U-space, digital twins), and establishing quality-assurance mechanisms for training provision.
- **Target groups:** lead trainers, programme coordinators, institutions responsible for maintaining and updating Drone4Build training offers.

8.2.5. SPECIAL Topic. Train-the-Trainer and Programme Delivery for Drone Skills in Construction

Module T.1 – Basic Trainer Readiness and Pedagogical Foundations

- **Learning focus:** trainer roles and competencies, didactic strategies for mixed-experience groups, design of short modular sessions, supervision of practical exercises, safety management during training flights, and assessment of basic operational and compliance skills.
- **Target groups:** VET trainers, in-company trainers, experienced practitioners beginning to teach drone use in construction.

Module T.2 – Advanced Curriculum Integration, Innovation Topics and Quality Assurance

- **Learning focus:** integration of drone modules into broader construction curricula, design of progression paths from foundational to advanced topics, use of simulators and case-based learning, updating content for emerging technologies (AI-assisted inspection, U-space, digital twins), and establishing quality-assurance mechanisms for training provision.
- **Target groups:** lead trainers, programme coordinators, institutions responsible for maintaining and updating Drone4Build training offers.

8.3. Recommended programme architecture

The four proposed programmes should not be treated as isolated courses, but as interconnected pathways that share modules, recognition logic, and progression routes. A learner may start in Programme 1 and move toward Programme 2 or Programme 3, while experienced practitioners or teachers may enter directly into Programme 4 depending on prior competence and professional role.

Table 5: Recommended architecture of the training program

Programme	Target group	Main emphasis	Typical maturity level
Programme 1: Foundations of Drone Operations for Construction and Renovation	Construction workers, site technicians, entry-level drone users, and managers needing operational awareness	Basic and advanced safe operations, practical field use, sensors, regulation, and construction-site mission planning	Foundational to lower-intermediate
Programme 2: Drone-Based Building Inspection and Energy Assessment	Inspectors, retrofit teams, engineers, technical specialists	Basic and advanced inspection workflows, defect detection, thermography, energy diagnostics support, and reporting	Intermediate
Programme 3: Drone Data Processing, BIM/GIS and Digital Construction Workflows	Drone users, data staff, BIM/GIS-oriented, and digital construction profiles	Basic and advanced post-processing, photogrammetry, quality assurance, BIM/GIS integration, and digital workflows	Intermediate to advanced
Programme 4: Advanced Drone Applications for Sustainable Construction	VET trainers, in-company trainers, experienced practitioners beginning to teach drone use in construction	Hybrid professional profiles, AI-supported defect detection, digital twins, future workforce requirements, business implementation skills	Advanced
SPECIAL Programme: Train-the-Trainer and Programme Delivery for Drone Skills in Construction (aiming to be developed in separate WP4)	VET trainers, institutional trainers, master trainers, internal company trainers	Basic and advanced trainer preparation, pedagogy, demonstration, assessment, curriculum integration, and technical updating	Cross-level

Across the four topics, the programme can be implemented as separate short courses or combined into longer pathways adapted to national maturity levels. Countries with lower current adoption, such as North Macedonia and Germany, may initially focus on Modules 1.1–1.2, 2.1 and 4.1, while contexts with stronger digital readiness, such as Italy and Spain, can progressively incorporate Modules 2.2, 3.2 and 4.2. Greece provides a strong reference for role-based sequencing and SME-accessible short modules.

8.4. Implications for next WP2, WP3 and WP4 steps

The workshop conclusions indicate that the consortium should use this integrated report as the immediate basis for finalising A2.1 and structuring WP3 curriculum development. The next step is to update A2.1 with the validated workshop evidence, clarify skills priorities and maturity differences, and make the progression logic more practical and explicit without changing the overall structure of the strategic report.

