MOTIVATE XR

Maintenance, Support & Operation Training using Immersive Virtual and Augmented Technology for Efficiency with XR

D7.1 INNOVATIVE TRAINING CURRICULUM AND TRAINING ACTIVITIES REPORT

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WP7 - Task 7.1 – First Release at Month 15th

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Abstract	This report presents the first version framework and planned activities for developing and validating an end-to-end XR training curriculum within the MotivateXR project. Building on the outputs of WP3 (industrial requirements and use-cases), WP4 (authoring tools) and WP5 (experiencing tools), it defines the pedagogical structure, learning objectives, and pilot-specific training plans across five industrial sectors. This report sets the baseline for iterative refinement through hands-on pilots and user feedback, with a final, consolidated curriculum to be delivered at M32
Keywords	XR training curriculum; Pilot-based validation; Industrial Use-Case scenarios

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EXECUTIVE SUMMARY

This deliverable constitutes the first iteration of the MotivateXR training curriculum and associated activity plan, scheduled for Month 15. Grounded in the requirements defined in WP3, the authoring capabilities realised in WP4, and the experiencing modules developed in WP5, underpinned by the platform integration led in WP6, this report outlines both the pedagogical framework and the roadmap for its practical validation across five industrial pilots.

After a concise **Introduction & Scope**, the document reviews the **Inputs & Rationale**, summarising key findings from:

- **D3.3** on industrial end-user requirements and priority system requirements;
- **D3.7** on UX co-design methodologies and identified user personas;
- **D4.1** on the functionalities of the Beta authoring tools;
- **D5.1** on the Beta experiencing tools and multi-user remote assistance modules.

The **Methodological Approach** defines a user-centric, iterative SCRUM process, incorporating co-design workshops, pilot deployments, and continuous feedback to refine both content and delivery mechanisms. Core evaluation metrics —coverage of learning objectives, user satisfaction, and efficiency gains— are established to guide iterative improvements.

In the **Innovative Curriculum Framework**, the report specifies high-level learning goals (familiarity with XR authoring tools, procedural mastery within each use case, effective use of remote collaboration features), modular content structure (theory, hands-on labs, assessment), and delivery modalities (in-person workshops, VR simulations, mobile AR sessions).

The **General Training Activities** section describes the suite of planned activities: interactive webinars on authoring workflows, on-site labs using the MotivateXR Platform, and peer-to-peer learning circles. It details how WP4 and WP5 tools will be embedded in each format to maximise hands-on engagement.

In **Pilot-Specific Training Plans**, tailored curricula are outlined for:

1. **Aerospace** – automated conversion of Liebherr Aerospace/Airbus[1] I technical manuals into XR scenarios;
2. **Home Appliance** – XR-guided self-repair workflows for washing machines;

[1] A collaboration agreement is under discussion with **Airbus Commercial,** but has not yet been signed. If finalised, it would provide access to A320 technical documentation for scenario contextualization and validation in the second pilot iteration and the final MotivateXR release.

3. **Aluminium** – remote assembly assistance with real-time error detection;
4. **Energy Distribution** – digital-twin-enabled on-site maintenance training;
5. **Human-Robot Manufacturing** – immersive robot-interaction simulations.

Each plan maps content modules to pilot objectives, delineates required resources, and schedules training sessions synchronized with pilot timelines.

The **Evaluation & Iteration Plan** defines data collection methods (surveys, task completion times, system-log analytics), criteria for success (≥80% satisfaction, ≥20% task-time reduction), and the mechanism to integrate findings into the M32 final version.

In **Conclusions & Next Steps**, the deliverable reaffirms its role as the baseline for curriculum development, highlights immediate actions (pilot preparations, tool refinements), and sets the stage for the final, robust training package due at Month 32.

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ABBREVIATIONS

AMM	Aircraft Maintenance Manual
AR	Augmented Reality
ATA	Specific part of the airplane subjected of maintenance
MR	Mixed Reality
SPL	Spare Part List
UX	User Experience
VR	Virtual Reality
XR	eXtended Reality

1 INTRODUCTION & SCOPE

This document, D7.1 “Innovative Training Curriculum and Training Activities Report – Version 1” delivers the MotivateXR project’s initial training curriculum framework and detailed plan of activities, situated at the project’s midpoint (Month 15). Its purpose is to:

- Define the pedagogical objectives and modular structure of the XR training curriculum.
- Describe the methodology and tools used for curriculum co-design, development, and evaluation.
- Present both general training activities and pilot-specific plans across five industrial domains.

Building on the technical and user-centric outputs from WP3 (Industrial Requirements & Use-Cases), WP4 (Authoring Tools), WP5 (Experiencing Tools), and WP6 (Platform Integration), this report lays the foundation for hands-on validation through pilot deployments (WP7).

Document Structure:

- **Chapter 1: Introduction & Scope** (this chapter)
- **Chapter 2: Inputs & Rationale** – synthesises key findings from predecessor deliverables.
- **Chapter 3: Methodological Approach** – outlines the iterative, co-design and evaluation strategy.
- **Chapter 4: Innovative Curriculum Framework** – defines the innovative, modular training structure.
- **Chapter 5: General Training Activities** – describes cross-pilot workshops, labs, and resources.
- **Chapter 6: Pilot-Specific Training Plans** – details tailored curricula for each of the five pilots.
- **Chapter 7: Evaluation & Iteration Plan** – sets out metrics, data collection methods, and feedback loops.
- **Chapter 8: Curriculum overview and dissemination assets** – describes how the training curriculum will be shared both within the consortium and with a wider open community
- **Chapter 9: Conclusions & Next Steps** – summarises the first-version outcomes and prepares for the final release.

The aim is to establish a robust, scalable training curriculum that leverages the MotivateXR authoring and experiencing toolset, ensuring that industrial end-users can efficiently learn, apply, and assess XR content creation and consumption.

Note that this is the first version of this document, released at Month 15. The final, comprehensive D7.1 will be delivered at Month 32, incorporating feedback from pilot executions and further refinements to the curriculum and activity plan.

2 INPUTS & RATIONALE

This chapter synthesises the key outputs from WP3, WP4, WP5 and WP6 to ground the training curriculum design in validated requirements, tool capabilities and integration plans.

The industrial End-User requirements and Use-Case scenarios deliverable (D3.3) provided a structured list of user needs, system requirements and prioritised use-case descriptions. These findings established the baseline scenarios for which training modules must be developed, ensuring alignment with pilot objectives and real-world constraints.

The UX co-design report (D3.7) offered the methodological foundation for a user-centred curriculum, identifying personas, storyboards and iterative co-design techniques. These insights inform both the pedagogical approach and the design of hands-on activities, ensuring that the curriculum accommodates content creators and end-users alike.

The Authoring Tools beta deliverable (D4.1) described the current capabilities of the MotivateXR authoring environment, including 3D asset generation, AI-assisted content creation and multi-tool interoperability. These technical specifications determine the scope of what trainees must learn to author XR content effectively.

The Experiencing Tools beta deliverable (D5.1) outlined the software and hardware components for content playback, collaboration, remote assistance and gesture-based interaction. Its roadmap of future enhancements defines the features that trainees will progressively adopt through advanced modules.

The platform integration work (WP6) specified the common data models, taxonomy and interoperability protocols binding WP4 and WP5 tools into a unified ecosystem. These integration requirements shape the curriculum's emphasis on cross-tool workflows, data exchange and end-to-end content lifecycle management.

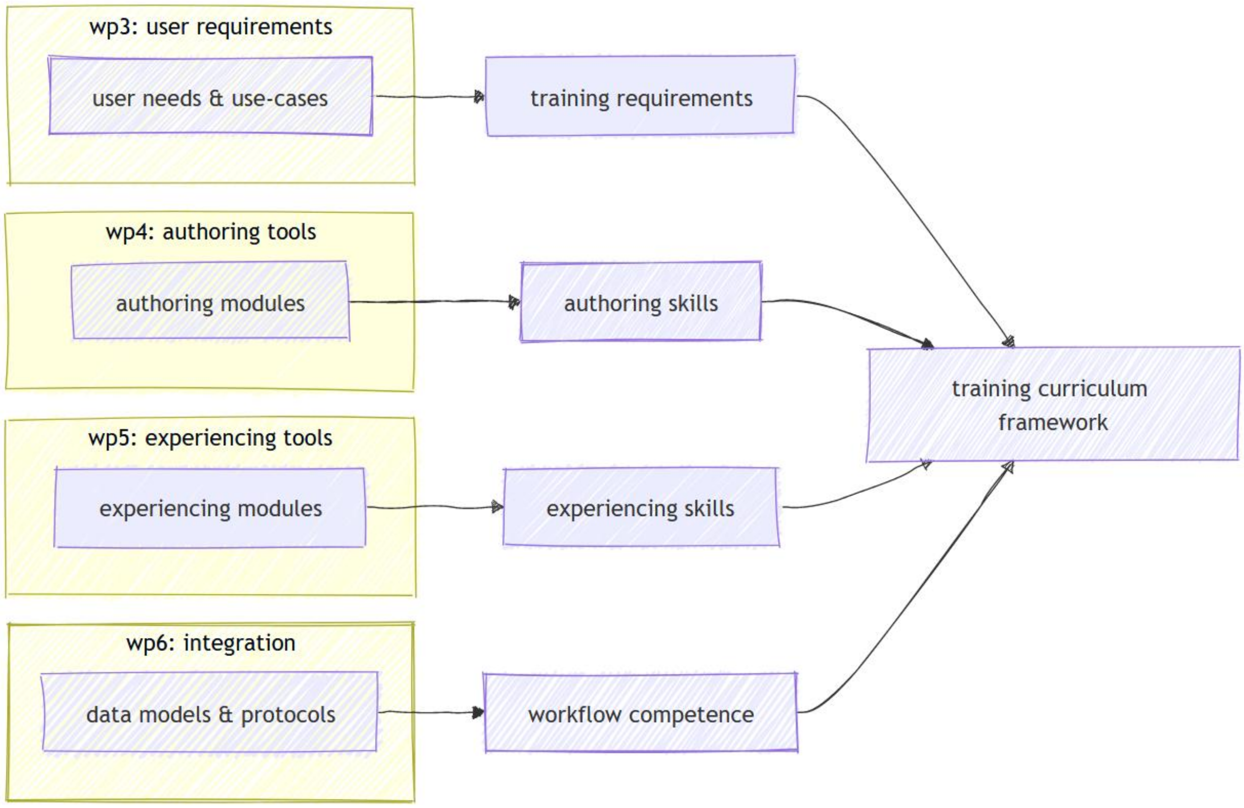


FIGURE 1 - INTEGRATION DIAGRAM

The diagram above illustrates how each work package output feeds into the core dimensions of the curriculum framework: requirements definition, authoring proficiency, experiencing proficiency and workflow competence.

In addition, a consolidated table summarises the deliverable contributions and their impact on chapter sections:

TABLE 1 - DELIVERABLE CONTRIBUTIONS

Deliverable	Key contribution	Chapter mapping
D3.3	Prioritised user and system requirements	3.2 Phase 1 – Alignment and KPI Mapping; 3.3 Phase 2 – Co-design and Curriculum Build
D3.7	User personas and co-design methodology	3.2 Phase 1 – Alignment and KPI Mapping; 3.3 Phase 2 – Co-design and Curriculum Build
D4.1	Beta authoring tool capabilities	3.2 Phase 1 – Alignment and KPI Mapping; 3.4 Phase 3 – Beta Implementation

D5.1	Beta experiencing tool capabilities	3.2 Phase 1 – Alignment and KPI Mapping; 3.4 Phase 3 – Beta Implementation
D6.1	Integration protocols and data models	3.2 Phase 1 – Alignment and KPI Mapping; 3.4–3.6 Implementation & Refinement

By weaving these inputs together, this chapter ensures that the curriculum rests on solid technical and user-centred foundations, ready for pilot-based validation and iterative refinement.

3 METHODOLOGICAL APPROACH

This chapter presents the methodology adopted to co-design, develop, validate, and progressively refine the MotivateXR training curriculum. The process is organised into six sequential yet cyclical phases that cover the entire project timeline, from consolidating inputs delivered by WP3-WP6 to publishing the curriculum for an open community of XR practitioners.

A key feature of the methodology is the distinction between **two release cycles**:

- a **beta cycle** (M14–M17) in which roughly 35 % of the platform's functionality is tested through foundational and operational modules;
- a **final cycle** (M32–M35) that integrates the advanced components of social interactivity, learner agency, and next-generation mixed reality.

Each phase is designed to generate measurable outputs feeding directly into the project's **Key Performance Indicators (KPIs)**. Support tools, such as questionnaire templates, observation logbooks, log-export specifications, and analytics dashboards ensure uniform data collection across pilots, as detailed in Chapter 7. The process culminates in the open publication of the curriculum, guaranteeing that lessons learned and materials produced can be reused by the wider XR community.

3.1 METHODOLOGICAL ROADMAP

The methodological roadmap offers a high-level view of how the MotivateXR curriculum moves from consolidated inputs to open dissemination through two distinct release cycles: the **beta cycle** (M14–M17) and the **final cycle** (M32–M35).

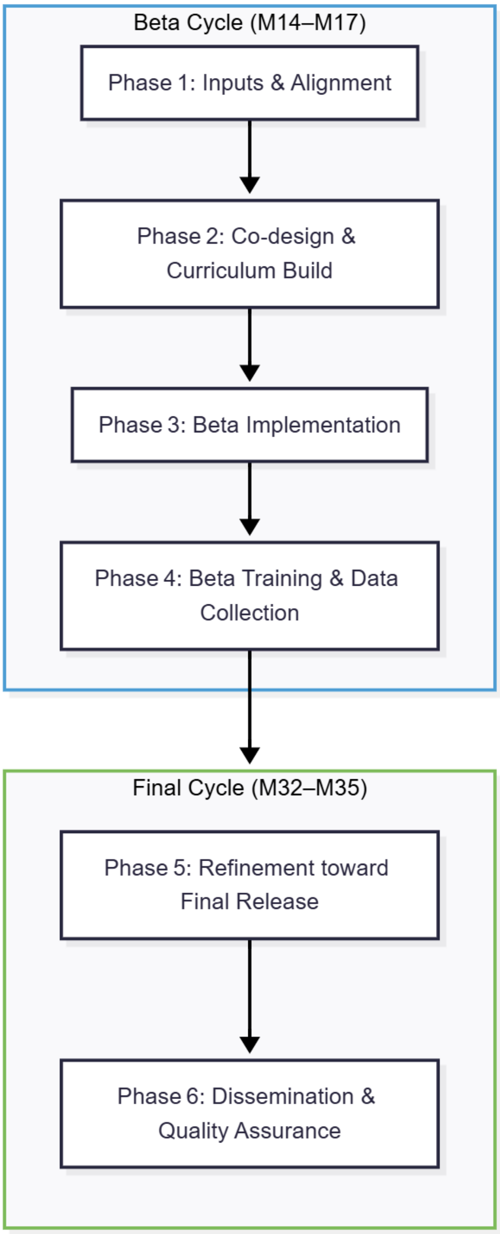


FIGURE 2 - MOTIVATEXR METHODOLOGICAL ROADMAP

The diagram divides the process into two colour-coded blocks.

The blue block represents the beta cycle. Phase 1 consolidates deliverables from WP3–WP6 and aligns them with project KPIs. Phase 2 translates these inputs into a minimum viable curriculum through co-design workshops. The content produced in Phase 3 is packaged and internally tested, preparing authors and pilot participants for Phase 4, where beta training is delivered, and data is collected with the templates introduced in the Appendix.

The green block maps the final cycle. Data captured in Phase 4 flows directly into Phase 5, where feedback drives backlog refinement and the integration of advanced features: social interactivity, learner agency, and mixed reality. Finally, Phase 6 publishes the matured curriculum, complete with quality-assurance checks, to a public web portal and open-source repository, transforming it into a lasting dissemination asset for the XR community.

3.2 PHASE 1: ALIGNMENT AND KPI MAPPING

This phase connects the technical and pedagogical inputs synthesised in Chapter 2 to the project-level KPIs that will steer MotivateXR's evaluation. The deliverable-to-KPI alignment matrix (Table 2) specifies which curriculum features trace back to each work-package output and how their success will be measured.

TABLE 2 - CONSOLIDATION MATRIX: DELIVERABLES, CURRICULUM IMPACT, KPI LINKAGE

Source Deliverable / WP	Principal insights for training	Direct impact on Curriculum	KPIs addressed
D3.3 Industrial User Requirements (WP3)	Prioritised end-user needs and system requirements	Defines learning objectives for operational modules	6.1, 4.1
D3.7 UX Co-design Report (WP3)	Personas, storyboards, and co-design methodology	Shapes instructional strategies and user journeys	1.1, 6.6
D4.1 Authoring Tools Beta (WP4)	Current authoring capabilities and limitations	Determines the scope of foundational author training	3.4
D5.1 Experiencing Tools Beta (WP5)	XR player features, device compatibility	Informs scenario fidelity and physical accessibility design	4.2, 6.6
D6.1 Integration Guidelines (WP6)	Data models, interoperability protocols	Guides technical alignment for asset packaging and analytics	5.2, 3.6

Figure 3 visualises the workflow, from input consolidation to stakeholder approval of the beta scope, thus bridging raw requirements with measurable objectives without re-listing the underlying deliverables. All detailed descriptions of D3.3, D3.7, D4.1, D5.1, and D6.1 outputs can be found in Chapter 2.

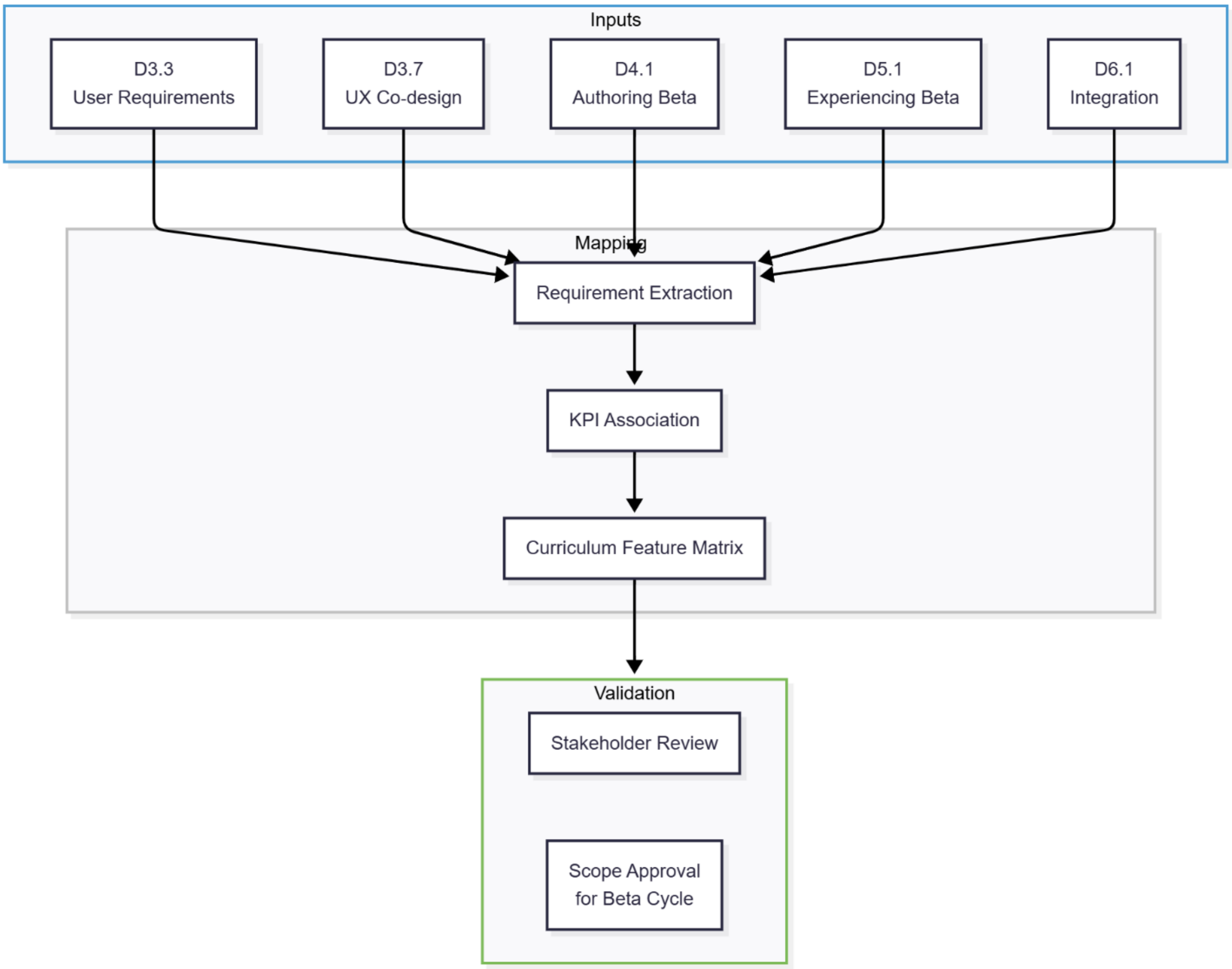


FIGURE 3 - ALIGNMENT FLOW: FROM INPUTS TO APPROVED SCOPE

By completing Phase 1, the project secures a shared understanding of priorities, objectives, and evaluation criteria, ensuring that subsequent co-design and development activities remain tightly coupled to both user needs and project-level success metrics.