Once this revision is made, the proposed four-programme modular architecture can provide a strong basis for the Drone Competency Framework and the WP3 curriculum phase. The implications are also reflect on the WP4 for the development of the train-the-trainer programme

Table 6: Proposed four-programme modular training programme

COURSE 1	**Foundations of Drone Operations for Construction and Renovation**	
	Learning objective: *To enable construction professionals to safely operate drones and select appropriate platforms and sensors for construction, renovation, and inspection activities.*	
	WP2 Link:	Operational and flight skills gap, technical and sensor knowledge gap, regulatory compliance requirements, need for a standardised curriculum for construction drone technicians
	Module 1.1 Basic Drone Systems, Use Cases and Sensors in Construction	
	Module 1.2 - Advanced Safe Drone Piloting, Mission Planning and Regulatory Compliance	
COURSE 2	Drone-Based Building Inspection and Energy Assessment	
	Learning Objective: To equip learners with practical competencies to perform drone-assisted building inspections supporting renovation and climate mitigation strategies.	

	WP2 Link:	Façade assessment, building envelope diagnostics, thermal imaging, energy efficiency audits, renovation applications
	Module 2.1 - Building Inspection and Defect Detection Using Drones	
	Module 2.2 - Advanced Thermography and Energy Performance Assessment	
COURSE 3	Drone Data Processing, BIM/GIS and Digital Construction Workflows	
	Learning Objective: To develop learners' capacity to convert drone data into digital assets supporting renovation and construction management.	
	WP2 Link:	*Data acquisition is happening, but organisations lack the skills to transform drone data into actionable BIM-integrated outputs.*
	Module 3.1 - Photogrammetry, Mapping and 3D Modelling and Quality Checks	
	Module 3.2 – BIM/GIS Integration and Digital Construction Workflows	
COURSE 4	Advanced Drone Applications for Sustainable Construction	
	Learning Objective: To prepare learners to implement drone-enabled innovation strategies supporting sustainable construction and renovation projects.	
	WP2 Link:	*Hybrid professional profiles, AI-supported defect detection, digital twins, future workforce requirements, business implementation skills*
	Module 4.1 - Photogrammetry, Mapping and 3D Modelling and Quality Checks	
	Module 4.2 – BIM/GIS Integration and Digital Construction Workflows	
SPECIAL COURSE for Train-the-Trainer (to be developed in WP4)	Train-the-Trainer and Programme Delivery for Drone Skills in Construction	
	Learning Objective: To prepare trainers to implement drone-related training programs, didactic strategies for mixed-experience groups, and for integration of drone modules into broader construction curricula, design of progression paths from foundational to advanced topics, use of simulators and case-based learning, updating content for emerging technologies	
	WP2 Link:	Development of trainers' professional profiles and capabilities, AI-supported defect detection, digital twins, future workforce requirements, business implementation skills
	Module T.1 - Basic Trainer Readiness and Pedagogical Foundations	
	Module T.2 - Advanced Curriculum Integration, Innovation Topics and Quality Assurance	

This approach allows the consortium to address foundational workforce needs, digital workflow integration, construction-specific applications, and trainer capacity-building in a coherent structure aligned with both stakeholder conclusions and the project's broader objective of supporting digital transformation in construction and renovation.

9. Conclusion

The stakeholder engagement workshops completed so far provide strong preliminary validation for the strategic direction of DRONE4BUILD WP2, while also offering practical evidence on how the strategic report should be strengthened before finalisation.

Across Italy, Spain, North Macedonia, Greece, and Germany, participants consistently confirmed the need for a broader understanding of drone competence that combines operational, digital, regulatory, and construction-specific knowledge, alongside modular and practice-oriented training approaches.

At the same time, the country reports clearly show that the consortium should finalise the strategic report only after incorporating workshop-based evidence, country-sensitive interpretation, clearer implementation recommendations, and stronger guidance for curriculum development and trainer capacity-building. This consolidated report should therefore be treated as the final integrated synthesis based on the five available national workshop reports.

Glossary

Abbreviation/ Term	Full Form/Definition
A2.1	Activity 2.1 – Strategic Technology Roadmap for Drone Skills
A2.2	Activity 2.2 - Stakeholder Engagement Workshops for Validation of the Strategic Technology Roadmap
AI	**Artificial Intelligence:** Technology that enables computer systems to perform tasks that typically require human intelligence, such as image recognition, anomaly detection, data analysis, and decision support. In drone applications, AI supports automated inspection, object detection, and predictive analytics.
ARC	**Air Risk Class**: A parameter within the SORA methodology that characterises the level of risk a drone operation poses to other aircraft, based on the operational environment and flight characteristics.
BBSN	Bau Bildung Sachsen, Germany (Drone4Build Consortium partner)
BIM	**Building Information Modelling**: A digital process for creating, managing, and sharing information about a built asset throughout its lifecycle. BIM integrates geometric, physical, and functional information to support planning, design, construction, renovation, and maintenance.
BVLOS	**Beyond Visual Line of Sight**: A category of drone operation in which the remote pilot cannot maintain unaided visual contact with the aircraft. Under EASA regulations, BVLOS operations generally require authorisation in the Specific category.
Digital Twin	A dynamic digital representation of a physical asset, process, or environment that is continuously updated using real-world data. In construction, digital twins combine drone data, BIM models, IoT sensors, and other digital information to support monitoring and decision-making.
DigComp	The European Digital Competence Framework for Citizens developed by the European Commission.
DRONE4BUILD	Elevating the knowledge of construction professionals on the use of drones in construction (project acronym)
DSM	**Digital Surface Model:** A georeferenced elevation model representing the terrain surface together with above-ground

	objects such as buildings, vegetation, and infrastructure, commonly generated from drone surveys.
DTM	Digital Terrain Model
EACEA	European Education and Culture Executive Agency
EASA	**European Union Aviation Safety Agency:** The European agency responsible for civil aviation safety, including the development and implementation of regulations governing unmanned aircraft systems (UAS).
ESCO	**European Skills, Competences, Qualifications and Occupations**: The European multilingual classification system developed by the European Commission that describes occupations, skills, competences, and qualifications to support education, employment, and labour market mobility.
EQF	**European Qualifications Framework**: A common European reference framework consisting of eight qualification levels that enables comparison of qualifications across European education and training systems.
EU	European Union
FLC	FUNDACION LABORAL DE LA CONSTRUCCION (Drone4Build Consortium partner)
GDPR	**General Data Protection Regulation**: Regulation (EU) 2016/679 governing the collection, processing, storage, and protection of personal data within the European Union.
GeoBIM	The integration of geospatial information with Building Information Modelling to combine geographic context with building-scale digital models for planning, analysis, and asset management.
GIS	**Geographic Information System:** A system used to capture, manage, analyse, and visualise geospatial information to support planning, monitoring, and decision-making.
GNSS	Global Navigation Satellite System
GRC	**Ground Risk Class**: A parameter within the SORA methodology describing the level of risk a drone operation poses to people on the ground.
GSD	Ground Sample Distance
IIPLE	ISTITUTO PER L' ISTRUZIONE PROFESSIONALE DEI LAVORATORI EDILI DELLA PROVINCIA DI BOLOGNA
KA220-VET	Erasmus+ Cooperation Partnerships in Vocational Education and Training

K&S	Knowledge and skills management centre K&S Skopje (Drone4Build Consortium partner)
IFC	**Industry Foundation Classes**: An open and standardised data format that enables interoperability and information exchange between different BIM software platforms.
IMU	**Inertial Measurement Unit**: An onboard sensor that measures acceleration, angular velocity, and orientation to support drone stabilisation, navigation, and flight control.
KSA Model	The Knowledge–Skills–Attitudes model used in competence frameworks to describe what individuals know, what they are able to do, and the behaviours or attitudes they demonstrate in professional practice.
LiDAR	**Light Detection and Ranging:** A remote sensing technology that uses laser pulses to measure distances and generate highly accurate three-dimensional representations of objects and terrain.
Orthomosaic	A geometrically corrected aerial image created by combining multiple overlapping photographs into a single map with uniform scale and geographic accuracy.
PEDMEDE	PANHELLENIC ASSOCIATION OF ENGINEERS CONTRACTORS OF PUBLIC WORKS (Drone4build Consortium partner)
Photogrammetry	The science of obtaining accurate measurements and three-dimensional information from overlapping photographs captured by drones or other imaging systems.
Point Cloud	A dense collection of three-dimensional points generated through photogrammetry or LiDAR that accurately represents the geometry of physical objects or environments.
PPK	**Post-Processed Kinematic**:A satellite positioning technique in which GNSS data are corrected after the flight to improve the positional accuracy of drone survey data.
PV	Photovoltaic
RGB	Red, Green, Blue (visible-spectrum imaging)
Remote ID	A digital identification system that enables drones to broadcast information such as their identity, location, altitude, and operator details to support safety, security, and regulatory compliance.
ROI	**Return on Investment**: A financial performance indicator used to evaluate the benefits or value generated by an investment relative to its cost.