3.3 PHASE 2: CO-DESIGN & CURRICULUM BUILD

During Phase 2, the curriculum takes shape through a series of structured workshops that bring together end-users, pilot owners, and technology partners. The methodological backbone combines design-thinking principles with participatory design practices, adopting the CIEMER process (Co-creative, Interdisciplinary Exergame Design in XR) proposed by Retz et al. [1] to enable rapid, interdisciplinary collaboration.

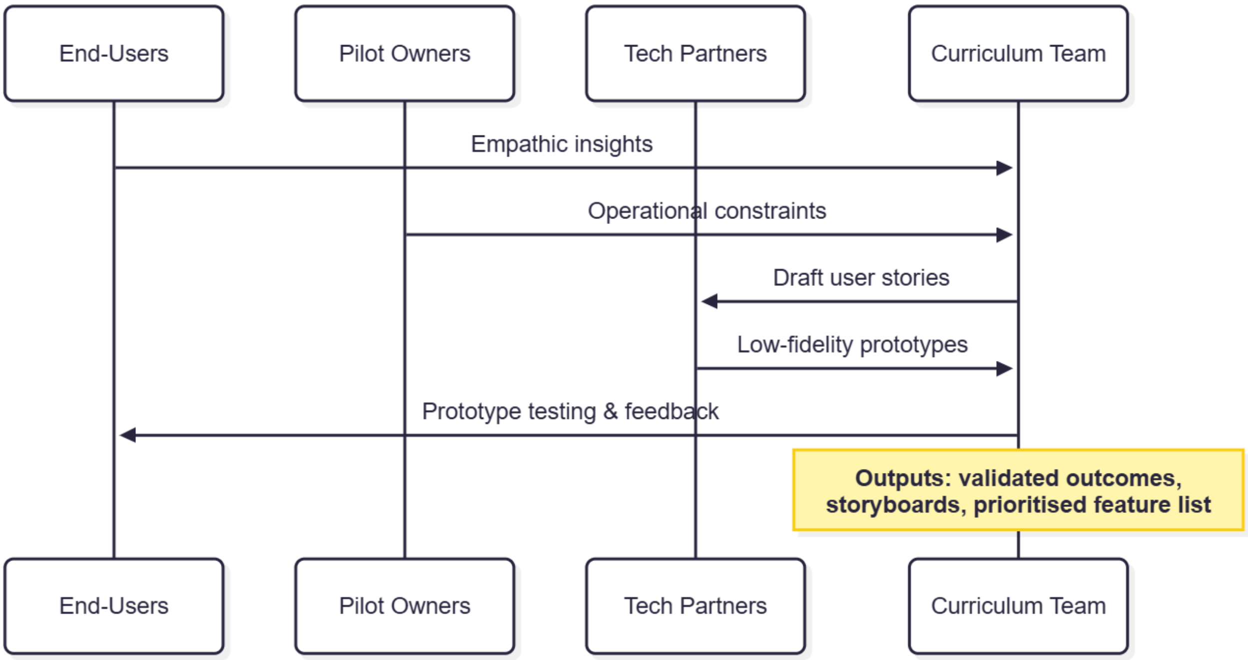


FIGURE 4 - CIEMER CO-DESIGN WORKSHOP FLOW

Each workshop opens with an **empathic user-exploration block** in which contextual interviews and empathy maps capture operational needs, technical barriers, and motivational drivers previously identified in WP3. A round of **ideation sketches** follows, where mixed teams produce quick visual solutions and preliminary storyboards on shared digital whiteboards. Those concepts are then converted into **low-fidelity prototypes,** simplified XR scenes or paper mock-ups, that participants can manipulate immediately, reflecting CIEMER's "fail fast, learn faster" principle.

Three key outputs are gathered at the end of every session: validated learning outcomes directly linked to D3.3 user requirements; instructional storyboards describing step-by-step XR experiences; and a prioritized feature list tagged "beta-ready" or "final-ready", indicating whether the functionality enters the M17 release or is deferred to the refinement phase.

The workshop-prototype cycle was conducted monthly from M9 to M13. At the end of M13, the team froze the **minimum viable curriculum** (MVC) containing all beta-ready features. From M14 to M16 the MVC is packaged into the MotivateXR training curriculum (D7.1) and pilots organise their train-the-trainer sessions according to internal constraints. Platform use and data collection are primarily concentrated in M17, while final documentation is completed by the end of M18.

Because feature status is explicitly labelled during co-design, traceability to project KPIs becomes straightforward: a module marked beta-ready, for example, local multi-user functionality, feeds directly into KPI 4.2 measurement during training, while deferred items populate the backlog for advanced refinement.

3.4 PHASE 3: BETA IMPLEMENTATION

With the minimum viable curriculum frozen at the end of M13, Phase 3 converts every "beta-ready" feature into a deployable XR module. Within the global M14–M18 window, and most intensively between M14 and M16, curriculum designers and technical partners work in short sprints to convert 'beta-ready' features into deployable XR modules, allowing each pilot to adapt the exact pacing to its internal schedule. Each sprint begins with a backlog refinement session that breaks down the approved storyboards into development tasks: final 3D modelling, animation, interaction scripting, contextual overlays, and assessment template configuration. WP4 focuses on authoring tasks inside Inscape VTS and KAYROX, while WP5 optimizes the headset experience to meet the physical-accessibility and scenario-fidelity requirements set in Phase 1.

Halfway through every sprint, an internal build review loads the package into a continuous-testing environment, where automated scripts confirm asset initialization, trigger integrity, and minimum performance levels (load time < 15 s; frame rate ≥ 60 fps). Instructional designers conduct a parallel walkthrough to verify pedagogical coherence. Critical bugs or content gaps are re-entered in the backlog and resolved in the next sprint. At sprint close, a live demo—open to pilot owners and WP6 stakeholders—showcases progress, captures rapid feedback, and records change requests.

When a module clears both the pedagogical and technical reviews, it is labelled **Release Candidate** and moved to the Internal Beta Repository together with questionnaires and logging templates. These assets feed the train-the-trainer programme, which pilots will launch within the M14–M16 preparation window according to their internal planning.

The phase concludes with a **Beta Build v1.0** prepared by the end of the preparation window (M14–M16), with exact cut-off dates set by each pilot to fit their internal constraints. The build is signed off with a quality report that lists functional and performance test results, maps which KPIs can begin measurement in Phase 4 (notably 4.1, 4.2, and 6.1) and identifies the "final-ready" backlog to be tackled during Phase 5 refinement.

3.5 PHASE 4: EVALUATION & DATA COLLECTION

The first deployment of the MotivateXR platform takes place mainly in M17, within the broader M14–M18 window. Pilots may adjust exact session dates to their operational needs, ensuring that all activities conclude in time for documentation by the end of M18.

This phase is devoted entirely to assessing the effectiveness of the beta curriculum and gathering a comprehensive dataset for the next iteration cycle.

The **training programme** begins with concise train-the-trainer sessions that familiarise internal instructors with the foundational and operational modules. Pilot participants then complete the XR learning paths packaged in Beta Build v1.0. Each training session follows a standard protocol that blends quantitative and qualitative instruments:

- online **ex-ante and ex-post questionnaires** (anonymised on TUD servers) capture expectations, usability and satisfaction;
- **pre/post knowledge tests**—separate versions for authoring and experiencing—measure theoretical and operational gains;
- automated **system logs** from the Experiencing Tool record task-completion time, error counts and interaction events;
- a structured **observation logbook** is filled by facilitators to document critical behaviours or incidents;
- the **SUS / UEQ questionnaire** provides a concise usability score.

All instruments follow the standard templates described in the Appendix. Raw files are uploaded within 24 hours to a central repository, where cleaning scripts check format consistency. A WP7 data manager oversees classification and anonymisation in full GDPR compliance.

The beta evaluation allows direct measurement of three KPIs—**6.1** (number of users trained), **4.1** (XR scenarios published and experienced) and **4.2** (remote multi-user sessions)—and provides an initial estimate for **KPI 6.6** by comparing task-completion times in traditional versus XR-assisted procedures. Results are displayed in an internal dashboard showing task-time trends, knowledge-gain scores, and usability ratings.

At the end of M17 a synthesis workshop brings together data managers, pilot owners and WP leads to validate datasets, discuss key insights and compile a prioritised list of pedagogical and technical improvements that will populate the backlog for Phase 5.

Below, Table X summarises the evaluation instruments and indicates which KPIs each instrument supports.

TABLE 3 - BETA EVALUATION INSTRUMENTS AND KPI COVERAGE

Instrument	Data captured	KPI linkage
Ex-ante / Ex-post questionnaires	Expectations, usability, satisfaction	6.1
Pre/Post knowledge tests	Theoretical and operational knowledge gain	6.1, 6.6 (indirect)
System logs	Task-completion time, error counts, interaction events	4.1, 4.2, 6.6
Observation logbook	Qualitative incidents, behavioural notes	Context for all KPIs
SUS / UEQ usability score	Perceived ease of use	4.1, 4.2

3.6 PHASE 5: REFINEMENT TOWARD FINAL RELEASE

Between M18 and M31 the data gathered during the beta evaluation is transformed into concrete improvements that raise the curriculum and platform to final-release maturity. The work unfolds in a recursive loop of four steps: data analysis, backlog reprioritisation, advanced development sprints, and continuous validation.

During the **analysis step**, the WP7 team reviews quantitative dashboards: task-completion time, knowledge-gain scores, SUS ratings, and qualitative notes from observation logbooks. Findings are cross-referenced with the XR-Ed framework, which advocates balancing cognitive load and learner agency [2], and with recent guidelines on collaborative VR learning [3].

The **improvement backlog** is then reorganised. Features marked "final-ready" in Phase 3 are ranked by educational impact and development efforts. High-impact, low-effort items, such as micro-assessment checkpoints or adaptive contextual overlays, move immediately into the next sprint. More complex capabilities, like persistent social hubs or mixed-reality telepresence, are broken into subtasks and scheduled over multiple sprints.

Each **advanced development sprint** lasts three weeks, synchronised across WP4 (authoring), WP5 (experiencing), and WP6 (integration). Instructional designers update learning modules to incorporate new functionality, while technical partners implement automation scripts, new triggers, and extended data models. At sprint close, a rapid validation session checks pedagogical coherence, software stability, and alignment with KPI 3.4 (authoring-time reduction) and KPI 3.6 (data-driven iteration cycles).

Once a feature passes validation, it is moved to the **Ready for Final Build** column, joining all advanced modules required for the M32–M35 release.

Below is a compact Kanban view of the refinement cycle, illustrating how items flow from backlog to final build.

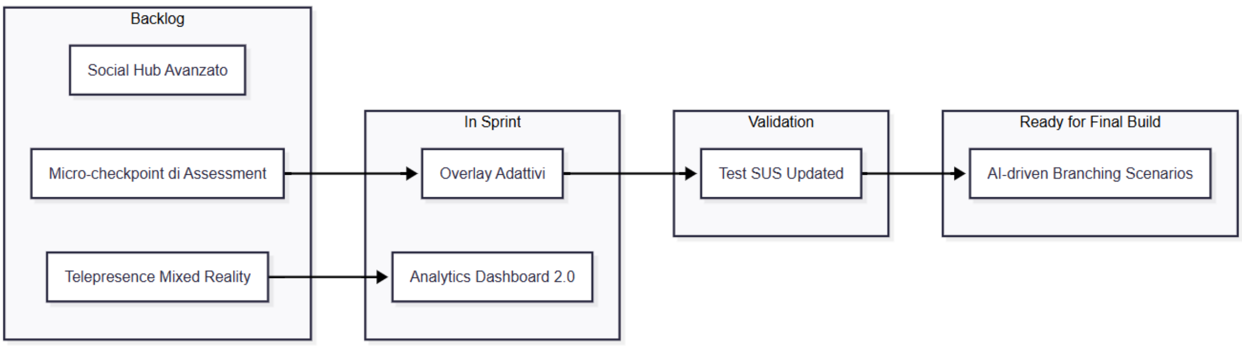


FIGURE 5 - KANBAN VIEW OF THE REFINEMENT CYCLE

The diagram shows how a low-effort, high-impact item (micro-assessment checkpoint) moves swiftly into the current sprint, is validated, and reaches "Ready". By contrast, a complex yet high-value feature (mixed-reality telepresence) requires multiple sprints before validation. This visual helps partners and reviewers grasp task priorities and overall progress toward the final build.

3.7 PHASE 6: DISSEMINATION & QUALITY ASSURANCE

In the closing stage (M32–M36), the MotivateXR curriculum is packaged as **Final Build v2.0**, subjected to a multilayer quality-assurance regime, and then released as an open dissemination asset. Distribution occurs through a public web portal, an open-source Git repository, and a series of recorded webinars showcasing use cases, pedagogical guidelines, and technical best practices.

The **quality-assurance protocol** comprises three complementary reviews:

- A **technical review** executes regression tests on the authoring and experiencing tools, verifies hardware compatibility, and stress-tests the newly added social-hub and mixed-reality features.
- A **pedagogical review** checks alignment with Kolb's experiential learning cycle (1984) and cognitive-load management principles (Sweller et al., 2019), ensuring that immersive modules maximise active experimentation while avoiding "seductive details" that distract from learning objectives [4].
- A **participatory review** takes place in Social VR sessions where stakeholders and early adopters validate content and interaction paradigms, following the co-design framework proposed by Dorta et al. [5].

After passing all three gates, the curriculum is version-tagged **v2.0**, accompanied by full documentation and a permissive licence to encourage reuse. An open ticketing system invites the wider community to report issues or suggest enhancements, thereby initiating a continuous-improvement loop that extends beyond the formal project lifetime.

Below is a schematic view of the QA and dissemination loop.

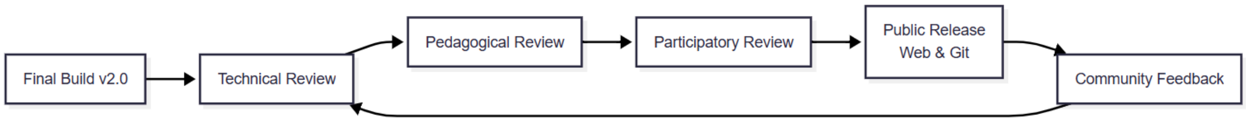


FIGURE 6 - QA AND DISSEMINATION LOOP

The diagram illustrates the closed loop in which Final Build v2.0 passes through three quality gates before public release. Community feedback flows back into the ticketing system, feeding a new QA cycle that safeguards the curriculum's long-term sustainability.

Through this phase, MotivateXR delivers a robust, validated, and reusable curriculum to the XR community, anchored in experiential-learning theory and cognitive-load management, and strengthened by participatory co-design practices that place user contribution at the centre.

4 INNOVATIVE CURRICULUM FRAMEWORK

This chapter defines the pedagogical architecture of the MotivateXR Training Programme, detailing its design principles, learning objectives, modular structure, delivery modalities, and assessment strategy.

Diagrams and tables illustrate how theoretical foundations and tool capabilities translate into concrete learning pathways. References to recent educational XR research support each element of the framework.

4.1 DESIGN PRINCIPLES AND THEORETICAL FOUNDATIONS

This chapter outlines the complete MotivateXR curriculum in two successive phases, highlighting what is already implemented in the beta version and our objectives for the final release.

During the **beta version**, the overall window spans M14 to M18, with curriculum preparation and training activities generally planned across M14–M16 and platform use primarily concentrated in M17. Each pilot will schedule its resources within this window to ensure all activities are completed and documented by the end of M18. Fully operational are the first two XR-ED design dimensions:

- **Physical accessibility** ensures that every learner can engage comfortably and safely. In beta, we provide lightweight headsets with adjustable straps, simplified gesture controls, high-contrast interfaces, and built-in ergonomic prompts for micro-breaks. Seating and standing options adapt to individual needs. In the final version, we will add voice-control alternatives, customizable font sizes, and an automated head-fit calibration routine to optimise comfort and usability.
- **Scenario fidelity** aims to reproduce operational contexts with sufficient realism to ensure skills learned transfer directly to the workplace. In the beta version, fidelity is achieved through high-quality 3D models, scripted animations of equipment behaviour, and interactive manipulation using standard VR controllers. Learners can pick up, rotate, and inspect virtual components, trigger sequence animations, and receive visual feedback on correct procedures—all without reliance on real-world hardware.

For the final release, we will explore advanced fidelity enhancements, to be refined over the coming months. Potential extensions include integrating real-time data streams from live systems to drive virtual instrument readings, implementing particle or fluid dynamics for more authentic visual effects, and adding physics-based interaction layers that simulate realistic weight, friction, and material responses. These proposals will be evaluated iteratively and represent our medium-term objectives for elevating scenario immersion and authenticity.

The **continuous assessment** dimension, while not yet equipped with interactive checkpoints or embedded quizzes, is supported by the data-collection documents described in the Appendix ("Document Templates"). During beta, we capture timestamps of key actions, error counts, and deploy pre- and post-knowledge tests along with structured observation logs. Learners receive automated summary reports after each module. In the final version, we will embed formative checkpoints directly within XR scenes—scenario questions that pause the simulation until answered correctly and branch adaptively—to deliver immediate feedback without disrupting flow.

The dimensions of **social interactivity**, **learner agency**, and **degree of virtuality** are being explored in proof-of-concept form:

- **Social interactivity** transforms XR into a collaborative space. In beta, participants join local cluster rooms where up to four avatars share the same virtual hangar, pointing to components and using voice chat. In the final platform, we will introduce persistent XR social hubs for global collaboration, scenario sharing, live peer reviews, and remote expert sessions with virtual whiteboards and annotation tools.
- **Learner agency** gives users control over their learning path. Beta users choose among a set of preconfigured modules —inspection, assembly, troubleshooting— and the system tailors follow-up recommendations based on their sequence of choices. In the final release, learners will craft custom scenario branches in a built-in storyboard editor, annotate steps with voice or text, adjust difficulty sliders, and publish modules to a shared library for colleagues.
- **Degree of virtuality** calibrates the mix of real and virtual elements. The beta alternates between AR overlays —tagging real pumps and valves with floating labels— and fully immersive VR scenes of an aircraft cabin, with seamless toggling. In the final system, we will add advanced mixed-reality features such as pass-through video integration, spatial anchoring of virtual gauges to physical controls, and a telepresence mode that overlays a remote mentor's live video feed onto the learner's view.

Throughout both phases, the curriculum is grounded in **Kolb's experiential learning cycle**, which alternates concrete experience, reflective observation, abstract conceptualisation, and active experimentation. In beta, this cycle applies at the individual module level; in the final release, it will span end-to-end learning journeys with advanced journaling and insight dashboards tracking each stage.

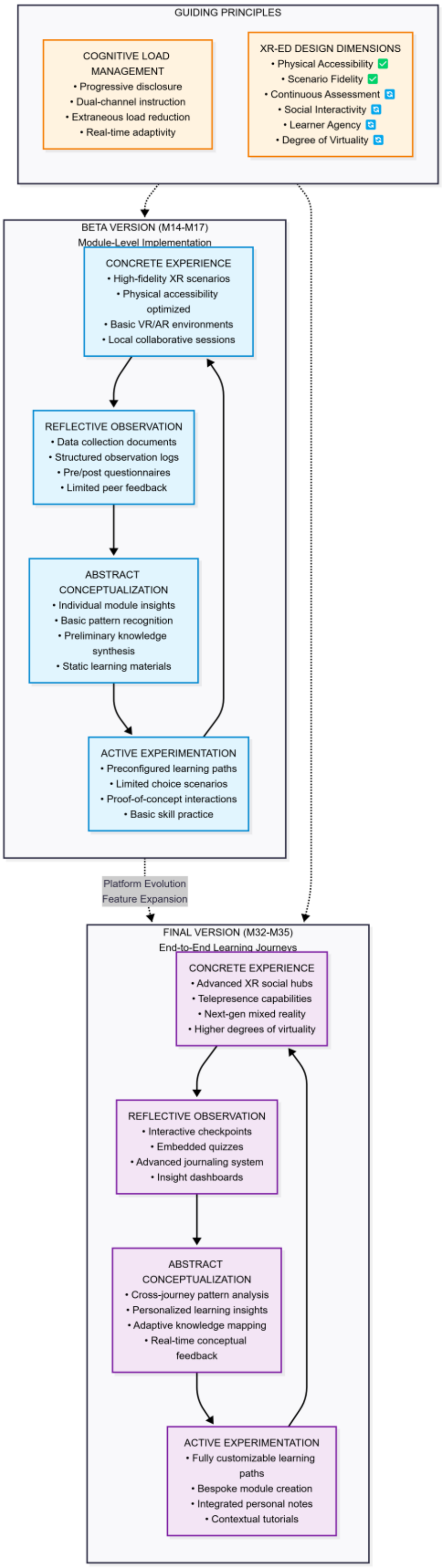


FIGURE 7 - MOTIVATEXR EXPERIENTIAL LEARNING CYCLE

Evidence from recent systematic reviews underscores the effectiveness of XR-based training in professional education. In healthcare education, virtual reality interventions have demonstrated significant gains in knowledge acquisition and skill performance compared to traditional methods [6]. Meta-analyses further indicate that immersive VR training leads to greater retention and engagement among learners, with effect sizes suggesting substantial improvements in clinical competence [7]. These findings support our investment in high-fidelity XR scenarios to maximise learning impact.

Finally, **cognitive load management** remains a guiding principle. From the beta onward, we employ progressive disclosure and dual-channel instruction to prevent sensory overload, presenting only essential information at each step and balancing visual overlays with concise audio narration. In the final version, we will further refine extraneous load reduction through contextual tutorials and real-time adaptivity, ensuring that learners remain focused on critical tasks without distraction.

By validating key foundational dimensions early and providing a clear roadmap for advanced components, we ensure transparency about our current capabilities and alignment with overall project objectives.

4.2 LEARNING OBJECTIVES AND OUTCOMES

The MotivateXR training curriculum is organised into three progressive proficiency levels, **Foundational**, **Operational**, and **Advanced**, each mapped to our platform's release phases and the project's Key Performance Indicators (KPIs). This tiered design allows us to validate essential capabilities in the beta version and then expand toward full maturity in the final release.

In the **Foundational** phase, learners acquire basic XR fluency: navigating menus, positioning 3D assets, and executing simple controller-based interactions. During the beta (M14–M17), these skills are taught through concise video tutorials, guided demonstrations, and on-site practice sessions. Although dedicated KPIs are not yet defined for this level in beta, we will monitor module completion rates and participant satisfaction surveys in line with **KPI 6.1** (total trained users) to assess early engagement. Recent systematic reviews in higher education confirm that immersive virtual reality significantly enhances initial learner engagement and knowledge retention at the foundational stage [8].

The **Operational** level builds on this base by guiding participants to assemble complete XR workflows, integrate AI-assisted annotations, and configure local multi-user sessions. Training is delivered through interactive virtual workshops and collaborative on-site labs. In the beta, we will track uptake of these operational features via **KPI 4.1** (number of published and experienced XR applications) and **KPI 4.2** (number of remote training sessions). These metrics indicate how effectively learners can apply operational tools in realistic scenarios. Evidence from immersive educational technologies (e.g. in medical physics) demonstrates that such operational training delivers measurable improvements in procedural accuracy and task completion speed [9].

At the **Advanced** level, learners focus on continuous improvement, content lifecycle optimisation, and custom scripting. Beta users experiment with basic version control and annotation functions, while the final release will introduce a storyboard editor, automation scripts, and advanced analytics dashboards for reflective practice. We will use **KPI 6.6** (reduction in time for complex tasks) as an early proxy for impact during beta, with the understanding that full measurement of **KPI 3.4** (reduction in authoring time) and **KPI 3.6** (number of data-driven iteration cycles) will occur in the final phase. The literature supports the idea that advanced immersive training fosters deeper mastery of complex skills and promotes iterative content refinement [8][9].

To clarify our measurement approach, the following table compares which KPIs can be assessed during the beta phase, and which targets remain for the final release:

TABLE 4 - KPI COMPARISON – BETA VS FINAL PHASE

KPI ID	KPI Description	Measured in Beta (M14-M17)	Final target (M34-M35)
6.1	Total number of users trained	Count of participants completing foundational and operational modules	> 100 trained users
4.1	Number of XR scenarios published and experienced	Number of operational workflows created in lab sessions	> 10 scenarios published and experienced
4.2	Number of remote multi-user training sessions	Local collaborative sessions executed	> 10 remote multi-user sessions
6.6	Reduction in time for complex tasks with XR assistance	Preliminary pre/post comparison on sample tasks	> 20% time reduction on complex tasks
3.4	Reduction in XR content authoring time	N/A (advanced authoring tools not yet available)	> 75% reduction in authoring time
3.6	Number of data-driven content iteration cycles	Initial log collection for continuous improvement	> 3 iterations per module based on analytics

4.3 MODULAR CURRICULUM STRUCTURE

The curriculum comprises five core modules—orientation (authoring essentials, experiencing essentials, scenario integration and evaluation & iteration), each mapping onto the six design dimensions and proficiency levels.

Modules reuse a common template of introduction, demonstration, hands-on lab and reflective debrief.

The following flowchart visualises module interdependencies:

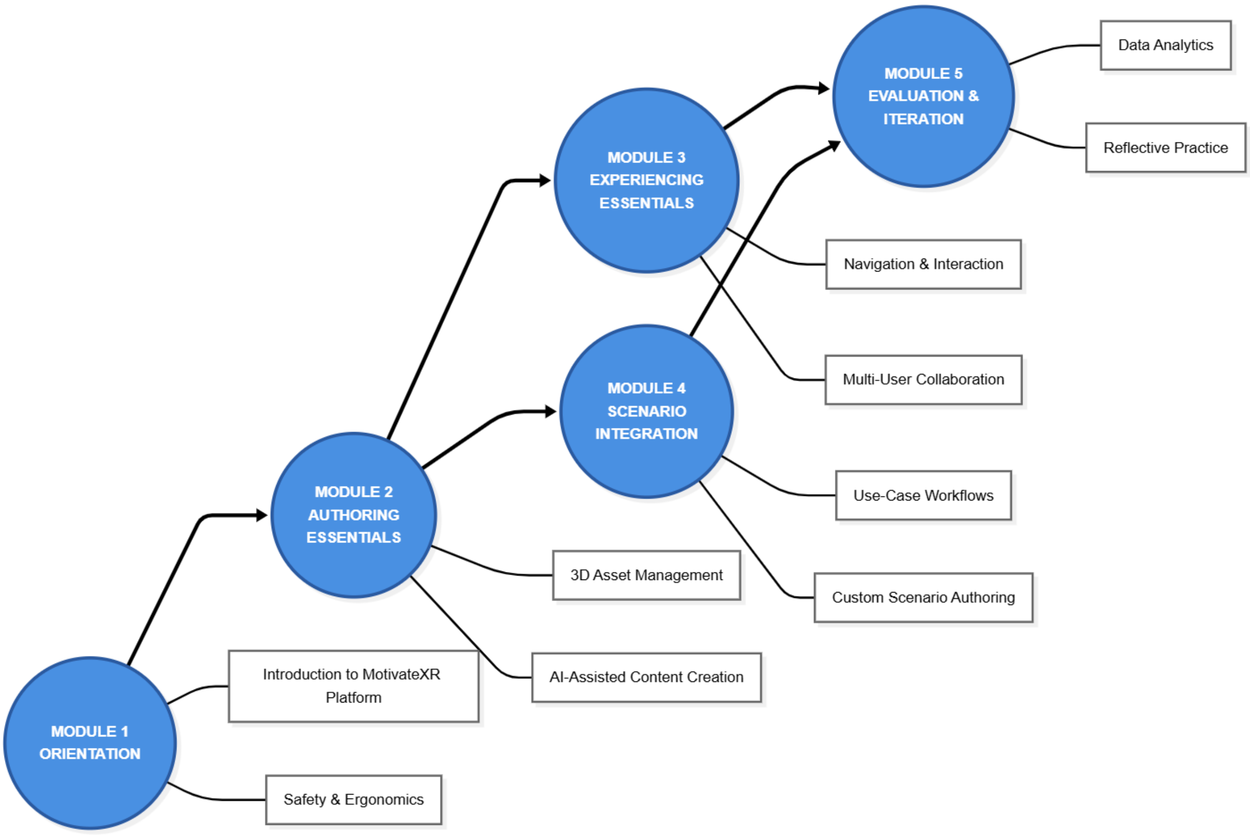


FIGURE 8 - MODULE INTERDEPENDENCIES IN CURRICULUM STRUCTURE

4.4 DELIVERY MODALITIES AND LEARNING ACTIVITIES

To accommodate diverse pilot contexts, the curriculum employs blended modalities: asynchronous e-learning for foundational theory, synchronous virtual workshops for instructor-led demonstrations, on-site hands-on labs for experiential practice, and remote co-design sessions for scenario customisation.

4.5 ASSESSMENT AND EVALUATION STRATEGY

Assessment integrates formative and summative approaches.

Formative assessment uses in-module quizzes, interactive checkpoints, and peer reviews to provide immediate feedback.

Summative assessment comprises scenario deployment tasks evaluated against rubrics for task completion time, error rates, and user satisfaction.

Analytics dashboards aggregate system logs and questionnaire data to track knowledge gain and tool proficiency over time.

The table below maps assessment methods to curriculum components:

TABLE 5 - ASSESSMENT METHODS TO CURRICULUM COMPONENTS

Component	Formative method	Summative method
Authoring essentials	Real-time progress checkpoints	Complete scenario authoring assignment
Experiencing essentials	Guided peer observation	Multi-user mission performance
Scenario integration	Workshop critiques	Pilot-specific scenario execution report
Evaluation & iteration	Reflective journal entries	Analysis of usage analytics

5 GENERAL TRAINING ACTIVITIES

This chapter outlines the overall architecture of MotivateXR training activities, clearly distinguishing what is realistically deliverable in the **beta phase** (overall window M14–M18, with hands-on use preferably completed by M17 and documentation by M18) from what may be further developed in the **final phase**. The aim is not to lock partners into rigid future targets, but to offer a palette of possibilities: each partner can decide how deep to go on specific elements, according to resources, priorities, and the evidence emerging from beta tests.

During the beta period, we focus on an "essential" blended mix: short asynchronous micro-modules to introduce tools and procedures, a limited number of targeted virtual workshops to consolidate operational skills, and concise on-site sessions to validate ergonomics and scenario fidelity. Remote co-design touch points are used pragmatically to refine freshly released content.

For the final phase, richer approaches, such as more structured social hubs, advanced mixed-reality features, or expanded support resources, are currently under consideration as potential evolutions. Their scope and priority will be discussed jointly by all MotivateXR partners after we analyse the beta feedback; no implementation is assumed at this stage.

Each subsection (5.1–5.7) follows the same logic: it states what is "beta-ready" and proposes "final-ready" options without turning them into fixed commitments, allowing every partner to plan timing and effort with the flexibility they need.

5.1 BLENDED LEARNING ECOSYSTEM

The blended learning ecosystem for MotivateXR is presented in two complementary views so partners can focus calmly on what is feasible now and decide later how far to extend each element. The **beta configuration** (M14–M18, with hands-on use ideally completed by M17 and documentation by M18) privileges an essential mix: short self-paced micro-modules to introduce tools and procedures, a limited number of targeted live virtual workshops to consolidate operational skills, and concise on-site immersive labs only where hardware familiarisation or ergonomic checks are indispensable. Remote co-design touch points are employed pragmatically to fine-tune freshly released content rather than to open new complex design strands.

The **final configuration** (M32–M35) is framed as a set of optional extensions rather than fixed obligations. Partners may enrich asynchronous paths with adaptive quizzes and multilingual content, open persistent social/telepresence hubs, or run extended immersive labs and comparative XR/non-XR studies. Each pilot can modulate these additions according to its resources, priorities and the evidence gathered during beta.

The following Figure 9 visualises the beta flow: the sequence from self-paced foundation to workshops, to on-site immersive labs (when needed), and finally to remote co-design touch points, with feedback loops that channel insights back to the earlier stages.

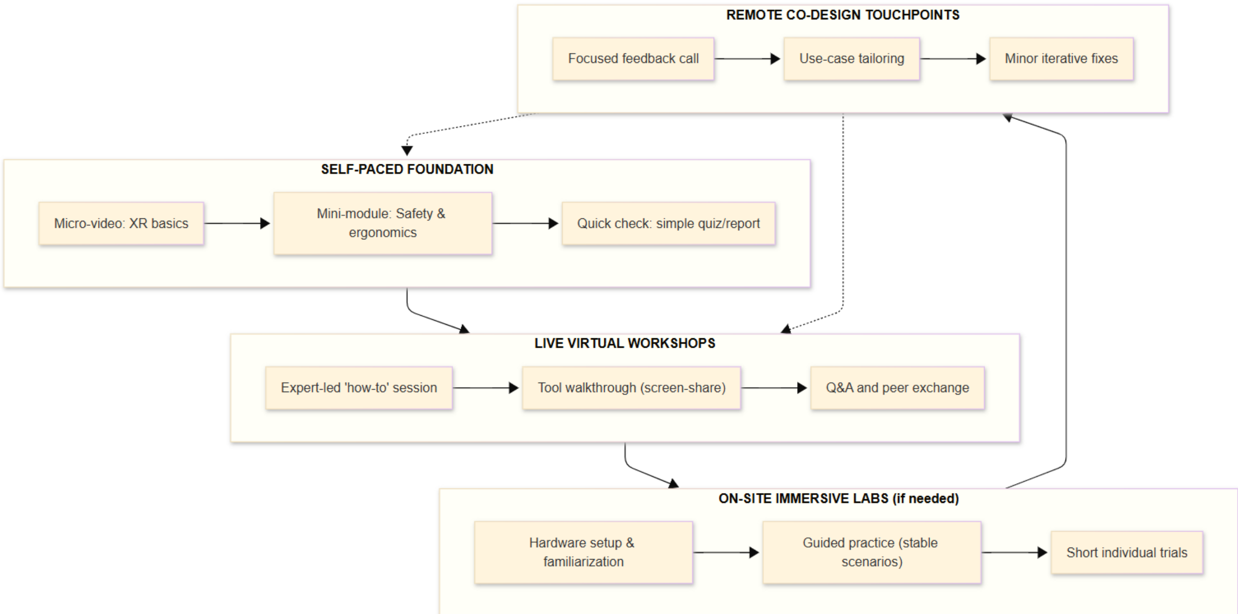


FIGURE 9 - BETA BLENDED LEARNING FLOW (M14–M18)

The following Figure 10 depicts the portfolio of final-phase options (advanced asynchronous learning, social hubs and telepresence, support resources, and extended labs) linked in a continuous improvement loop.

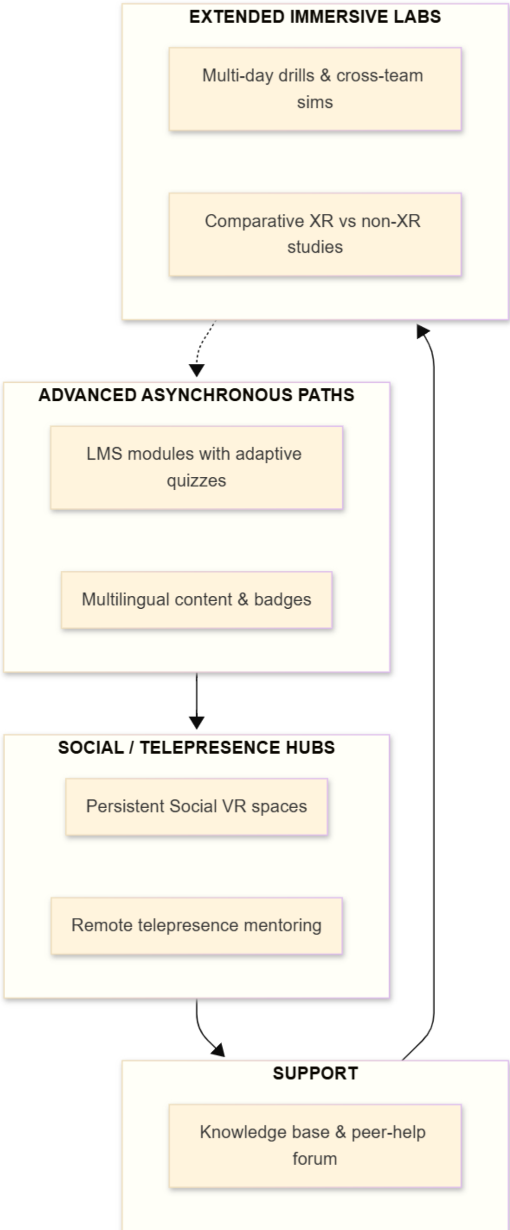


FIGURE 10 - FINAL BLENDED LEARNING OPTIONS (M32–M35)

Together, the two diagrams make clear which components are core for the beta and which are candidates for later enhancement, leaving each partner free to calibrate depth and timing within the agreed project windows.

5.2 ASYNCHRONOUS E-LEARNING MODULE

In the **beta phase**, the asynchronous module is intentionally lean and pragmatic. The goal is to give participants just enough to start using the tools without overload: short tutorial videos (3–5 minutes) focused on single authoring or experiencing functions, downloadable quick guides (PDFs with screenshots and operational checklists), and one or two simple self-check questionnaires hosted on readily available online forms. Publication can rely on a shared internal repository (no full LMS is required) and each partner may manage access as they prefer (intranet, protected links, shared folders). Content must be easy to update, since interfaces and workflows may evolve quickly during beta.

For the **final phase**, we suggest a non-binding evolution: adopting a more structured LMS with progress tracking, adaptive quizzes embedded in the XR experience, multilingual content, completion badges or certificates, and a continuously updated FAQ/knowledge base. The e-learning can also feed analytics dashboards to identify challenging sections and personalise learning paths automatically. Each pilot and technology partner will decide how far to implement these enhancements based on beta results and available resources.

5.3 LIVE VIRTUAL WORKSHOPS

In the **beta phase**, live virtual workshops are lean and highly operational. The aim is to clarify "how to use the available tools and to answer questions that surfaced during self-paced study. Each partner can host 1–2 focused sessions (60–90 minutes), record them, and make them available on demand. A typical structure includes a brief recap, a live demonstration of key authoring/experiencing functions, an open Q&A segment, and instant feedback collection via a short poll. Scheduling remains flexible: pilots choose time slots and platforms (Teams, Zoom, Webex) according to internal constraints. It is advisable to prepare a shared outline (agenda plus technical checklist) to ensure coherence across partners' workshops while still allowing local adaptation.

In the **final phase**, workshops may evolve into advanced thematic sessions. Topics can include advanced scripting, telepresence and social hubs, AI integration, or usage-data analysis. Collaborative work in breakout rooms, guided drills on real cases, and asynchronous follow-ups with small assignments or micro-projects can be introduced. Again, nothing is mandatory: each partner decides whether and how far to expand the format, based on beta findings and available resources.

5.4 ON-SITE IMMERSIVE LABS

In the **beta phase**, on-site labs are short, tightly scoped sessions designed to verify ergonomics, hardware setup, and the fidelity of a limited number of stable XR scenarios. Partners schedule only what is strictly necessary (e.g., a half-day slot to test headset comfort, controller mapping, and a single maintenance or assembly workflow). Local safety protocols and facility availability drive up the calendar; documentation (photos, short checklists, observation notes) should be captured immediately to avoid drifting beyond M18.

In the **final phase**, labs can expand into multi-day residencies, cross-team simulations, or comparative studies (XR versus traditional procedures). Advanced mixed-reality configurations, multi-user coordination drills, and instrumented performance measurements (e.g., wearable sensors, eye-tracking) can be added. Each pilot will decide whether such depth is warranted, based on beta evidence and resource constraints.

5.5 REMOTE CO-DESIGN SESSIONS

In the **beta phase**, remote co-design is used sparingly and pragmatically: brief screen-share meetings or lightweight social-VR touch points to refine recently released modules, adjust wording, or confirm UI tweaks. The focus is on rapid turnaround—capture feedback, update the asset, move on. Tools can be as simple as a shared whiteboard or a versioned document; the important part is the traceability of decisions within the beta window.

In the **final phase**, co-design can become a standing practice. Partners may host regular Social-VR studios, maintain shared scenario branches, and welcome contributions from external stakeholders. Structured protocols for idea submission, voting, and iterative prototyping can be adopted, but only if pilots see clear value and have the bandwidth to sustain them.

5.6 MAPPING ACTIVITIES TO OBJECTIVES AND TOOLS

This section links each training activity to the learning objectives it supports and to the MotivateXR tools (authoring/experiencing) it relies on, distinguishing clearly between what is implemented in the **beta phase** and what may be expanded in the **final phase**. Presenting the two horizons side by side prevents confusion: partners can focus first on the essential beta scope while already seeing optional avenues for future growth.

The first table (Table 6) maps the **beta configuration**: minimal activities, foundational/operational objectives, and the specific WP4/WP5 components in play.

TABLE 6 - BETA MAPPING: ACTIVITIES VS. OBJECTIVES AND TOOLS (M14–M18)

Activity (Beta scope)	Primary objective level(s)	Key outputs / evidence collected	Tools & components used (WP4 / WP5)
Self-paced micro-videos & quick guides	Foundational (tool fluency, safety basics)	Inscape VTS basic authoring features; KAYROX viewer; PDF/HTML guides	Inscape VTS basic authoring features; KAYROX viewer; PDF/HTML guides
Live virtual "how-to" workshops	Foundational → Operational (workflow assembly)	Session recordings, Q&A transcripts, mini-polls	Screen-share of authoring tools; Experiencing tool demo builds
Short on-site immersive labs (as needed)	Operational (procedure fidelity, ergonomics)	Observation logbooks, task-time measurements	Headsets (LeonardoXR/others), stable XR scenarios from WP5

Remote co-design touch points	Operational (content refinement)	Change logs, annotated storyboards, updated assets	Shared whiteboards/docs; versioned scene files; WP6 integration templates
Simple self-check questionnaires	Foundational (knowledge verification)	Pre/post scores, SUS/UEQ metrics	Online form tools; exported CSVs feeding WP7 analytics

The second table (Table 7) mirrors the structure for the final configuration, showing potential extensions, advanced objectives, and additional tool features.

TABLE 7 - FINAL MAPPING: ACTIVITIES VS. OBJECTIVES AND TOOLS (M32–M35, OPTIONAL EXTENSIONS)

Activity (Final options)	Advanced Objective Focus	Added Outputs / Metrics	Additional Tools / Features (beyond Beta)
LMS-based adaptive e-learning paths	Personalisation, continuous assessment	Progress analytics, adaptive quiz scores	Full LMS integration; embedded XR checkpoints; analytics dashboards
Thematic advanced virtual clinics	Scripting, AI integration, telepresence workflows	Project artefacts, peer review notes, follow-up tasks	Social/telepresence hubs; advanced authoring scripts; AI modules
Extended immersive lab residencies	Complex collaboration, mixed-reality operations	Comparative XR/non-XR data, multi-user performance logs	MR telepresence, multi-user sync, sensor/eye-tracking add-ons
Persistent Social-VR co-design studios	Learner agency, community content creation	Versioned scenario branches, contribution records	Social VR platforms, shared asset repositories, co-authoring APIs

These tables should be updated as pilots confirm their schedules and as tools evolve. They are not binding checklists but navigational aids: they show, at a glance, which activity supports which objective and which tool must be ready, both now (beta) and later (final).