RTK	**Real-Time Kinematic**: A high-precision GNSS positioning technique that provides real-time centimetre-level accuracy for drone surveying and mapping operations.
SME	Small and Medium-sized Enterprise
SORA	**Specific Operations Risk Assessment**: A standardised risk assessment methodology developed by JARUS and adopted by EASA to evaluate and mitigate the operational risks of drone flights conducted in the Specific category.
Thermal Imaging (Thermography)	A sensing technique that detects infrared radiation emitted by objects to visualise temperature differences. In construction, it is commonly used to identify heat loss, moisture intrusion, insulation defects, and other building performance issues.
UAS	Unmanned Aircraft System
U-SPACE	A set of digital services and procedures designed to support the safe, secure, and efficient integration of drones into shared airspace, particularly in areas with high traffic density.
USSP	**U-space Service Provider**: An organisation certified to provide U-space services, including digital flight authorisation, traffic information, conformance monitoring, and other services supporting drone operations.
VET	Vocational Education and Training
VLOS	**Visual Line of Sight**: A category of drone operation in which the remote pilot maintains continuous unaided visual contact with the aircraft throughout the flight to ensure safe operation.
VR	**Virtual Reality**: A fully immersive digital environment used for training and simulation. In drone education, VR enables learners to practise flight operations and mission scenarios safely before conducting real-world flights.
VTOL	Vertical Take-Off and Landing
WP2	Work Package 2 – Digital Skills Ecosystem for Drones
WP3	Work Package 3 – Curriculum and Training Programme Development
XR	**Extended Reality**: An umbrella term that includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). In drone training, XR supports realistic simulation and practical skill development in safe learning environments.

ANNEX

Proposed Modular Drone Training Programme for Construction and Renovation

This modular programme translates the validated findings from the five national workshops into four training topics, each consisting of a basic (X.1) and advanced (X.2) module. It builds on the original proposal while strengthening staged progression, construction-site relevance, data processing, BIM/GIS integration and trainer capacity, in line with the curriculum needs identified in Italy, Spain, North Macedonia, Greece and Germany.

Topic 1. Foundations of Drone Operations for Construction and Renovation

Module 1.1 – Basic Drone Systems, Use Cases and Sensors in Construction

- **Learning focus:** core drone components, platform types, basic payloads and sensors; typical construction and renovation use cases (site inspection, roof and façade assessment, progress photos, simple surveying); basic limitations and suitability of drones for different tasks.
- **Target groups:** construction workers, site technicians, supervisors, managers needing operational awareness.

Proposed learning units

1. UAS fundamentals and flight principles (components, control, basic flight stability in construction contexts).
2. Types of Drones Used in Construction. Platform types and suitability for renovation, inspection and monitoring (multirotor, fixed-wing, VTOL).
3. Payloads and sensors for building applications (RGB, thermal, LiDAR, GNSS; matching to tasks).
4. Operational limitations and safe envelopes (weather, endurance, payload, airspace around sites).
5. Equipment Maintenance and Safety Checks (batteries, calibration, inspections, storage).

Expected learning outcomes

After Module 1.1, participants should be able to:

1. Describe the main components of a construction-relevant UAS and explain how they interact to enable controlled flight.
2. Compare common drone platform types and justify a suitable choice for specific renovation or inspection tasks.
3. Select appropriate sensors and payloads for visual inspection, thermal assessment and basic building surveying.
4. Perform basic maintenance and pre-operational checks that support safe and reliable site operations.
5. Judge, at a basic level, when drone use is technically appropriate or unsuitable for a given construction or energy-renovation scenario.