6 PILOT-SPECIFIC TRAINING PLANS

6.1 PILOT 1: AEROSPACE MAINTENANCE TRAINING

This subsection describes the beta-test of the MotivateXR curriculum within the aerospace maintenance context. The pilot owner will oversee scenario selection, participant recruitment and assessment alignment. Technology providers will configure the authoring and experiencing tools to match aircraft component workflows.

The following flowchart illustrates a structured process divided into six key phases: Pilot Setup, Technology Configuration, Training Execution, Data Collection & Analysis, Evaluation & Feedback, and Iterative Refinement. Each phase contains specific activities and tasks, depicted as nodes within subgraphs. The diagram showcases the sequential flow and interdependencies between these phases, highlighting feedback loops and cross-phase interactions to ensure continuous improvement and alignment throughout the process.

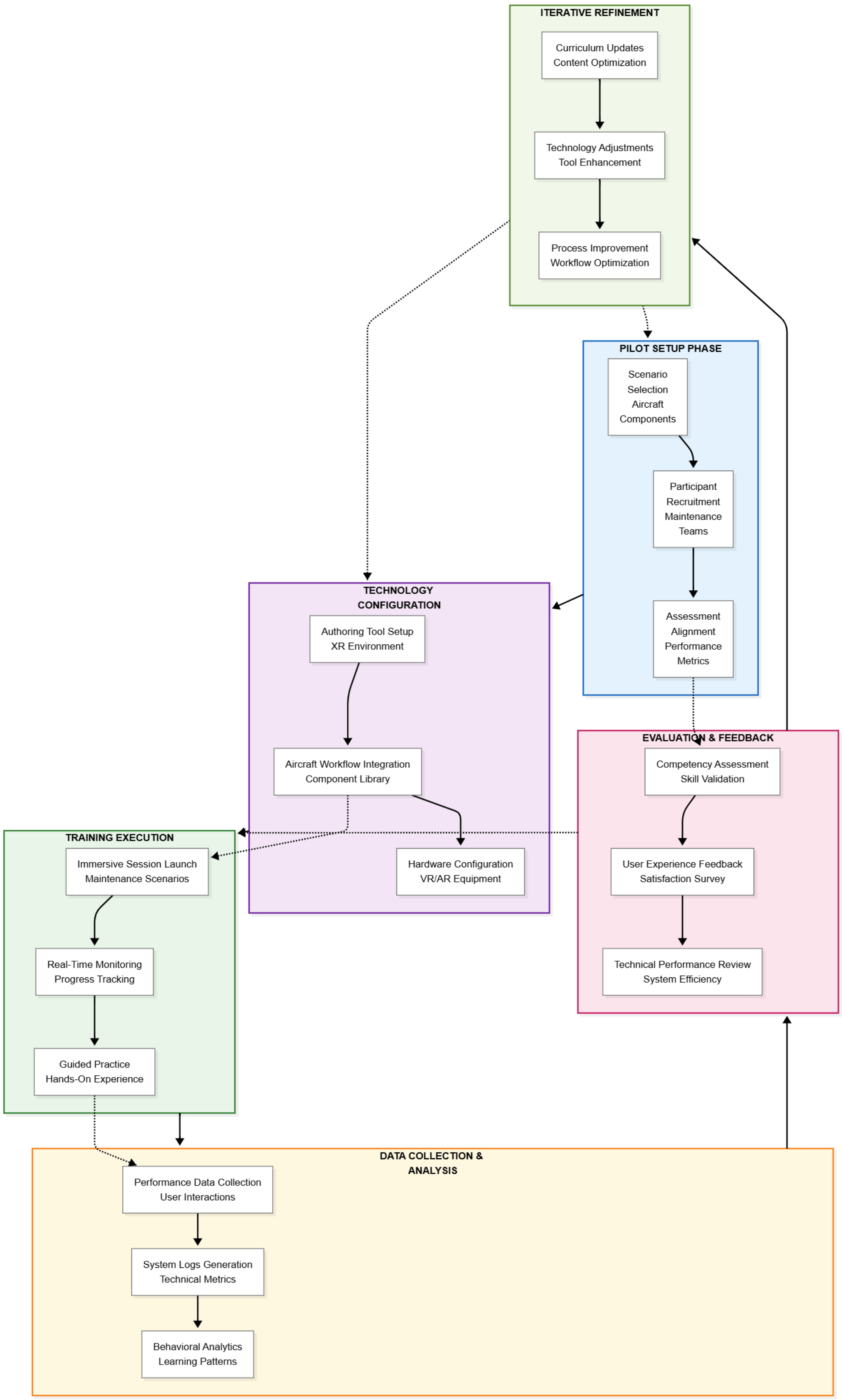


FIGURE 11 - STRUCTURED PROCESS FLOWCHART WITH PHASES AND FEEDBACK LOOPS

6.1.1 AEROSPACE PARTNERS AND INDUSTRIAL COLLABORATIONS

Pilot 1 involves key aerospace industry partners collaborating to deliver an XR-based aerospace maintenance training solution.

TABLE 8 - PILOT 1 – PARTNERS AND ROLES

Role	Organisation / partner	Brief role description
Pilot owner (task leader)	AV	Leading aerospace cluster responsible for pilot scenario definition, partner coordination, and overall evaluation.
Experiencing Provider	AA	EASA PART 147-certified training centre, responsible for hosting XR training sessions and participant evaluation.
Technology Provider	CS	French XR and simulation provider, offering Inscape VTS no-code authoring platform for scenario creation, enhanced with a dedicated creation assistant to address MotivateXR objectives, allowing interaction with AI models from SOP.
Technology Provider	SOP	Provides AI-powered knowledge models (GraphRAG) to enrich XR scenarios with interactive technical documentation.
Industrial Partner	Liebherr Aerospace	Supplies detailed technical scenarios and documentation for A320 air conditioning systems.

Key industrial collaborations:

- **Liebherr Aerospace**: Collaboration focuses on defining realistic maintenance scenarios for the A320 air conditioning pack.
- **Airbus Commercial:** a collaboration agreement is under discussion but has not yet been signed. If finalised, it would provide access to A320 technical documentation for scenario contextualization and validation in the second pilot iteration and the final MotivateXR release.

6.1.2 PILOT SCOPE, SCENARIO, AND LEARNING OUTCOMES

Scope:

The beta test evaluates the efficacy and usability of the MotivateXR platform for training maintenance technicians in aircraft system inspections, specifically focusing on the Airbus A320 air conditioning pack.

Scenario details:

One maintenance procedure has been prioritised for the beta phase:

Primary Heat Exchanger (PHX) Inspection

a. Inspection steps include disassembly, visual checks, and reassembly.
b. Realistic interactions and error management are integrated.

This procedure was selected due to frequent operational use and complexity, providing rich data for evaluation.

Expected learning outcomes:

- Technicians demonstrate increased accuracy and speed in performing maintenance inspections.
- Technicians effectively use Virtual & XR tools to access and interpret technical documentation.
- Supervisors efficiently monitor and assess trainee performance in Virtual & XR sessions.

6.1.3 DETAILED WORKPLAN AND MILESTONES

The beta test timeline includes preparation, execution, and evaluation phases clearly articulated:

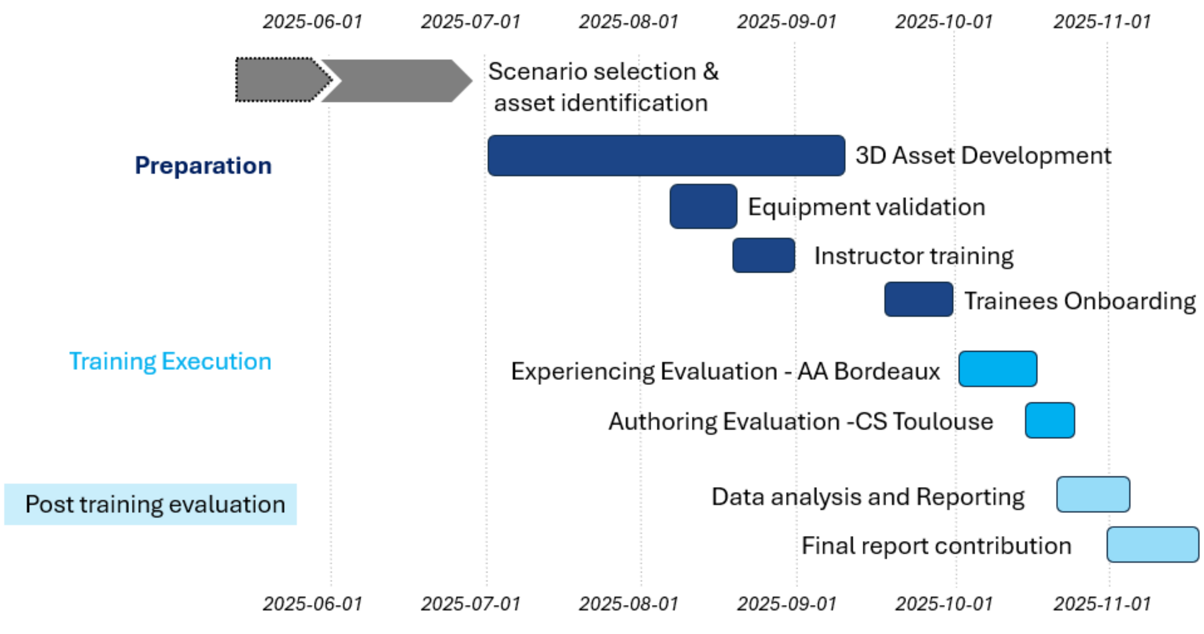


FIGURE 12 - AEROSPACE MAINTENANCE BETA PILOT SCHEDULE

Provided dates are indicative and meant to meet the main milestones and remain subject to adjustments depending on stakeholders' availability.

<u>Inscape VTS Authoring & Experiencing Training</u>

This section outlines the training plan for the use of **Inscape VTS**. The training is structured to efficiently build user proficiency in both the **Authoring Environment** (scenario creation) and the **Experiencing Environment** (scenario execution and supervision), tailored to the needs of aerospace maintenance training.

Objectives

The training aims to ensure that:

- **Instructors** can autonomously create and adapt XR training scenarios using Inscape VTS.
- **Trainees** can navigate and interact with XR scenarios in the Player environment.

Training Structure

The training is divided into two complementary tracks:

Track	Target Audience	Focus	Duration
Authoring Track	Instructors, content creators	Projects & Scenario creation, 3D asset integration, behaviour scripting, AI-assisted features	Total ~1.5day
Experiencing Track	Trainees, instructors	Scenario execution, interaction with virtual components, supervision tools	~0.5 day

Each track includes:

- **Introductory remote workshops** (live or recorded)
- **Quick reference guides** and tutorials
- **Hands-on labs** using real pilot scenarios
- **Support sessions** with CS experts

Authoring Track – Key Steps

1. **Project Setup**: Creating a new Inscape VTS project, importing 3D models (e.g.,PHX), and defining scenario metadata.
2. **Component Behaviour Definition**: Associating behaviours to components (e.g., disassembly steps, inspection logic).
3. **Procedure Scripting**: Using the visual logic editor to define step-by-step workflows.
4. **AI-Powered Enhancements**: Using an AI-based creation assistant to transform technical documentation information into scenario steps.
5. **Testing & Export**: Validating the scenario and exporting it for use in the Player.

Experiencing Track – Key Steps

1. **Scenario Launch**: Loading the XR scenario on the headset or desktop player.
2. **Interaction Training**: Performing inspection tasks using controllers or gestures.
3. **Supervision Tools**: Instructors monitor progress, trigger hints, and collect logs.
4. **Feedback & Logging**: System logs and observation notes are collected for evaluation.

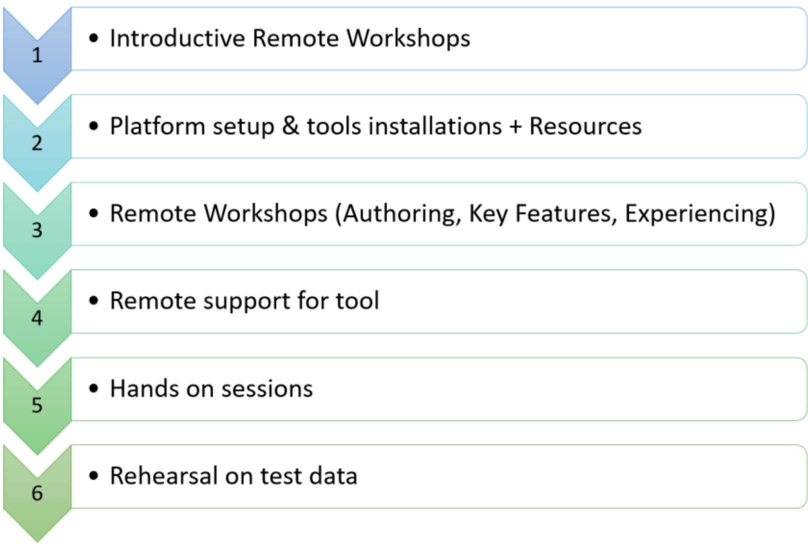
Resources Provided

- **Tutorials** (3–5 min each) for key authoring step
- **Quick guides** with annotated screenshots
- **Sample projects** for practice
- **Support channel** for Q&A and troubleshooting

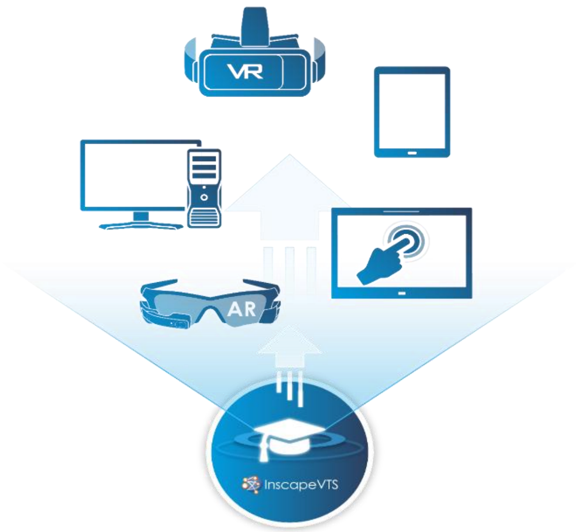
Timeline & Milestones

Activity	Responsible	Deadline
Finalization of training materials	CS GROUP	15/08/2025
Training sessions	CS GROUP + AA	15/08–30/09/2025
Trainees on boarding	AA	September 2025
Feedback collection & iteration	AV + AA	October 2025

To go further in the training details, the following steps are planned for Pilot Training, to make sure End Users acquire basic knowledge to be able to use and evaluate the technical solution for the dedicated Pilot:



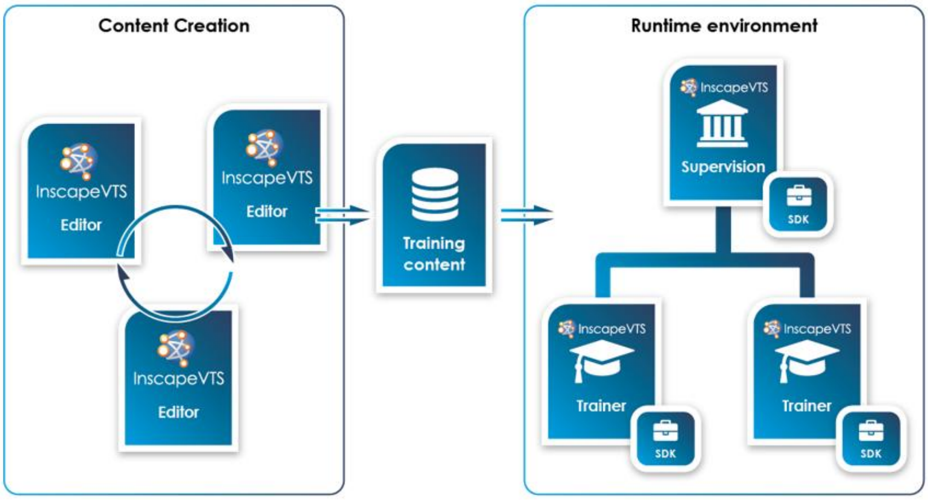
1. Remote Workshops for introduction on the MotivateXR solution and platform, and key features to evaluate



2. Motivate XR platform & tools installation for End Users

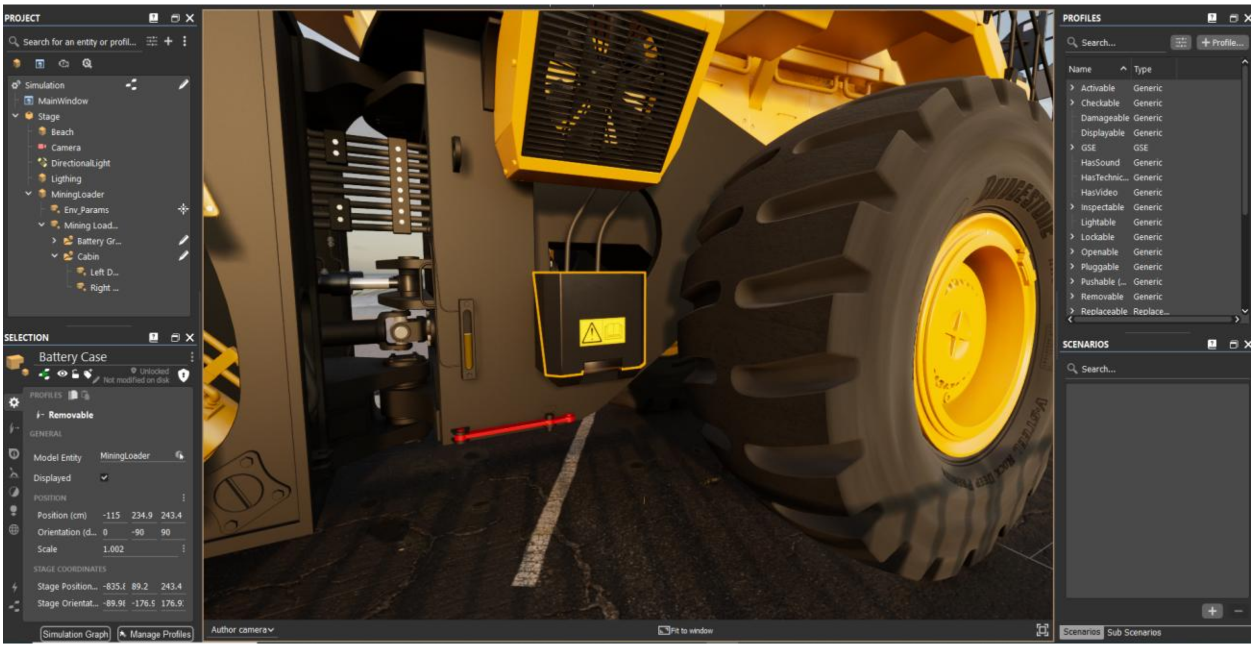
   Provide first resources (e.g. presentations, introduction videos, etc.) to consolidate basic knowledge

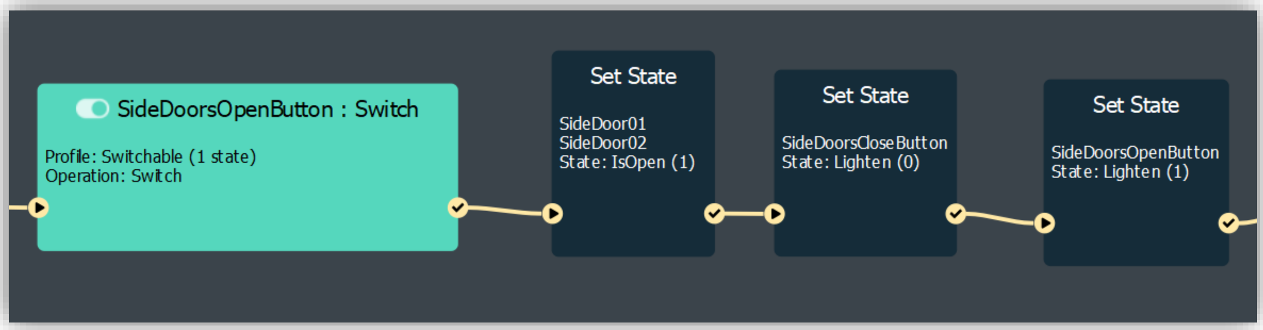
3. Remote Workshops on key steps on Authoring process for Pilot key features explanations & Experiencing phase (Instructor & trainees)



4. Remote support from solution providers

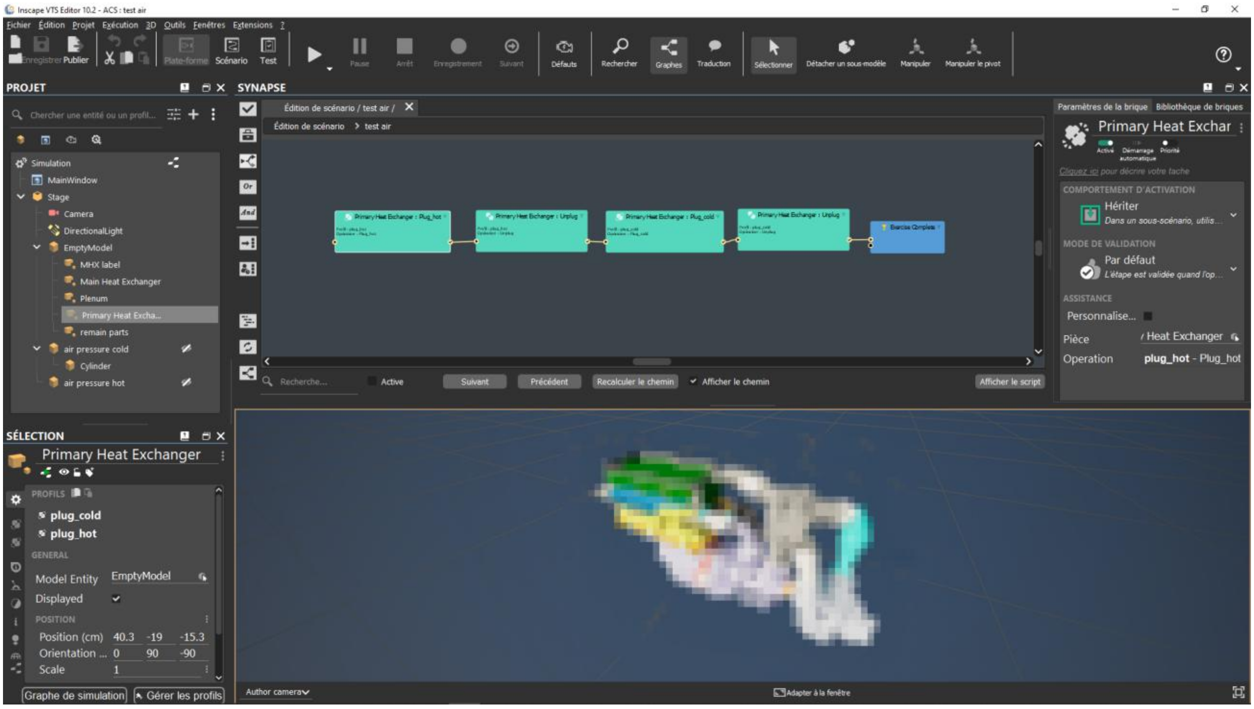
5. Hands-on sessions using the software solution





a. Technical documentation management (for knowledge graph construction)
b. Inscape VTS Authoring Project creation
c. Key authoring steps: 3D, components behaviour, procedures
d. Focus on AI-powered functionalities
e. Export project for Experiencing use
f. Experiencing specific steps: launch of exercises, trainees' actions on the platform, instructor follow-up for supervision

6. Pilot rehearsal on test data – to make sure practical skills are aligned to objectives



6.1.4 TECHNICAL INPUTS AND RESOURCES STATUS

TABLE 9 – PILOT 1 – TECHNICAL INPUTS

Input type	Description	Status (received/pending/due date)
Technical Documents	Liebherr CMM documentation (Pack, ACM, PHX, MHX, REH, COND, PL, FCV)	Received
Digital Assets	3D digital mock-up of A320 air conditioning pack	Partially received; additional models due by 15-09-2025
Hardware & Equipment	Instructor PCs at AA	Verified, OK
Hardware & Equipment	Headsets and student PCs at AA	Verified, OK

6.1.5 EVALUATION AND DATA COLLECTION METHODS

Aligned with the Evaluation and Iteration Plan (Chapter 7), the pilot evaluation will utilise:

- **UX questionnaires** to measure technician satisfaction and perceived usability.
- **System logs** to record task completion times, errors, and interaction patterns.
- **Observation logbooks** maintained by instructors to capture qualitative feedback.
- **Interviews** for in-depth user insights post-training sessions.

This methodology ensures a comprehensive assessment of learning effectiveness, platform usability, and operational improvement.

6.1.6 NEXT STEPS AND ACTION PLAN

TABLE 10 – PILOT 1 – NEXT STEPS

Next step activity	Responsible Partner/Person	Deadline	Status	Notes
Finalise 3D modelling of missing equipment	CS GROUP	15-08-2025	Done	Based on photos collected on 24/06
Scenario Step Definition	CS GROUP, Liebherr Aerospace	20-08-2025	Done	Collaborative review and definition
Airbus Documentation Synchronisation Meeting	AV, CS GROUP, SOPRA, Airbus, Liebherr	05-08-2025	Done	Meeting to clarify documentation delivery
Equipment Validation at AA	AA	31-08-2025	Done	Verify headsets and student computers
Instructor Training	AA, CS GROUP	31-09-2025	In progress	Ensure instructors are ready for trainee sessions
Trainees Onboarding	AA	31-09-2025	ToDo	Identify and prepare for the Experiencing evaluation, a representative panel of Aero students
Prepare the Post-training evaluation	AV, AA	20-10-2025	ToDo	Prepare the materials for the data analysis and benchmarking phase.
Finalise the collaboration agreement with Airbus.	AV, CS Group, Sopra Steria	30-11-2025	In progress	The NDA and collaboration agreement are currently under discussion. Airbus data is expected to be available for use in the final pilot.

6.2 PILOT 2: HOME APPLIANCE REPAIR TRAINING

The following diagram illustrates the comprehensive workflow for the Home Appliance Repair Training Pilot. It outlines a structured, iterative process across five key phases:

1. **Pilot Setup:** Initial preparations, including defining specific repair tasks, ensuring the lab is ready on-site, and recruiting technicians.
2. **Content Authoring & Integration:** The process of importing technical manuals and documentation, integrating them into a no-code authoring tool, scripting interactive checkpoints, and defining crucial error-handling scenarios.
3. **XR Workflow & Deployment:** Focusing on building the Extended Reality (XR) training scenarios, calibrating the headsets for optimal ergonomics, enabling offline functionality for field use, and finally deploying the content to the XR devices.
4. **Training & Data Collection:** The execution phase, where immersive training sessions are launched, user performance metrics are collected, system logs are generated, and behavioural analytics are monitored.
5. **Evaluation & Refinement:** The final stage involves assessing technician competency, gathering user experience feedback, reviewing technical performance, and iteratively refining the XR content and overall workflow based on the collected data and feedback.

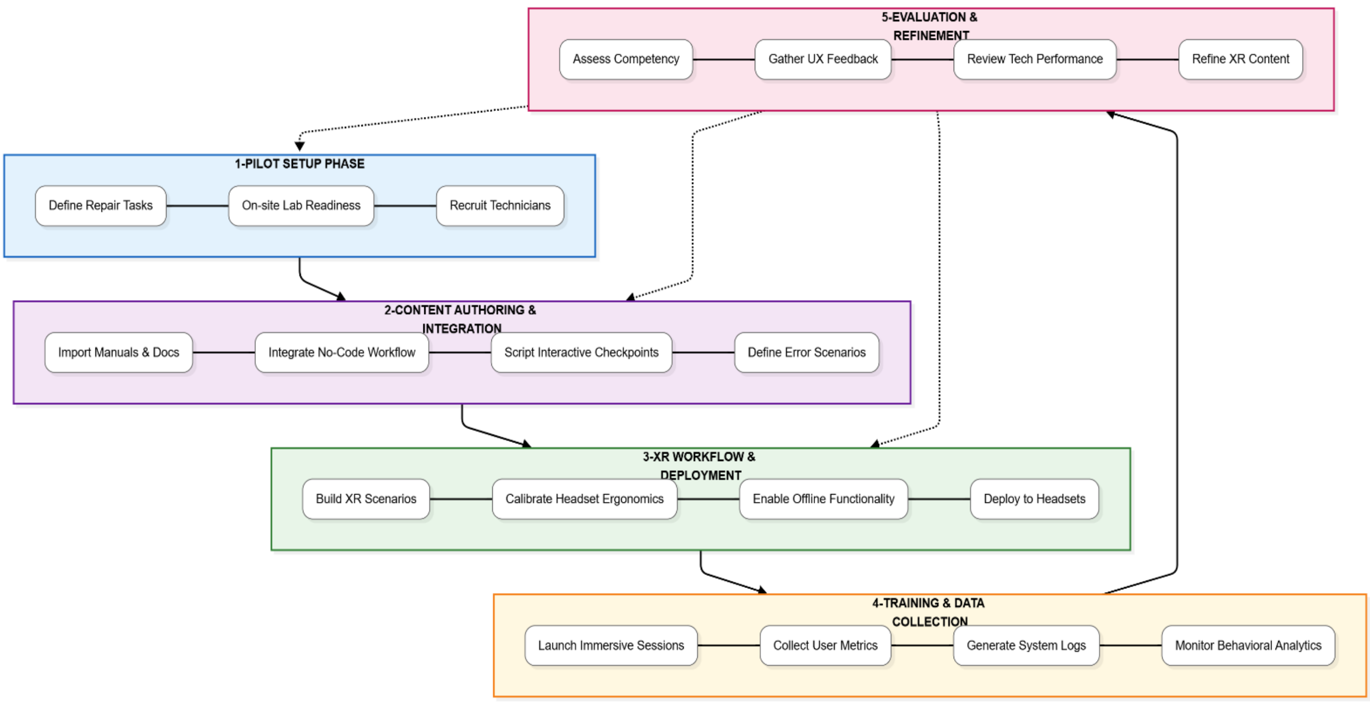


FIGURE 13 - HOME APPLIANCE REPAIR TRAINING PILOT WORKFLOW

6.2.1 HOME APPLIANCE PARTNERS AND INDUSTRIAL COLLABORATIONS

Pilot 2 of the MotivateXR project brings together the following partners:

TABLE 11 – PILOT 2 – PARTNERS AND ROLES

Role	Organisation / partner	Brief role description
Pilot owner (task leader)	GOR	Leading pilot implementation, pilot scenario definition, partner coordination, and overall evaluation
Technology Provider	TEC	TEC is offering KAYROX, enabling the creation of XR content by offering intuitive, no-code tools that empower non-expert users to design engaging and practical experiences with ease.
Technology Provider	CS	French industrial company, XR and simulation provider, offering Inscape VTS no-code authoring platform for scenario creation, enhanced with a dedicated creation assistant to address MotivateXR objectives, allowing interaction with AI models from SOP.
Technology Provider	2F	2F is offering a 3D videogrammetry scanning system to generate high-quality 3D models from visual data for XR-based training and support.
Technology Provider	UPM	Technology provider, bringing Semantic Processing Engine
Technology Provider	CETMA	Assisting with the pilot scenario definition.

6.2.2 PILOT, SCOPE, SCENARIO, AND LEARNING OUTCOMES

Scope:

The beta test evaluates the efficacy and usability of the MotivateXR platform for training service technicians in the home appliances industry, specifically focusing on the repair of washing machines (WM). The pilot will focus on the after-sales maintenance support, and washing machines repairing operations performed by technicians, or end-users. Additionally, the pilot will provide an enhanced spare part list (SPL), which is currently available as a 2D drawing. This SPL is usually used by technicians and service managers for identifying spare parts that are needed in the repair process. The goal is to upgrade this SPL from 2D to an interactive 3D SPL. The interactive SPL should allow rotating the appliance view, zooming in/out, removing or hiding unnecessary parts, and accessing interactive data (e.g., code, dimensions, weight, version, video manuals) related to each spare part, speeding the identification process and helping technicians with the ordering process, which is performed outside MotivateXR.

Scenario details:

For the beta phase, we selected/prioritised the preparation of extended reality (XR) troubleshooting instructions for resolving the washing machine malfunction identified as ERROR-07 (E7). This error is related to a pumping failure, which occurs when the water level does not drop below the hydrostat level after draining. In such cases, the washing program will automatically attempt the draining step again. If the error reappears a second time in succession, the washing program halts, and an error code is displayed. The XR instructions will be split into two levels: simple troubleshooting steps intended for end-users, and more advanced repair procedures reserved for service technicians. The aim is to create an immersive, guided repair experience, where users can follow visual and interactive steps to resolve the malfunction efficiently and safely, depending on their skill level.

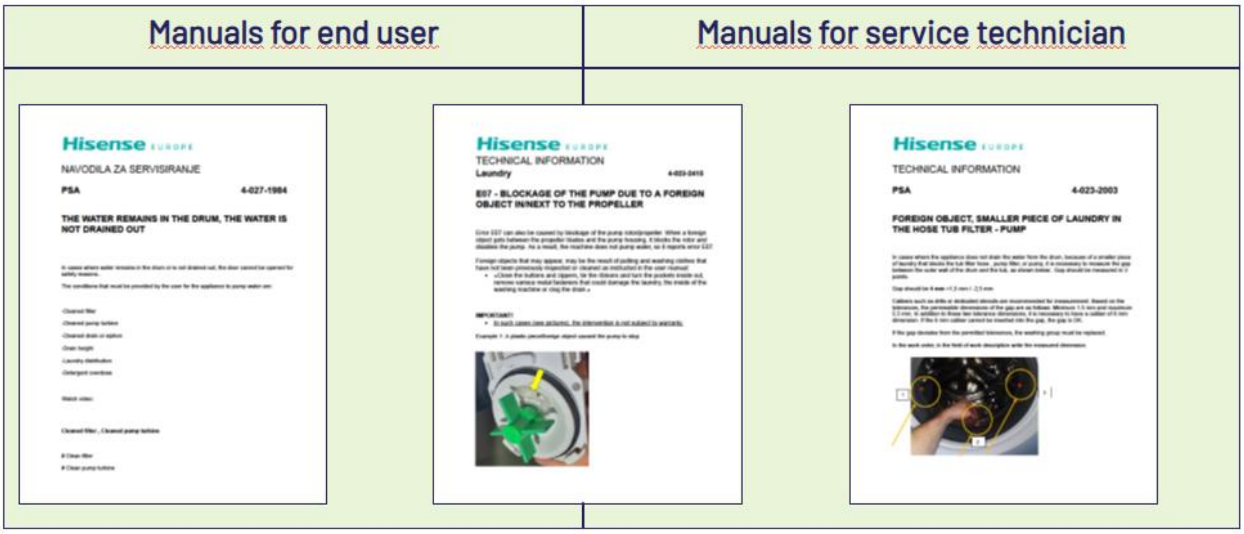


FIGURE 14 – MANUALS EXAMPLES

For the end-user pathway, the XR guide will include instructions such as cleaning the filter, checking and cleaning the wall siphon, inspecting and cleaning the pump turbine, and adjusting the detergent dosage to prevent overdosing, which can cause foaming and other operational issues. Visual overlays in the XR environment will highlight the relevant components of the washing machine, guiding the user through each step interactively, from locating the filter to restarting the program after completing the recommended actions. The content will be designed for clarity and safety, ensuring the user can confidently handle these basic maintenance tasks without specialised tools or training.

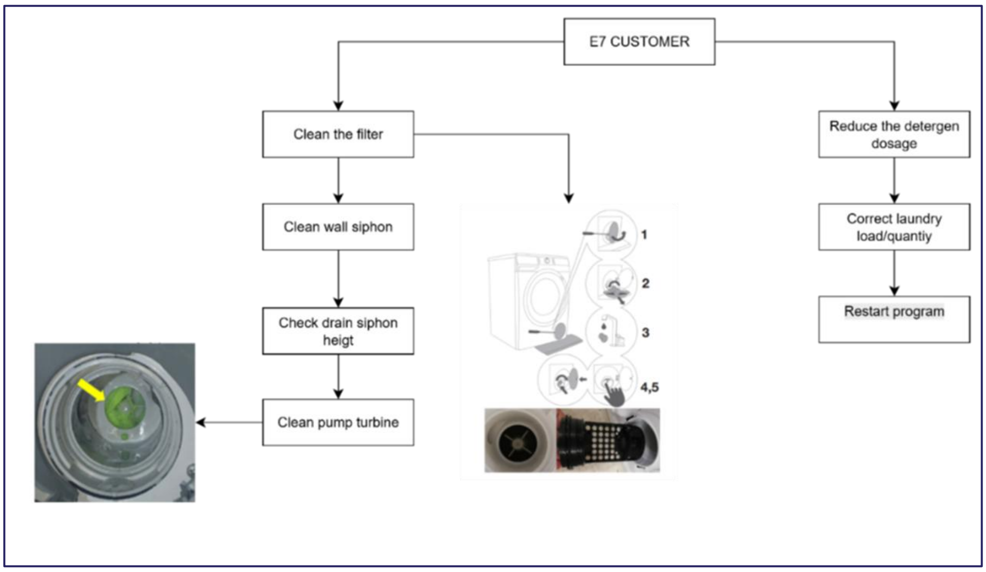


Figure 15: Simple E7 flowchart for end users

For the service technician pathway, the XR scenario will extend to more complex troubleshooting. This will include advanced diagnostics such as inspecting the wiring harness, verifying and adjusting the level sensor position, checking and clearing the outlet hose, and addressing potential clogs in the tub filter hose. Additionally, the XR guide will assist in pump inspection or replacement if necessary. Technicians will be able to access exploded diagrams, 3D component views, and real-time procedural cues, enabling them to carry out precise repairs. By dividing the troubleshooting flow into these two clearly defined tracks, the MotivateXR solution ensures that simple problems are resolved quickly by the user, while more technical issues are addressed by qualified professionals, thereby optimising repair efficiency and reducing downtime.

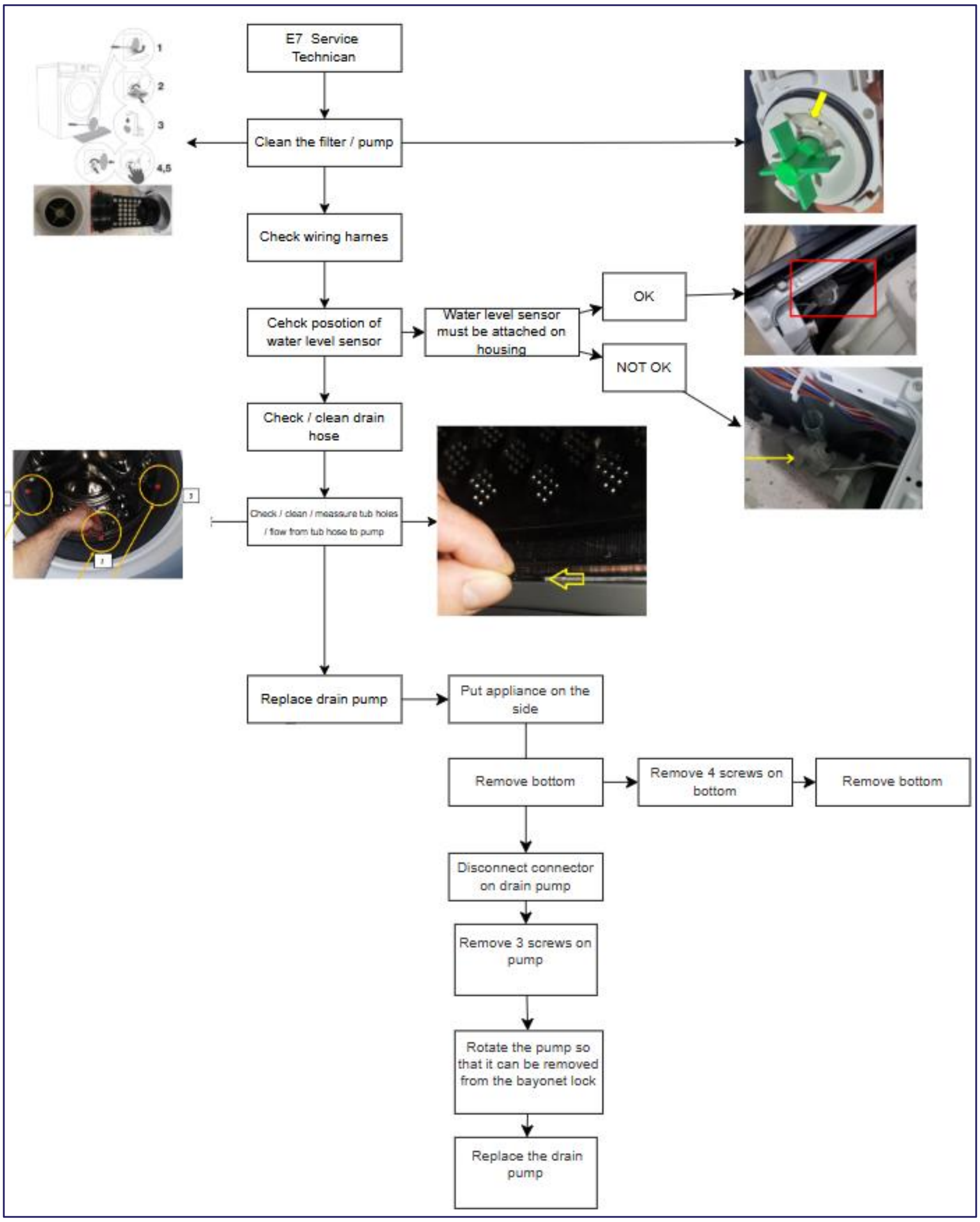


Figure 16: Simple E7 flowchart for service technicians

Expected learning outcomes:

- Technicians demonstrate increased accuracy and speed in performing maintenance inspections.
- Technicians effectively use Virtual & XR tools to access and interpret technical documentation.
- Supervisors efficiently monitor and assess trainee performance in Virtual & XR sessions.