Module 1.2 - Advanced Safe Piloting, Mission Planning and Regulatory Compliance

- **Learning focus:** pre-flight planning, site-specific risk assessment, emergency procedures, GNSS and environmental constraints, flight in active construction environments, European and national rules (EASA categories, local permits, privacy, insurance and liability), role-specific responsibilities.
- **Target groups:** operational drone users in construction, safety coordinators, company representatives responsible for compliance.

Proposed learning units

1. European and national Drone Regulations (EASA categories, national specifics).
2. Flight Safety and Risk Management (hazards, bystanders, interfaces with site safety).
3. Operational mission planning and flight procedures (airspace checks, geofencing, communication on site).
4. Emergency handling and incident response (loss of control, GNSS issues, reporting).
5. Roles, responsibilities and documentation (operator vs remote pilot vs site manager; logs and records).

Expected learning outcomes

After Module 1.2, participants should be able to:

1. Interpret the core requirements of European and national drone rules relevant to construction and renovation operations.
2. Conduct a structured, site-specific risk assessment for a planned drone mission on or near a building site.
3. Prepare a basic flight plan that respects airspace restrictions, site constraints and stakeholder communication needs.
4. Apply standard operating and emergency procedures to maintain safety during typical construction-site flights.
5. Maintain appropriate operational documentation and demonstrate responsible, legally compliant decision-making in drone use.

Topic 2. Drone-Based Inspection and Energy-Renovation Applications

Module 2.1 – Basic Building Inspection and Defect Detection Using Drones

- **Learning focus:** planning and executing façade and roof inspections, documenting existing conditions, progress monitoring and measurement support; simple defect detection methods; preparation of clear, practical technical reports for engineers, contractors and clients.
- **Target groups:** inspectors, site managers, engineers, SME contractors starting to use drones for inspection tasks.

Proposed learning units

1. Building Inspection Fundamentals (durability, safety, performance).
2. Façade and roof inspection strategies using drones (coverage, stand-off, angles, paths).
3. Image capture techniques for visibility of defects (resolution, overlap, lighting, camera orientation).
4. Data organisation and traceability (filing, metadata, linking images to locations and elements).
5. Recording and Reporting Findings (structuring findings for engineers and contractors).

Expected learning outcomes

After Module 2.1, participants should be able to:

1. Define clear, task-oriented objectives for drone-based inspections of façades, roofs and external building components.
2. Plan and execute visual inspection flights that provide sufficient coverage and detail while respecting safety constraints.
3. Capture and organise image data in a way that allows specific defects and locations to be easily retrieved and referenced.
4. Recognise common visible defects and describe their potential impact on building performance and durability.
5. Produce concise, structured inspection notes that feed into formal reports and renovation decisions.

Module 2.2 – Advanced Thermography and Energy Performance Assessment

- **Learning focus:** thermal imaging principles, configuration of thermographic payloads, detection of thermal bridges and envelope defects, energy-efficiency diagnostics, inspection of PV installations, case studies for renovation and climate-mitigation strategies.
- **Target groups:** energy-audit specialists, retrofit teams, consultants working on renovation and building-pathology analysis.

Proposed learning units

1. Introduction to Termography (emissivity, reflections, thermal gradients, environmental factors, camera setup, flight timing, weather conditions).
2. Building Energy Performance (heat transfer, thermal bridges, insulation defects, air leakage, PV faults).
3. Thermal Inspection Procedures (data collection, environmental conditions, best practices).
4. Interpretation and validation of thermograms (distinguishing artefacts, cross-checking with visual data).
5. Translating thermographic evidence into renovation strategies (prioritising measures, linking to energy audits).

Expected learning outcomes

After Module 2.2, participants should be able to:

1. Operate thermal imaging equipment for building inspection purposes.
2. Interpret thermal images and identify common energy-performance deficiencies.
3. Assess the impact of detected defects on building energy efficiency.
4. Support renovation planning through evidence-based thermal assessments.
5. Recommend improvement measures contributing to reduced energy consumption and climate-change mitigation.