6.2.3 DETAILED WORKPLAN AND MILESTONES

The beta test timeline includes preparation, execution, and evaluation phases clearly articulated:

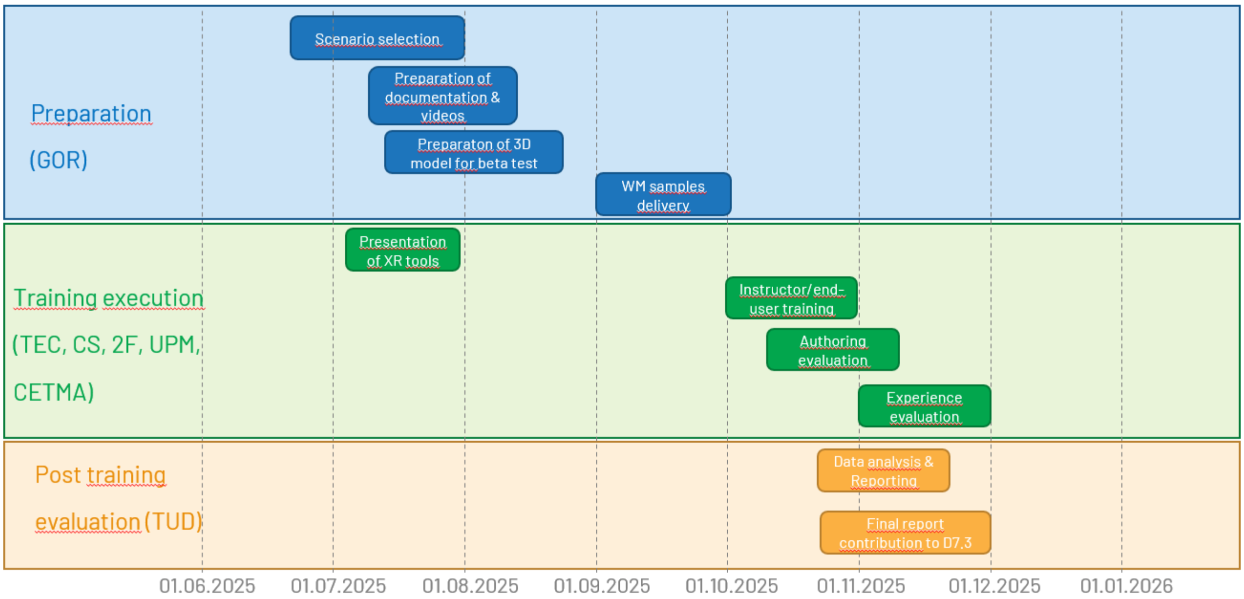


FIGURE 17 – HOME APPLIANCE REPAIR BETA PILOT SCHEDULE

Provided dates are indicative and meant to meet the main milestones and remain subject to adjustments depending on stakeholders' availability.

KAYROX Training

This training plan is designed to help the Gorenje team successfully adopt **KAYROX**, Tecnalia's no-code XR platform, enabling both the **creation** and **use** of immersive experiences across technical and end-user applications.

It combines hands-on authoring training with best practices for real-world deployment on XR devices such as tablets and smart glasses. In addition, at the end of this section, we list the resources that will be available.

Objectives:

By the end of this training program, Gorenje team will be able to:

- Confidently use the **KAYROX authoring platform** to create, modify, and manage XR experiences.
- Understand the structure of XR experiences: steps, markers, assets, and objects.
- Build content for **two key user profiles**:
    - **Field technicians**, through immersive XR-guided repair flows.

- **End users**, via intuitive, XR-guided instructions for product installation, use, and basic troubleshooting

- Deploy XR experiences efficiently on **target devices**: mobile, tablets, and XR glasses.
- Operate and support KAYROX players in real environments, including marker alignment and real-time editing when needed.
- Manage and organise their content ecosystem using folders, publication contexts, and collaborative workflows.

Authoring Key Steps:

These are the main sections that will be part of the training, and will be covered in detail in the workshops:

- **How to upload assets to KAYROX**
  Easily import images, videos, 3D models, or audio files via drag-and-drop or file selection from the browser.

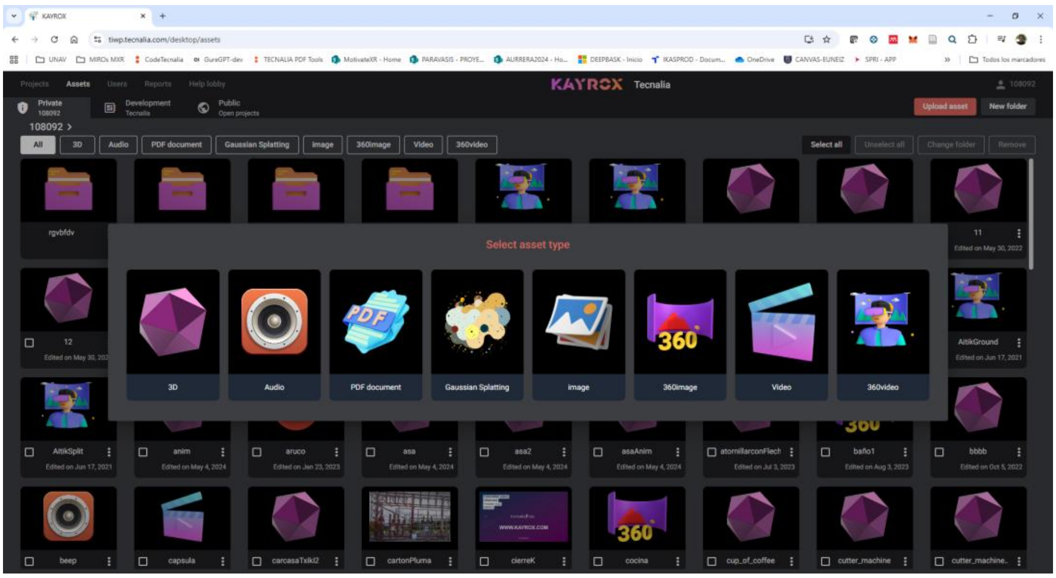


FIGURE 18 – KAYROX UPLOAD ASSET MENU

- **How to create an experience**
  Start from the dashboard by choosing a template or a blank project, then configure steps, assets, and logic.
- **How to add/duplicate steps in an experience**
  Each experience consists of sequential steps that can be added or duplicated to reuse structure or similar content.
- **How to link steps and create itineraries**
  Steps can be connected through buttons or conditions, enabling linear or branched navigation based on user interaction.
- **Explanation of the Marker concept and types of Marker**
  A marker anchors the experience to the real world and can be an image, QR code, or 3D reference object.

- **Explanation of how to add Objects and types of Object**
  Objects are visual elements in the experience (text, 3D models, buttons, images...) placed either in space or on screen.

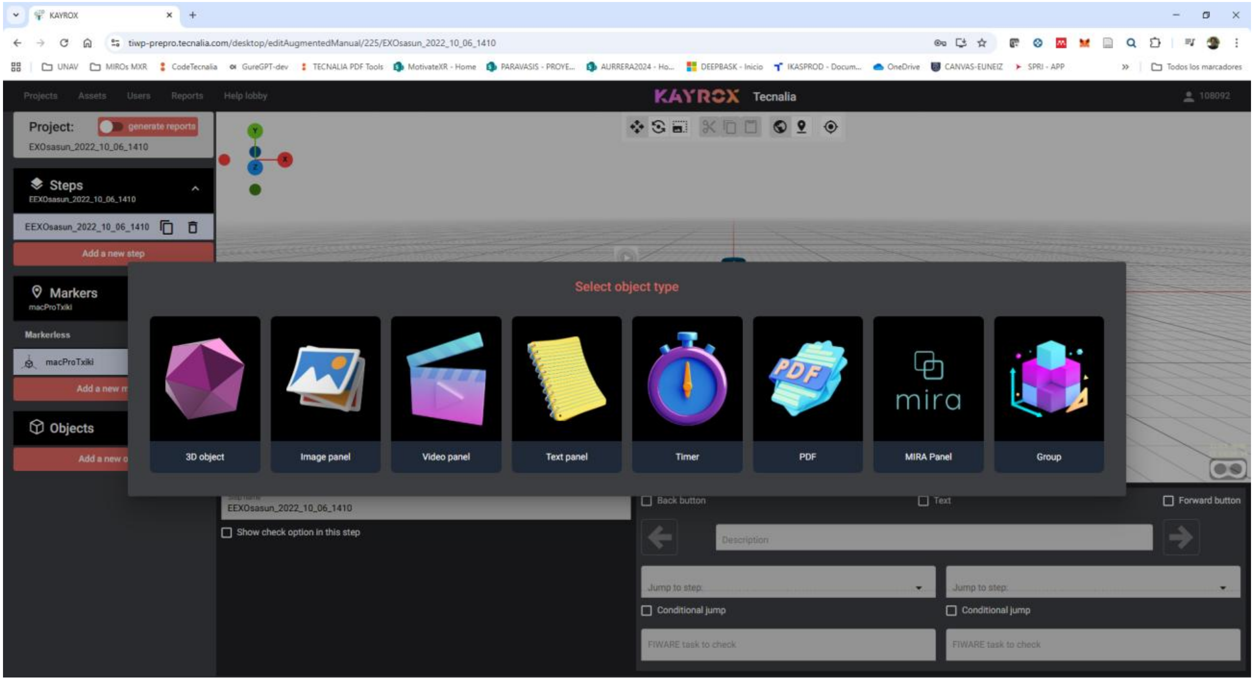


FIGURE 19 – KAYROX OBJECT SELECTION MENU

- **How to duplicate an experience**
  An existing experience can be cloned with one click to create a new editable copy without affecting the original.
- **Workspaces and publishing contexts**
  Experiences can be developed in testing environments and published into production contexts defined by user, device, or language.
- **How to organise assets and experiences in folders**
  KAYROX allows you to structure content in folders for easy management and reuse across projects, teams, or experience types.

Experiencing Key Steps:

These are the main sections that will be part of the training, and will be covered in detail in the workshops:

- **How to install the players (Tablet, glasses)**
  Players are installed via Google Play or direct installation, compatible with Android tablets and XR headsets like Quest 3 or Leonardo XR.
- **How to access and run an XR experience**
  Users launch experiences by selecting them from the player menu or scanning a QR code to start interactive playback.

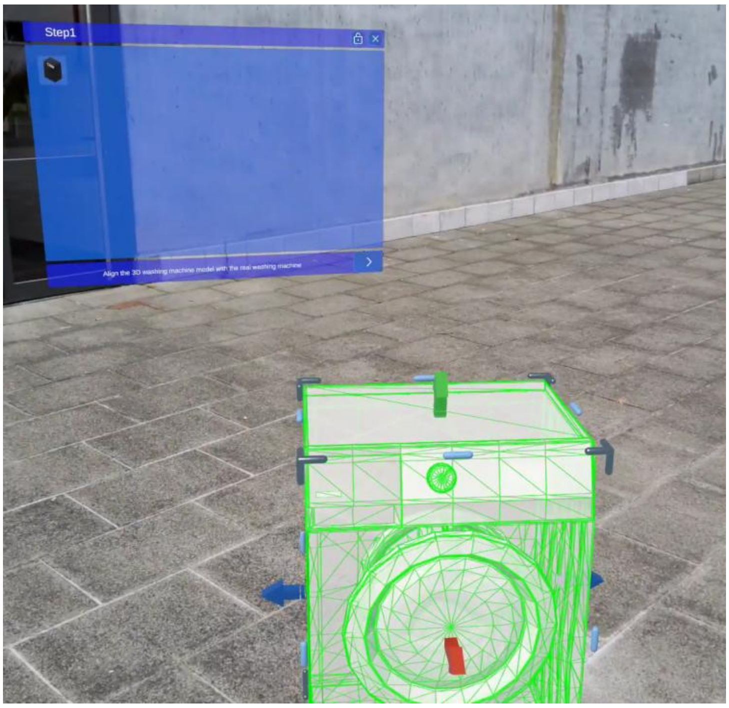


FIGURE 20 – KAYROX PLAYER SHOWING STEPS

- **How to align the marker**
  The user points the device at a physical marker (image, QR, object) to correctly anchor the virtual content to the real-world scene.
- **How to edit the experience from the player**
  Authorised editors can switch to editing mode directly from the player to adjust positions, texts, or steps in real time.

In a complementary manner, simple training will be provided on KAYROX Remote Assistance. It will consist simply of logging in, establishing a call, and sharing a relevant file (PDF or 3D).

Resources Provided:

- Video Tutorials for key (authoring/experiencing) steps
- PDF guides with screenshots
- Sample projects for practice
- Support channel for Q&A and troubleshooting

Schedule Overview:

TABLE 12 - WORKPLAN

Activity	Dates	Duration	Lead Partners	Location

KAYROX Authoring Training workshop	08/10/2025	0,5 day	TEC	Online
KAYROX Experiencing Training workshop (if needed)	TBD	1-2 hours	TEC	Online (Onsite can be considered if needed)

Inscape VTS Experiencing Training

The training plan will follow basically the same process as Pilot 1, focusing here on the Experiencing aspect.

Objectives

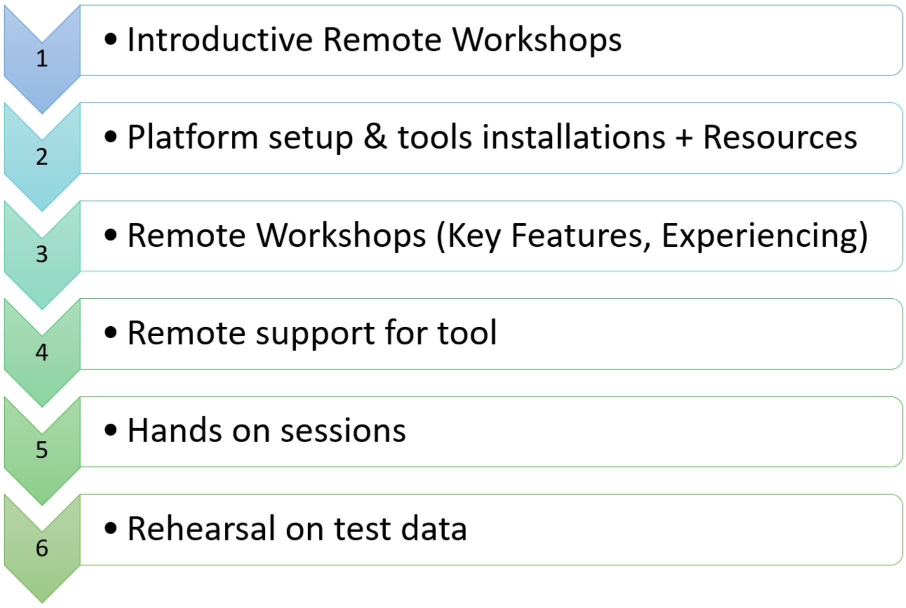
The training aims to ensure that:

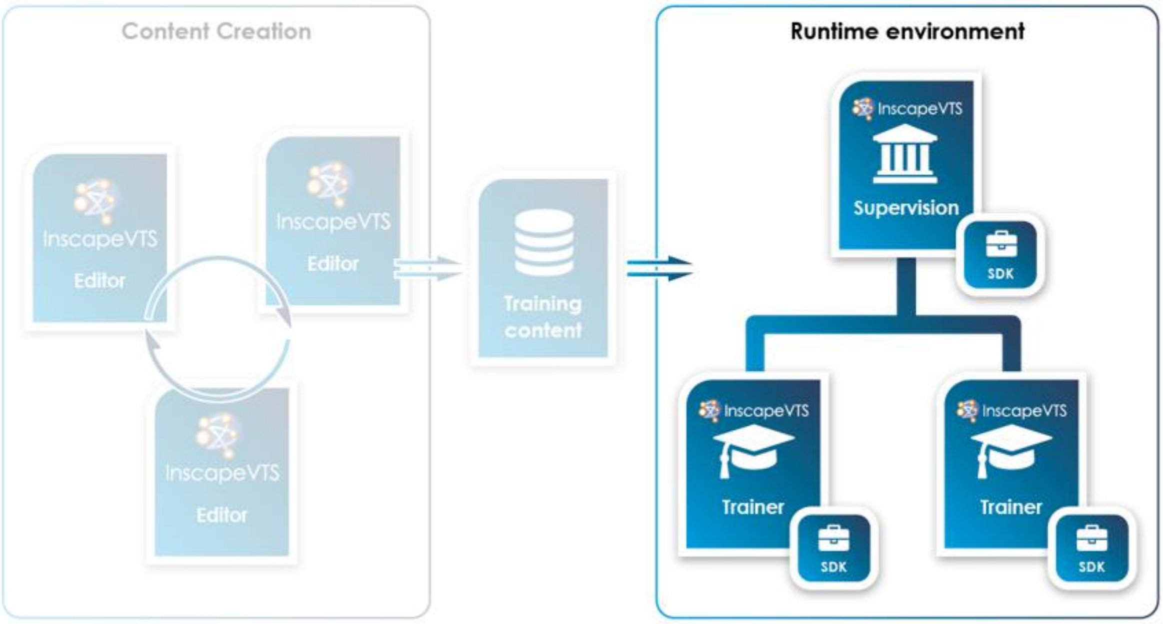
- **Instructors** can autonomously launch an XR training exercise using Inscape VTS.
- **Trainees** can navigate and interact with XR scenarios in the Player environment.

Experiencing Track	Trainees, instructors	Scenario execution, interaction with virtual components, and supervision tools	~0.5 day

The Experiencing track includes:

- **Introductory remote workshops** (live or recorded)
- **Quick reference guides** and tutorials
- **Hands-on labs** using real pilot scenarios
- **Support sessions** with CS experts





2F Training

This section provides a detailed overview of the training plan to enable the development of high-quality three-dimensional (3D) models. These models are intended for implementation in Extended Reality (XR) environments.

2F has developed precise instructions and recommendations that guide Gorenje experts on how to record videos in a way that ensures they are suitable for 3D reconstructions. These guidelines highlight the most important aspects of video capturing, ensuring that the recorded material meets both technical and quality standards required for accurate model generation.

Objectives:

- Equip Gorenje professionals with a solid understanding of the technical aspects that are critical when recording videos for 3D reconstruction.
- Establish a standardized approach to video recording so that all captured material is consistent and reliable. Following uniform procedures guarantees that the 3D models created are of a consistent quality, reduces variability in results, and streamlines the reconstruction process, making it both faster and more efficient.

6.2.4 TECHNICAL INPUTS AND RESOURCES STATUS

TABLE 13 – PILOT 2 – TECHNICAL INPUTS

Input type	Description	Status (received/pending/due date)
Technical Documents	3D model of Gorenje washing machine in STEP format	Shared
Technical Documents	3D model in STEP format of selected components for beta scenario (WM pump, pump housing …)	Shared
Technical Documents	Manuals (technical information) for error-07 troubleshooting (manuals for end user & service technician)	Shared
Technical documentation	Youtube videos	Shared
Technical documentation	Simple error-07 troubleshooting flowcharts for customers and service technicians	Shared

6.2.5 EVALUATION AND DATA COLLECTION METHODS

Aligned with the Evaluation and Iteration Plan (Chapter 7), the pilot evaluation will utilize:

- **UX questionnaires** to measure technician satisfaction and perceived usability.
- **System logs** to record task completion times, errors, and interaction patterns.
- **Observation logbooks** maintained by instructors to capture qualitative feedback.
- **Interviews** for in-depth user insights post-training sessions.

This methodology ensures a comprehensive assessment of learning effectiveness, platform usability, and operational improvement.

6.2.6 NEXT STEPS AND ACTION PLAN

TABLE 14 – PILOT 2 – NEXT STEPS

Next step activity	Responsible Partner/Person	Deadline	Notes
WM samples	Gorenje	09/2025	Gorenje will deliver WMs to partners CETMA, 2F and TEC
Instructor/end-user training	TEC, CS, 2F and UPM	10/2025	TEC, CS, 2F and UPM will provide training to GOR personnel
Authoring evaluation	All	10/2025	GOR together with TEC, CS, 2F and UPM will evaluate authoring tools
Experience evaluation	All	11/2025	GOR together with TEC, CS, 2F and UPM will evaluate experiencing tools
Data analysis & Reporting	TUD	11/2025	TUD will capture and analyse users' feedback
Final report contribution	All	11/2025	All partners will contribute to deliverable D7.3

6.3 PILOT 3: ALUMINIUM INDUSTRY ASSEMBLY TRAINING

6.3.1 ALUMINIUM PARTNERS AND INDUSTRIAL COLLABORATIONS

Pilot 3 targets the **aluminium frame assembly** domain, with the objective of modernising and streamlining the training processes involved in assembling complex aluminium systems. Conducted by the **Architectural Aluminium Academy (AAA)**, as the pilot owner, this pilot explores how XR technologies can enhance the comprehension, retention, and hands-on execution of industrial procedures in real-life vocational training environments.

Partner Profiles and Roles

Architectural Aluminium Academy (AAA) is the Greek competence centre for the Aluminium Architectural Systems. AAA organises pilot 3 for the AI-driven XR assembly system software suite and the industrial processes and methodologies to enable easier and safer for the user, aluminium assembly process. AAA provides domain expertise and training infrastructure, offering constructors 3D manuals and real-time remote assistance to guide assembly processes.

D-Cube (D3) specialises in cutting-edge quality assurance solutions for diverse industrial domains, using computer vision, machine learning, AI and big data analytics. Over the last few years, D-Cube (D3) has recognised a growing demand in the market for upgrading industrial training, especially through immersive technologies. Responding to this, D-Cube (D3) has actively invested in developing advanced XR applications, combining its expertise in technology with industrial insights.

D-Cube (D3) develops and maintains the remote training XR system tailored for AAA's needs, contributing critical XR authoring and visualisation tools integrated into the MotivateXR ecosystem.