Topic 3. Drone Data Processing, BIM/GIS Integration and Digital Construction Workflows

Module 3.1 – Basic Photogrammetry, Mapping, Quality Checks and Reporting Outputs

- **Learning focus:** image management, creation of orthomosaics, point clouds and simple 3D models; basic quality-control principles; exporting and using outputs in reports, drawings and simple decision-support tools.
- Target groups: operational users responsible for data capture and first-level processing, technicians supporting engineers and site managers.

Proposed learning units

1. Introduction to Photogrammetry (photogrammetric concepts and acquisition planning for construction sites, GSD, overlap, patterns, ground control).
2. Processing pipelines for drone imagery (alignment, dense reconstruction, DSM/DTM generation).
3. Production of orthomosaics and 2D maps for construction and renovation use.
4. Generation and exploration of point clouds and simple 3D models.
5. Quality checks, limitations and reporting of digital products.

Expected learning outcomes

After Module 3.1, participants should be able to:

1. Design image acquisition plans suitable for photogrammetric processing in

renovation and construction contexts.

2. Use appropriate software to process drone imagery into orthomosaics, point clouds and basic 3D models.
3. Conduct simple quality checks and identify key factors affecting the accuracy and completeness of outputs.
4. Derive measurements and visual materials from processed datasets for use in drawings, reports and site communication.
5. Clearly communicate processing steps, assumptions and limitations to technical and non-technical stakeholders.

Module 3.2 – Advanced BIM/GIS Integration and Digital Construction Workflows

- **Learning focus:** importing drone data into BIM and GIS environments, model alignment and georeferencing, interoperability between tools, collaborative data workflows, advanced analytics (including selected AI-assisted methods), and using processed outputs for planning, supervision and asset management. Attention is given to cybersecurity, data protection and quality assurance of digital deliverables.
- **Target groups:** BIM/GIS specialists, digital construction profiles, engineers and project managers in more digitally mature organisations.

Proposed learning units

1. BIM and GIS in renovation and asset management (coordination, analysis, documentation).
2. Drone data outputs in BIM/GIS tools (formats, coordinate systems, registration).
3. Digital Twins (comparing design models with as-is conditions using drone-derived data, progress checks, deviations, clashes).
4. Collaborative digital workflows and common data environments (sharing, versioning, commenting).
5. Data protection, cybersecurity and quality assurance of digital deliverables.

Expected learning outcomes

After Module 3.2, participants should be able to:

1. Explain the role of BIM and GIS environments and digital twins in modern construction and renovation projects.

2. Integrate drone-generated information into BIM-based workflows.

3. Compare planned and existing building conditions using digital models.
4. Collaborate effectively within digital construction environments.
5. Apply basic data protection, cybersecurity and quality assurance principles when managing drone related digital information

Topic 4. Advanced Drone Applications for Sustainable Construction

Module 4.1 – Basic Trainer Readiness and Pedagogical Foundations

- **Learning focus:** trainer roles and competencies, didactic strategies for mixed-experience groups, design of short modular sessions, supervision of practical exercises, safety management during training flights, and assessment of basic operational and compliance skills.
- **Target groups:** VET trainers, in-company trainers, experienced practitioners beginning to teach drone use in construction.

Proposed learning units

1. Introduction to Artificial Intelligence (AI) in Construction
2. AI-Based Building Defect Detection
3. Automated Analysis of Drone Data
4. Emerging Drone Technologies

Expected learning outcomes

After Module 4.1, participants should be able to:

1. Explain how Artificial Intelligence (AI) and Machine Learning (ML) can support drone-based building inspections.
2. Interpret outputs generated by AI-assisted inspection tools and evaluate their reliability.
3. Identify opportunities and limitations associated with automated defect detection systems.
4. Assess the potential benefits of emerging drone technologies for construction, renovation and maintenance activities.
5. Recognise future digital competence requirements associated with increasingly automated construction workflows.

Module 4.2 – Advanced Curriculum Integration, Innovation Topics and Quality Assurance

- **Learning focus:** integration of drone modules into broader construction curricula, design of progression paths from foundational to advanced topics, use of simulators and case-based learning, updating content for emerging technologies (AI-assisted inspection, U-space, digital twins), and establishing quality-assurance mechanisms for training provision.
- **Target groups:** lead trainers, programme coordinators, institutions responsible for maintaining and updating Drone4Build training offers.

Proposed learning units

1. Planning Drone Operations in Construction Projects
2. Economic and Organisational Aspects
3. Data Management and Governance
4. Drones for Sustainable Renovation
5. Climate Change Mitigation and Sustainability

Expected learning outcomes

After Module 4.2, participants should be able to:

1. Plan drone-assisted activities that support construction, maintenance and renovation projects.
2. Evaluate the operational, economic and organisational requirements of drone implementation.
3. Manage inspection data and project documentation according to professional and legal requirements.
4. Assess how drone technologies can contribute to energy-efficiency improvements and sustainable renovation practices.
5. Develop drone-based project proposals that support climate-change mitigation and building performance objectives.

Special Topic. Train-the-Trainer and Programme Delivery for Drone Skills in Construction

Module T.1 – Basic Trainer Readiness and Pedagogical Foundations

- **Learning focus:** trainer roles and competencies, didactic strategies for mixed-experience groups, design of short modular sessions, supervision of practical exercises, safety management during training flights, and assessment of basic operational and compliance skills.
- **Target groups:** VET trainers, in-company trainers, experienced practitioners beginning to teach drone use in construction.

Proposed learning units

1. Trainer roles and competence profiles for drone-related VET and in-company programmes.
2. Designing modular, practice-oriented learning paths for mixed-experience groups.
3. Facilitating learning in classroom, workshop and on-site settings, including inclusive strategies.
4. Planning and supervising safe practical flight exercises in training contexts.
5. Assessing operational, safety and compliance competences with clear criteria and feedback.

Expected learning outcomes

After Module T.1, participants should be able to:

1. Define the pedagogical and technical profile of trainers responsible for drone teaching in construction and renovation.
2. Design coherent modular sessions that connect drone skills with real construction tasks and competence frameworks.
3. Facilitate learning activities that accommodate different backgrounds while maintaining engagement and safety.
4. Organise and oversee practical flight exercises or simulations that comply with safety and regulatory requirements.
5. Implement fair, transparent assessment approaches for evaluating learners' operational and compliance capabilities.

Module T.2 – Advanced Curriculum Integration, Innovation Topics and Quality Assurance

- **Learning focus:** integration of drone modules into broader construction curricula, design of progression paths from foundational to advanced topics, use of simulators and case-based learning, updating content for emerging technologies (AI-assisted inspection, U-space, digital twins), and establishing quality-assurance mechanisms for training provision.

- **Target groups:** lead trainers, programme coordinators, institutions responsible for maintaining and updating Drone4Build training offers.

Proposed learning units

1. Integrating the 4×2 drone curriculum into VET qualifications and company training systems.
2. Planning and resourcing drone activities in projects (scheduling, budgeting, make-or-buy decisions).
3. Data management, ethics and governance for drone-based workflows (ownership, storage, GDPR, professional duties).
4. Positioning drones within sustainable renovation strategies and EU Green Deal/Levels principles.
5. Continuous improvement and quality assurance of drone-training provision (feedback, monitoring, updating for new tech like AI, U-space, digital twins).

Expected learning outcomes

After Module 4.2, participants should be able to:

1. Integrate drone-related modules into existing curricula or corporate training offers in a coherent progression.
2. Plan drone-enabled activities in construction projects considering operational, economic and organisational constraints.
3. Define and apply rules for responsible data management and governance in drone-supported renovation workflows.
4. Explain and advocate how drones contribute to energy-efficient renovation, reduced site impacts and wider climate-mitigation goals.
5. Establish mechanisms to monitor, evaluate and continuously improve drone training in line with regulatory and technological developments.

DRONE4BUILD

Elevating the knowledge of construction professionals on the use of drones in construction

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