The training activities take place in AAA's dedicated facilities and are designed to simulate real-world conditions as closely as possible. The learning journey is structured into three main phases:

1. **Familiarisation:** trainees are introduced to the aluminium system and its parts
2. **Visualisation:** they engage with an interactive, step-by-step XR-based simulation of the assembly process
3. **Execution:** they apply the knowledge by performing the physical assembly with XR guidance

At the core of the pilot are several XR tools developed by **D-Cube (D3)**, which is the primary technology provider, and integrated into the broader MotivateXR ecosystem:

- The **Narrative Editor**, a no-code XR scenario authoring tool, allows the creation of detailed assembly instructions based on CAD models and enriched with multimedia assets.
- The **RTXR Player** enables immersive playback of the authored scenarios through HoloLens 2 headsets, guiding trainees in a spatial, step-by-step manner.
- The **Streaming Editor** provides instructors with the ability to observe, supervise, and interact with learners remotely or in classroom settings.

The architecture of the platform is entirely modular and scalable, supporting the creation of multiple training scenarios for a wide range of aluminium systems. Thanks to the import support for CAD models from tools such as Autodesk Inventor, new systems can be integrated quickly, maintaining the original naming, structure, and part hierarchy.

This pilot not only focuses on effective skill transmission but also aims to evaluate how immersive training can shorten on boarding time, standardise assembly quality, and improve confidence among professionals entering the aluminium construction industry.

Upcoming piloting stages will validate the effectiveness of the XR tools and scenarios through structured training sessions with AAA participants in authentic workshop conditions.

TABLE 15 – PILOT 3 – PARTNERS AND ROLES

Role	Organisation / partner	Brief role description
Pilot owner (task leader)	AAA	Leads the design and implementation of the training workflow; provides domain and training expertise.
Technology Provider	D3	Develops and maintains the XR tools used in the pilot.

Key Industrial Collaboration

The pilot is based on a **strategic industrial partnership between the Architectural Aluminium Academy (AAA) and D-Cube (D3)**. AAA brings deep domain knowledge and direct access to real training workflows and environments, ensuring the relevance and applicability of the training content. D-Cube (D3), as the technology provider, contributes its XR authoring and visualisation expertise by developing and deploying the MotivateXR-compatible tools tailored to the aluminium assembly context.

An important facilitator of this collaboration is the geographical proximity of both partners, as AAA and D-Cube (D3) are both based in Thessaloniki, Greece. This has greatly simplified the logistics of ongoing co-design, frequent testing sessions, feedback cycles, and on-site iterations, reducing the need for travel and enabling a more agile and responsive development process.

This collaboration is essential to the pilot's success, ensuring that the technological innovations are grounded in the real industrial needs, constraints, and standards. By tightly aligning the technical tools with authentic assembly use cases, the pilot sets a strong foundation for later transferability and long-term impact in the industrial training sector.

6.3.2 PILOT SCOPE, SCENARIO, AND LEARNING OUTCOMES

Scope of the Beta Testing

The scope of Pilot 3 is to evaluate the effectiveness of XR-based training tools in the assembly of aluminium frame systems commonly used in the construction and architectural sectors. The focus is on testing how immersive training delivered through XR can improve knowledge retention, reduce dependence on in-person expert guidance, and increase trainee autonomy and confidence.

For the beta phase, the pilot targets the **M450 aluminium system**, a simple and representative assembly use case selected by the Architectural Aluminium Academy (AAA) in collaboration with D-Cube (D3). This system was chosen due to its relevance in real-world industrial applications, involving a rich set of parts, multiple tools, and a multistep assembly process. However, the XR toolchain is scalable and extendable, supporting additional aluminium systems in the future with minimal authoring overhead.

Scenario Description

The pilot scenario involves a step-by-step training session in the assembly of the M450 aluminium system, conducted in mixed reality using the RTXR Player developed by D-Cube (D3). Trainees are guided through a realistic training environment using 3D animations, spatial instructions, media references and interactive UI elements.

Scenario Steps:

1. **XR On boarding & Introduction:** The session begins with a brief on boarding tutorial to familiarize novice users with the XR interface, input methods (gaze, hand tracking, voice), and basic navigation within the RTXR Player. Users are also introduced to the structure of the training scenario and the objective of the session.

2. **Preparation:** During the preparation, the trainee is prompted with a **PPE compliance checklist** to ensure awareness and compliance with standard safety protocols. Following this, the trainee is introduced to the M450 aluminium frame system, including an overview of the required components, tools and workspace setup.

3. **Base Frame Assembly:** Guided placement of the primary aluminium profiles, using holographic overlays and animated 3D step instructions to show how components should be positioned and connected.

4. **Accessory Integration:** Installation of essential accessories (e.g., seals, corner cleats, gaskets) with part-specific instructions and multimedia support (e.g., images, videos, PDF manuals) to enhance understanding.

5. **Remote Quality Assistance:** While automated quality checks are not yet supported, trainees may receive real-time feedback or validation from a remote expert connected through the Streaming Editor. This enables experts to observe trainee progress, provide verbal or visual cues, and verify proper assembly remotely.

6. **Completion and Scenario Review:** The training concludes with a recap of key steps and an optional self-review mode (quiz). Trainees can freely revisit any previous step or supporting material to reinforce their understanding.

7. **Post-Training Questionnaire & Feedback Collection:** After completing the scenario, trainees are prompted to fill out a short questionnaire reflecting on their XR experience. This includes usability, clarity of instructions, perceived learning effectiveness, and overall comfort with the technology. The feedback is used for iterative improvement of both content and system design.

All content is authored via the Narrative Editor, and the training is consumed using RTXR on HoloLens 2.

Learning Outcomes

Trainees participating in the XR training scenario are expected to demonstrate the following competencies by the end of the session:

- Understand the step-by-step assembly process of the M450 aluminium frame system.
- Identify and correctly position core components and accessories based on spatial instructions and part metadata.
- Interpret and follow 3D animations and multimedia instructions (video, images, documents) for precise execution.
- Perform assembly procedures independently, without real-time expert intervention.
- Demonstrate ability to verify assembly correctness using embedded cues and guidance.

- Navigate and control an XR interface in an industrial training context, gaining digital tool fluency.

These learning outcomes aim to ensure that trainees are not only familiar with the theoretical steps of assembly but can confidently and safely apply the process in a practical, real-world setting.

6.3.3 DETAILED WORKPLAN AND MILESTONES

The work plan for Pilot 3 – Aluminium Industry Assembly Training – has been designed to ensure a smooth transition from authoring tool familiarisation to full scenario execution and evaluation. The activities are jointly conducted by **D-Cube (D3)** and the **Architectural Aluminium Academy (AAA)**, leveraging their close collaboration and geographical proximity in Thessaloniki to streamline testing and feedback cycles.

Schedule Overview:

TABLE 16 – PILOT 3 – WORKPLAN

Activity	Dates	Duration	Lead Partners	Location
Instructor & End-User Training	Early September 2025	~ 1 week	D3 -> AAA	Thessaloniki, GR
Authoring Evaluation	Early September – Mid October 2025	~ 6 weeks	D3 & AAA	Thessaloniki, GR
Experience Evaluation	Mid-October – Early November 2025	~ 3 weeks	D3 & AAA	Thessaloniki, GR

Milestones & Checkpoints:

1. **M1 – Authoring Tool Training Completed (Early September)**
   Delivery of a hands-on training session by D3 to AAA on the use of the Narrative Editor. Focus on scenario creation, multimedia integration, and exporting training-ready content for RTXR.
2. **M2 – First Authoring Evaluation Feedback (Late September)**
   AAA creates initial training scenarios for the M450 aluminium system using the Narrative Editor. D3 collects feedback to refine workflows and address any usability or stability issues.
3. **M3 – Scenario Finalisation for Pilot (Mid October)**
   Authoring phase concludes with a finalised training scenario, validated by AAA for technical correctness and training suitability.
4. **M4 – Experience Evaluation Start (Mid-October)**
   Trainees participate in the XR training session using RTXR. Data collection begins, including usage analytics, performance metrics, and qualitative feedback.
5. **M5 – Experience Evaluation Completion (Early November)**

All planned trainee sessions completed. Collected data compiled for analysis to assess learning outcomes, usability, and system performance.

6. **M6 – Pilot Interim Review (Mid November)**

   Joint review session between D3 and AAA to evaluate results, identify improvement opportunities, and define adjustments for the Final Release.

6.3.4 TECHNICAL INPUTS AND RESOURCES STATUS

The successful execution of Pilot 3 depends on the availability and readiness of technical resources, digital assets, and supporting infrastructure. The current status is summarized as follows:

TABLE 17 – PILOT 3 – TECHNICAL INPUTS

Input type	Description	Status (received/pending/due date)
Documents	Fabrication manuals, PPE guidance, technical documents	Partially Received
Digital Assets	Supplementary videos and digital material to be integrated into XR scenario	Partially received
Digital Assets	3d content for M450 aluminium frame system	Partially received
Equipment	Two HoloLens 2 headsets, Two Meta Quest 3 headsets	Received and Provided from AAA
Hardware	PC for trainer on-site	Provided by AAA
Hardware	PC for expert remote	Provided by AAA
Networking & Connectivity	Local Network configurations	Ready

The **Architectural Aluminium Academy (AAA)** premises provide a dedicated space for hosting classes, seminars, and technical training sessions. Available facilities and equipment include, among others:

- Training equipment for aluminium profiles
- R&D facilities for prototyping and assembly testing
- 5-axis CNC machine for high-precision machining
- MJF 3D printer for advanced polymer prototyping
- Metal 3D printer for custom component fabrication

These resources ensure that the training environment closely replicates industrial working conditions and supports both XR-based and hands-on learning activities.

In Figure 21, the assembly training table at the **Architectural Aluminium Academy (AAA)** is illustrated, showcasing the dedicated workstation used for hands-on practice with aluminium frame systems. The table is equipped with clamping systems, measurement tools, and ample working space, allowing precise alignment and secure handling of components.

FIGURE 21: ASSEMBLY TABLE IN THE AAA TRAINING FACILITY

The classroom facilities at the Architectural Aluminium Academy (AAA) provide a dedicated environment for the theoretical and preparatory phases, as depicted in the following figures.

FIGURE 22: VIEW OF THE CLASSROOM AREA AT THE AAA, EQUIPPED FOR THEORETICAL SESSIONS

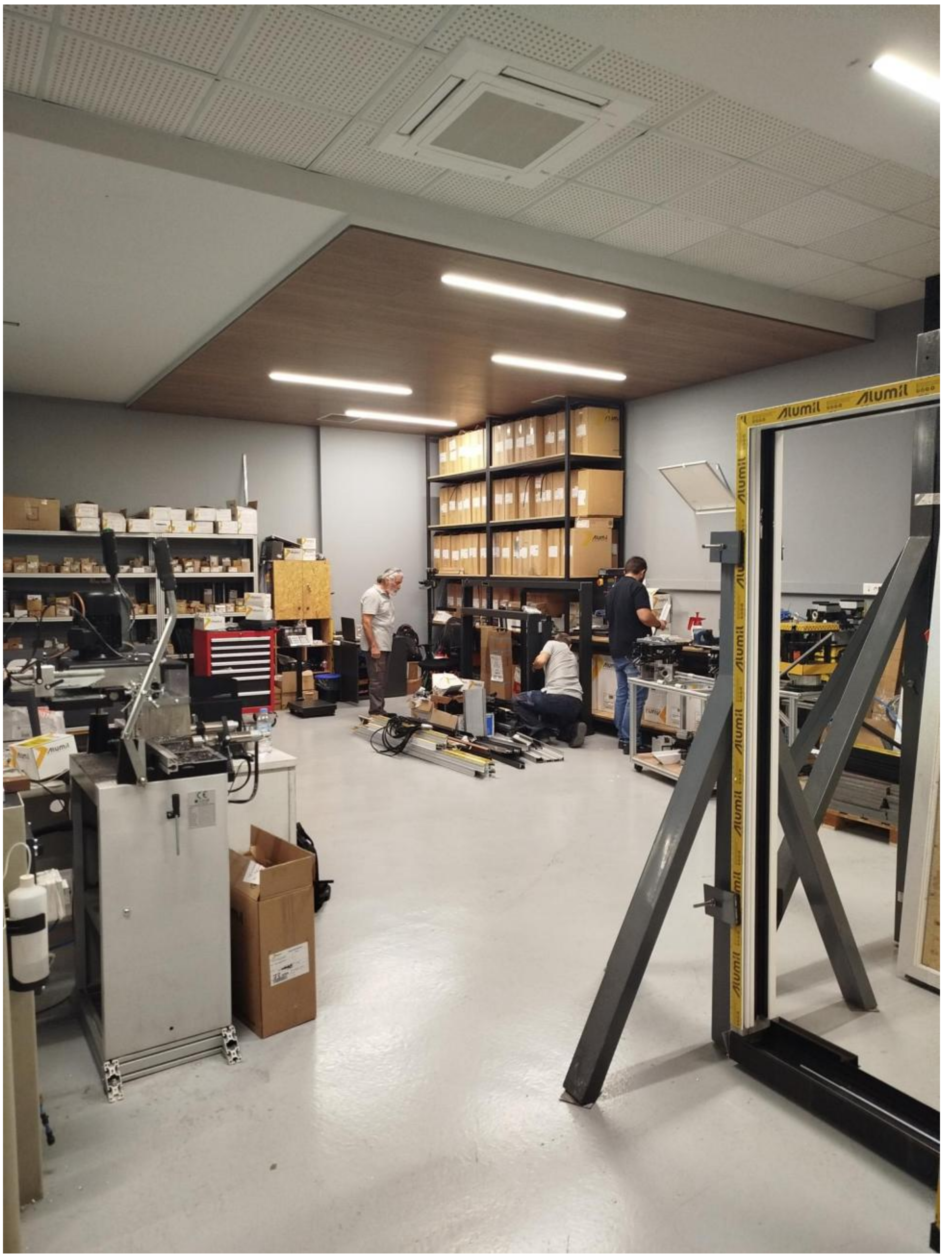


FIGURE 23: INTERIOR VIEW OF THE AAA TRAINING ROOM

6.3.5 EVALUATION AND DATA COLLECTION METHODS

The evaluation strategy for Pilot 3 is aligned with the methodology outlined in Chapter 7, combining both quantitative and qualitative measures to assess training effectiveness, usability, and technology adoption.

Evaluation Methods:

- **System Logs & Interaction Data:** The RTXR Player will automatically collect logs on task completion times, step navigation patterns, and frequency of help requests. This data will be used to evaluate improvements in efficiency and procedural adherence.
- **Observation Logs:** During training sessions, AAA instructors and designated observers will document trainee behaviour, focusing on areas of confusion, recurring errors, or challenges encountered with XR interactions.
- **User Experience (UX) Questionnaires:** Post-training surveys will capture user perceptions on usability, comfort, and overall satisfaction, using standardised metrics such as the System Usability Scale (SUS).
- **Knowledge & Skill Assessment:** Short tests or practical performance checks before and after the training will measure knowledge retention and the ability to complete assembly steps independently.
- **Post-Session Reflection Questionnaire:** Trainees will complete a brief self-reflection survey on their XR learning experience, highlighting the most beneficial aspects as well as areas needing improvement.

Alignment with Learning Outcomes:

- **Performance Metrics** (system logs, observation data) directly measure the ability of trainees to complete aluminium assembly tasks accurately and efficiently.
- **Usability & Engagement Metrics** (questionnaires) ensure that the XR environment supports learner confidence and reduces cognitive load.
- **Knowledge Retention Assessments** verify that skills acquired during the XR session translate into real-world assembly competence.

6.3.6 NEXT STEPS AND ACTION PLAN

The following activities are planned to ensure the smooth execution of Pilot 3 and the successful achievement of its objectives:

TABLE 18 – PILOT 3 – NEXT STEPS

Next step activity	Responsible Partner/Person	Deadline	Notes
Scenario Step Definition	AAA, D3	31-08-2025	Scenario Review & Detailed Definition.
Scenario Content	AAA	31-08-2025	Finalise & review all content required for the training scenario.
Scenario Creation	AAA, D3	31-09-2025	Complete the creation of the training scenario for the M450 aluminium system.

Equipment Validation	AAA	31-08-2025	Verify headsets & PCs for the training session.
Instructor Training	AAA, D3	31-08-2025	Ensure instructors are fully prepared to conduct trainee sessions.

6.4 PILOT 4: ENERGY DISTRIBUTION MAINTENANCE TRAINING

6.4.1 ENERGY DISTRIBUTION PARTNERS AND INDUSTRIAL COLLABORATIONS

Pilot 4 deals with maintenance and inspection works on the electrical distribution network and aims to optimise and modernise the training of new technicians and the remote assistance of trained personnel by experienced engineers. This pilot is led by the Hellenic Electricity Distribution Network Operator S.A. (HEDNO) and also includes the utilisation of information about the assets of the distribution network that are integrated in a GIS, hence making use of the digital twin advantages.

Hellenic Electricity Distribution Network Operator S.A. (HEDNO) is the sole administrator and owner of the Electrical Distribution Network of Greece. HEDNO is the task leader of Pilot 4 and offers its know-how on the challenges of field technical tasks, inspection and maintenance on electrical equipment and Geographic Information Systems (GIS). HEDNO shares technical manuals and documentation regarding the tasks and utilises the training experience of its senior engineers and technicians.

Pilot 4 involves several partners, whose role is briefly described in the table below:

TABLE 19 – PILOT 4 – PARTNERS AND ROLES

Role	Organisation / partner	Brief role description
Pilot owner (task leader)	HED	Leading HEDNO pilot, responsible for pilot scenario definition, technical documentation and asset creation, partner coordination, and overall evaluation.
Technology Provider	MAG	MAG is offering MIRA a digital twin platform aimed at supporting industrial operations. MIRA aggregates data from IoT sensors and provides the end-user with extended monitoring and reviewing capabilities of the data streams through a web-based application.
Technology Provider	TEC	TEC is offering KAYROX enabling the creation of XR content by offering intuitive, no-code tools that empower non-expert users to design engaging and practical experiences with ease.
Technology Provider	2F	2F is offering a 3D videogrammetry scanning system to generate high-quality 3D models from visual data for XR-based training and support.
User Experience	CETMA	Assisting with the pilot scenario definition.

Key Industrial Collaboration

The pilot depends on the technical and industrial collaboration between the Hellenic Electricity Distribution Network Operator S.A. (HEDNO) and Maggioli SPA (MAG). HEDNO has to offer its experience of industrial tasks in the outdoor field, detailed technical manuals regarding maintenance and inspection works on the distribution network and MAG brings its specialisation in simplifying processes and enhancing services through applications for digital twin solutions. In conclusion, this collaboration targets the enhancement of the maintenance and inspection works on wooden poles and the exploration of the advantages XR tools and a digital twin platform in this specific use case.

6.4.2 PILOT SCOPE, SCENARIO, AND LEARNING OUTCOMES

Scope of the beta testing:

The purpose of the beta testing is to assess how effective and user-friendly the MotivateXR platform is for training technicians in wooden pole inspection and maintenance. Wooden poles extend along the entire length of the Greek electricity grid; therefore, their number is quite large. This fact makes their inspection, maintenance and inspection tracking records a challenging procedure, which can be simplified using the MotivateXR platform.

Scenario description:

The selected scenario involves:

- Health and safety steps, which define important measures that workers and trainees must follow before starting any procedure, for their well-being,
- Wooden pole Inspection steps, which compose the official inspection process for the wooden poles that HEDNO follows,
- Wooden pole Maintenance steps that describe all the necessary actions for the effective maintenance of the wooden poles.

Expected learning outcomes:

- Reduced inspection time.
- Precise measurement and efficient record keeping.
- Ability to assist the technicians remotely.

FIGURE 24 - WOODEN POLE INSPECTION BY DRILLING

FIGURE 25 - EXTERNAL MAINTENANCE WITH PRESERVATIVE

6.4.3 DETAILED WORKPLAN AND MILESTONES

The beta testing process is divided into two main phases: Authoring and Experiencing.

1. Authoring Phase (September – Beginning of October)

This phase includes:

- On boarding: Introduction and familiarisation with the tools provided.
- Asset Authoring: Creation and integration of content and assets provided by HEDNO based on the scenario created.

2. Experiencing Phase (October)

This phase includes:

- Internal Testing: Conducted by HEDNO to evaluate the initial implementation and performance.
- Beta Final Testing: A final testing round to finalise the beta experience.

Preparation and Evaluation: Review of testing outcomes, identification of necessary adjustments, and evaluation of the overall beta performance.

3. Experience feedback collection and evaluation (end of October – mid-November)

From end-October until the mid of November all the feedback will be collected, reviewed and evaluated, identifying eventual necessary adjustments.

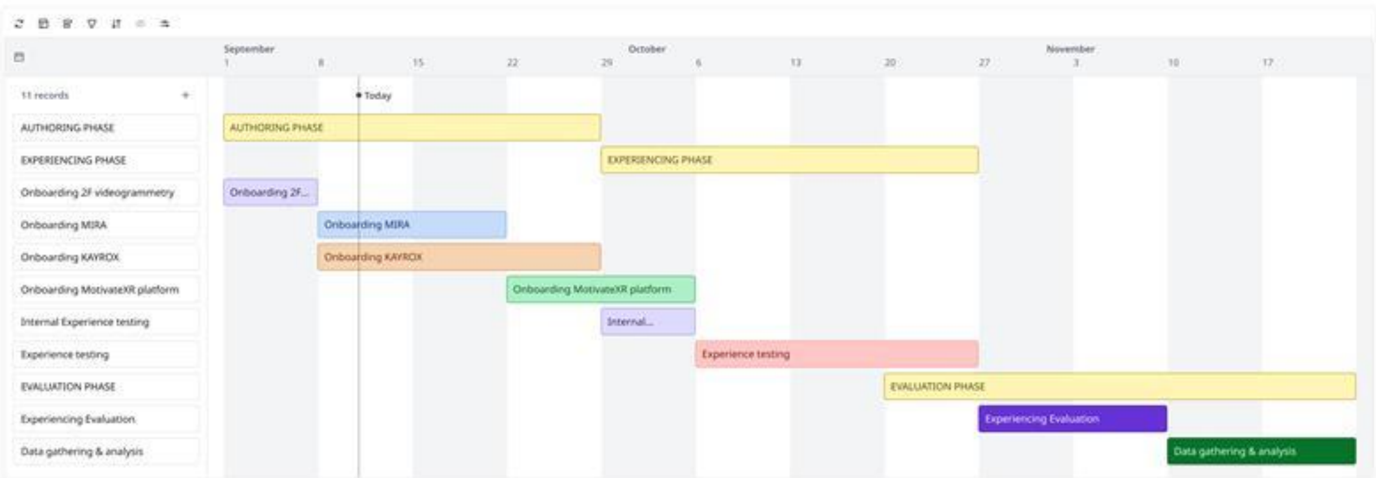


FIGURE 26: WORKPLAN FOR P4

2F Scanning Service Training

This section provides a detailed overview of the training plan specifically designed to support the creation of high-quality three-dimensional (3D) models generated from video recordings. These models are intended to be applied within Extended Reality (XR) environments, serving both training activities and operational scenarios defined by HEDNO.

Organisation 2F has issued a set of clear and precise guidelines to help HEDNO experts record video material that is suitable for the 3D reconstruction process. These instructions cover the essential aspects of video capture, ensuring that the resulting footage meets the technical requirements necessary for producing accurate and reliable 3D models.

Objectives:

The training aims to ensure that:

- HEDNO experts gain a solid understanding of the technical requirements involved in video recording for 3D reconstruction purposes.
- Video recordings follow standardised procedures to ensure consistency and quality.

Overall, this training plan aims not only to strengthen the technical competencies of HEDNO's personnel but also to establish consistent practices that support the effective integration of XR technologies into HEDNO's operational scenarios.

Resources Provided:

- Guideline document
- Support for questions and troubleshooting

KAYROX Training

This section outlines the training plan for the use of KAYROX. The training is structured to efficiently build user proficiency in both the **Authoring Environment** (scenario creation) and the **Experiencing Environment** (scenario execution and supervision), tailored to the needs of HEDNO.

Objectives

The training aims to ensure that:

- **Authoring experts** can autonomously create and adapt XR training scenarios using KAYROX.
- **Trainees** can navigate and interact with XR scenarios in the Player environment.

The training will be based on the same process used in the Home Appliance pilot. See section 6.2.3for more details. However, for this pilot, special emphasis will be placed on the connection with MIRA.

MIRA Training

This section outlines the training plan for the use of the MIRA web-based interface. The training is structured to efficiently build user proficiency in the **creation and management of Digital Twin** (DT) **assets** with an emphasis on integrating 3D data into the digital twin environment.

Objectives:

The training aims to ensure that:

- **Authoring experts** can autonomously create, edit, and manage Digital Twin (DT) assets through the MIRA interface.

Key steps:

Users will learn:

1. How to create a new DT asset.
   The user will be able to create a new DT asset by adding description and design data associated with the asset.
2. How to add 3D scanned data to a DT asset
   The user will be able to integrate 3D scanned data from 2F scanning service into a DT asset through the following steps.
3. How to import a preconfigured Data Source that represents the scanned asset from the 2F scanning service.
   The user will be able to link the scanned asset and its associated information (3D design data).
4. How to assign the Data Source to the Digital Twin asset.
   The user will be able add the imported Data Source to the desired Digital Twin.
5. How to import Telemetry Values.
   The user will be able to upload values related to the Data Source through the import function, using a CSV or Excel file. To facilitate this process, a template can be downloaded directly from the MIRA web interface.

This training will equip users with the necessary skills to effectively use the MIRA web-based interface within the MOTIVATE XR framework, enabling the creation and management of Digital Twin assets that support the XR-based maintenance and training scenarios of HEDNO.

Resources Provided:

- PDF guide with screenshots
- Support for questions and troubleshooting

Motivate XR Platform Training

This section outlines the training plan for the use of the **Motivate XR Platform.** The training is structured to efficiently build user proficiency in both the **Authoring Environment** and the **Experiencing Environment of the platform.**

6.4.4 TECHNICAL INPUTS AND RESOURCES STATUS

TABLE 20 – PILOT 4 – TECHNICAL INPUTS

Input type	Description	Status (received/pending/due date)
Technical Documents	Documentation of HEDNO explaining how they perform inspection and maintenance of wooden poles. Additional documents outlining the safety and health measures that workers and trainees must follow.	RECEIVED
Videos for the creation of 3d Assets	HEDNO has provided videos of tools used during the inspection and the maintenance stages in order to generate 3d assets using 2F's scanning service	RECEIVED
3d Digital Assets	2F is preparing the 3d assets that will be used for the authoring stage.	IN PROGRESS

6.4.5 EVALUATION AND DATA COLLECTION METHODS

Aligned with the Evaluation and Iteration Plan (Chapter 7), the pilot evaluation will utilize:

- **UX questionnaires** to measure user satisfaction and perceived usability. After each trainee technician completes a sufficient number of training sessions, they will complete an individual survey that covers the usability, comfort, and overall satisfaction, using standardised questionnaires such as the System Usability Scale (SUS) to allow comparability.
- **System logs** to record task completion times, errors, and interaction patterns. The training platform will automatically generate the data which then can be analysed.
- **Observation logbooks** maintained by instructors to capture qualitative feedback. These will be completed during all training sessions by HEDNO supervising engineers who will document the performance, progress, problematic behaviour, challenges and timing of all trainees using the XR tools. The logs will be spreadsheets in digital form and questionnaires.
- **Interviews** for in-depth user insights post-training sessions. These will be conducted by the evaluation team and will explore themes emerging from the questionnaires and the system logs.

This methodology ensures a comprehensive assessment of learning effectiveness, platform usability, and operational improvement.

6.4.6 NEXT STEPS AND ACTION PLAN

TABLE 21 – PILOT 4 – NEXT STEPS

Next step activity	Responsible Partner/Person	Deadline	Notes
Scenario Step Definition	HEDNO, MAG	30-08-2025	Finalisation of scenario.
Finalise 3D Assets	2F	15-09-2025	Based on videos collected 24/07.
Training for the Authoring Phase	HEDNO, TEC, MAG	30-09-2025	Ensure instructions are ready for the sessions
Upload content Authoring Phase	HEDNO	30-09-2025	
Training for the Experiencing Phase	HEDNO, TEC, MAG	31-10-2025	

6.5 PILOT 5: HUMAN-ROBOT COLLABORATIVE MANUFACTURING TRAINING

6.5.1 HUMAN-ROBOT COLLABORATIVE PARTNERS AND INDUSTRIAL COLLABORATIONS

Pilot 5 of the Motivate XR project brings together the following partners:

TABLE 22 – PILOT 5 – PARTNERS AND ROLES

Role	Organisation / partner	Brief role description
Pilot owner (task leader)	BIR	BI-REX Competence Centre is responsible for pilot scenario definition, robotics programming, technical documentation and asset creation, partner coordination and overall evaluation.
Technology Provider	TEC	TECNALIA is offering KAYROX enabling the creation of XR content by offering intuitive, no-code tools that empower non-expert users to design engaging and practical experiences with ease.

6.5.2 PILOT SCOPE, SCENARIO, AND LEARNING OUTCOMES

Scope:

The beta test assesses the effectiveness and usability of the MotivateXR platform in collaborative support of technicians during the assembly phase of a gearbox, with a specific aim of reduce the risk of error and to make complex assembly steps more intuitive and accessible.

Scenario details:

The procedure consists of a series of repeated steps until the assembly completion:

- Requesting the robot to send the part to be assembled
- Displaying the assembly instructions
- Checking any accompanying documentation if necessary
- Performing the assembly step

In this beta test, communication will happen through a touch of the robot wrist, while in the final release robot and operator will communicate through virtual buttons or with hand gesture recognition features.

Learning outcomes:

- Unexperienced technicians can successfully and autonomously complete the assembly task
- Increased technician confidence

6.5.3 DETAILED WORKPLAN AND MILESTONES

- **Material finalisation**

  Version 2.0 of the folder containing the digital assets for the beta experience creation and the support material has been shared with the technical partner and is currently under review. We expect to finalise it by the first week of September

- **XR platform onboarding and scenario preparation**

  The rest of September will be dedicated to the installation of the XR development tool and the authoring of the beta experience.

- **Test environment preparation**

  During the first week of October the experience environment in the BI-REX Pilot Line will be finalised. This activity includes robot programming according to the specified mounting sequence.

- **Beta experience testing**

  Beta experience testing will be performed according to the evaluation and data collection method, as reported in 6.5.5.

- **Experience feedback collection and evaluation**

  During the final week of October all the feedback collected will be reviewed and evaluated, identifying eventual necessary adjustments.

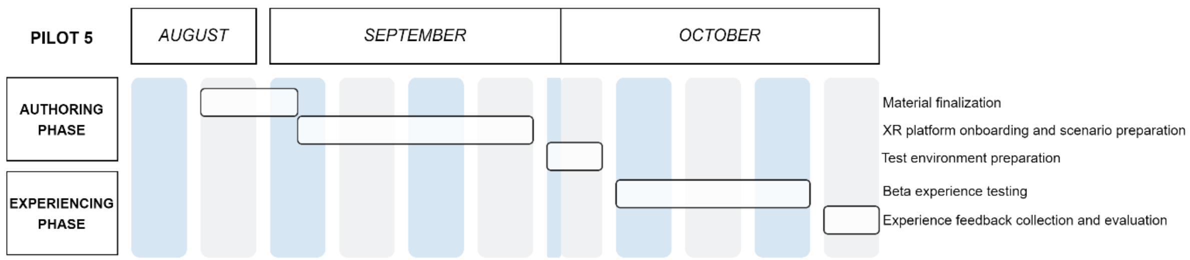


FIGURE 27 - HUMAN-ROBOT COLLABORATIVE MANUFACTURING BETA PILOT SCHEDULE

All the above in-person activities will be performed at BI-REX headquarters with possible remote support from technical partners.

KAYROX Training

The training will be based on the same process used in the Home Appliance pilot. See section 6.2.3 for more details.

6.5.4 TECHNICAL INPUTS AND RESOURCES STATUS

TABLE 23 – PILOT 5 – TECHNICAL INPUTS

Input type	Description	Status (received/pending/due date)
Digital Assets	3D files of each assembly part and of the robot	Received (evaluation pending)
Support materials	Videos of each assembly step, part photos and extra documentation	Received (evaluation pending)
Mounting sequence documentation	Detailed list of actions specifying for each assembly step which part, text to be prompted and related support video	Received (evaluation pending)

6.5.5 EVALUATION AND DATA COLLECTION METHODS

Aligned with the Evaluation and Iteration Plan (Chapter 7), the pilot evaluation will utilise:

- **UX questionnaires** to measure technician satisfaction and perceived usability.
- **System logs** to record task completion times, errors, and interaction patterns.
- **Observation logbooks** maintained by instructors to capture qualitative feedback.
- **Interviews** for in-depth user insights post-training sessions.

This methodology ensures a comprehensive assessment of learning effectiveness, platform usability, and operational improvement.

6.5.6 NEXT STEPS AND ACTION PLAN

TABLE 24 – PILOT 5 – NEXT STEPS

Next step activity	Responsible Partner/Person	Deadline	Notes
Evaluation of the delivered material	TEC	03-09-2025	
XR platform installation, Training and Authoring Phase	BIR, TEC	22-09-2025	
Test environment preparation for the Experiencing Phase	BIR	31-09-2025	

7 EVALUATION & ITERATION PLAN

This chapter defines a phased strategy for measuring training effectiveness, collecting pilot data, and iteratively refining the MotivateXR curriculum. In the beta window (M14–M18) we prioritise a pragmatic, comparable evidence set; in the final phase (M32–M35) we expand measurement depth and automation to meet KPI-level targets. The chapter also introduces the documentation suite each pilot team should complete during beta, so that the cross-pilot analysis in D7.3 (led by TUD) receives consistent, high-quality inputs.

7.1 OVERARCHING EVALUATION FRAMEWORK

The evaluation framework integrates formative and summative endpoints across three core dimensions (learning outcomes, usability, and operational impact) while distinguishing between the beta evidence set and the final KPI validation. Continuous feedback loops are embedded throughout the curriculum lifecycle.

The following diagram visualises how pilot data gathered in beta flows into iteration cycles and feeds D7.3, and how the refined metrics will later support the final-phase validation.

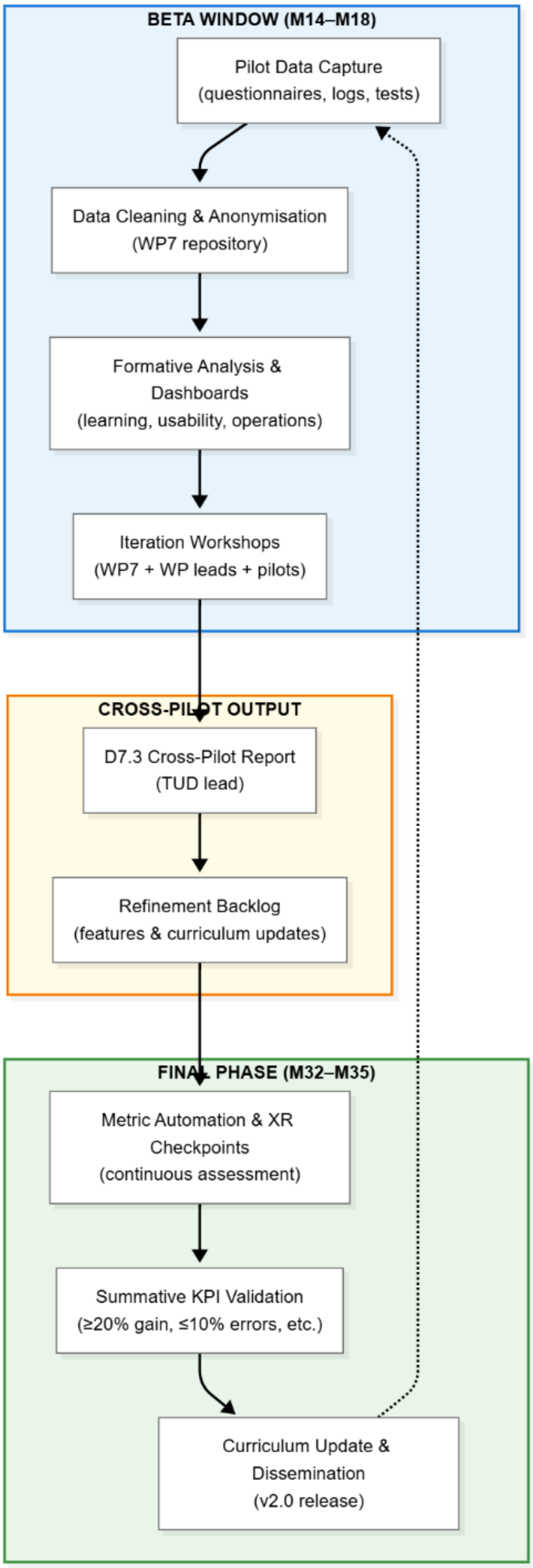


FIGURE 28 - EVALUATION DATA FLOW

7.2 KEY EVALUATION METRICS AND METHODS

To ensure consistency with the phased rollout of the curriculum (Chapter 5), key metrics are differentiated between the **beta window (M14–M18),** where we prioritise feasibility and core evidence, and the **final phase (M32–M35)**, where we expand measurement depth and automation. Thresholds in beta are indicative rather than binding; final targets align with the project KPIs and will be validated across all pilots.

Beta focus (M14–M18)

Learning effectiveness is gauged through pre/post knowledge tests (authoring vs. experiencing variants), aiming for a **meaningful positive delta** rather than a fixed threshold. Usability is captured via the System Usability Scale (SUS) and the User Experience Questionnaire (UEQ) immediately after sessions, and operational impact is observed through task-time logs and facilitator checklists on a subset of stable scenarios. Data completeness and comparability are prioritised over exhaustive coverage.

To provide a robust baseline for cross-pilot comparison and track progress, a Technology Readiness Level (TRL) assessment will be conducted at the start of the beta phase (M14-M15). Furthermore, the determinants of technology acceptance will be measured using a pre-adoption version of the Technology Acceptance Model 3 (TAM3), administered as part of the Ex-Ante survey.

Mid-term focus (M18–M31)

The period between the beta and final phases is dedicated to analysis, iteration, and refinement. Based on the consolidated beta data, the consortium will execute the refinement backlog, implementing improvements to the curriculum, platform features, and evaluation protocols. An optional intermediate TRL assessment may be conducted to monitor technological progress and anticipate risks. This phase ensures the solution matures and stabilises in preparation for the rigorous, KPI-driven final validation.

Final focus (M32–M35) With the full feature set available, we consolidate a **20 % knowledge gain** target, automate continuous assessment checkpoints inside XR, and refine operational metrics (task-time reduction ≥ 20 %, error rate ≤ 10 %) across all pilots. Usability and engagement are tracked longitudinally, enriched by analytics dashboards and adaptive assessments. This phase includes the second, longitudinal Ex-Post survey to measure sustained technology acceptance and its determinants after a period of actual use and platform refinement. The final summative TRL assessment will also be conducted to demonstrate industrial readiness. Mixed-methods remain the backbone, in line with best practices in XR education research [2].

The final validation will include a summative TRL assessment to demonstrate industrial readiness and a full post-adoption TAM3 survey to confirm technology acceptance and its determinants.

TABLE 25 - METRICS AND METHODS: BETA VS FINAL

Dimension	Beta (M14–M18) – Pragmatic Evidence	Final (M32–M35) – KPI-level Validation
Learning effectiveness	Pre/Post tests (separate for authoring/experiencing); report % delta without hard target	≥ 20 % average improvement across modules; embedded XR checkpoints
Usability & UX	SUS / UEQ right after sessions (sample-based)	SUS / UEQ + longitudinal UX dashboards; trend analysis
Operational impact	Task time & error notes from logs/observation on key scenarios	≥ 20 % task-time reduction; ≤ 10 % procedural errors (all pilots)
Engagement & adoption	Attendance, module completion, qualitative feedback	Full analytics (LMS + XR logs), badge/quest completion (if adopted)
Continuous improvement	Manual review of logs & templates (Appendix)	Automated data-driven iteration cycles (KPI 3.6)

These phased methods balance rigour and practicality: we collect robust, comparable datasets early, then expand and tighten metrics as the platform reaches full maturity.

7.3 DOCUMENTATION SUITE FOR PILOT TEAMS

To standardise data collection, each pilot must complete the following documents.

Templates are provided in the appendix and must be filled out electronically and submitted to the shared repository.

TABLE 26 – LIST OF DOCUMENTS FOR PILOT'S STAKEHOLDERS

Document number	Document name	Purpose
1	Pilot evaluation protocol	Defines clearly the context, objectives, participants, schedule, and data collection methods for each pilot
2	Pre-post knowledge test	Evaluates participants' theoretical knowledge (Authoring) and practical skills (Experiencing) before and after XR training
3	Ex-Ante questionnaire	Collects expectations, prior XR experiences, and potential challenges from participants before the training
4	Ex-Post questionnaire	Gathers feedback, satisfaction ratings, and perceived usability from participants after training sessions
5	UX questionnaire report	Summarises user experience survey results (usability, clarity, engagement) collected from all participants

6	Observation logbook	Records qualitative observations, incidents, and relevant contextual information during training sessions
7	System log export specification	Specifies standard data logging events, parameters, and procedures required for automated data collection
8	Interview guide & transcript	Structures and documents qualitative interviews conducted after training to gain deeper insights from participants
9	Analytics dashboard template	Standardises visual reporting of collected data, facilitating ongoing monitoring and final evaluation analysis

These documents are essential to standardise the evaluation across all MotivateXR pilots. They support a consistent and structured collection of data before, during, and after pilot training sessions. Considering the two main components of the MotivateXR project (Authoring and Experiencing), each document has been carefully tailored to reflect clearly both theoretical learning (Authoring) and practical performance improvements (Experiencing). Pilot Owners and Technology Providers should carefully read the instructions provided for each template, fill them out accurately, and submit according to the guidelines provided.

These documents form the basis for the cross-pilot evaluation (D7.3) and the subsequent iterative refinement of the MotivateXR curriculum.

7.4 INTEGRATED EVALUATION INSTRUMENTS

This section details the standardized instruments to be deployed alongside the core documentation suite to ensure a deep, multi-faceted understanding of technological maturity and user acceptance.

7.4.1 TECHNOLOGY READINESS LEVEL (TRL) ASSESMENT

A standardised TRL assessment will be implemented to benchmark the technological maturity of each pilot component (authoring, experiencing, devices, analytics) and support consistent cross-pilot comparison. The assessment provides a common language to assess progress, manage risks, and plan for commercialisation [10] [11]. Pilot owners will conduct the assessment at the beginning of the Beta phase (M14–M15) to establish a baseline, and again at the end of the final validation (M32–M35) to demonstrate maturity. An optional intermediate assessment may be conducted during beta consolidation (M16-M18) to monitor advancements. The framework is based on international standards from NASA, the European Commission, and the U.S. Department of Defence. Matrix: TRL Definitions and Checklist (1-9) (This matrix would contain the detailed TRL chart from your document, with levels 1-9 and their associated definitions, descriptions, and checklists).

TABLE 27 - TECHNOLOGY READINESS LEVEL (TRL) ASSESSMENT

Technology Development Stage	TRL	Definition	Description	Checklist of activities to achieve this level
Fundamental Research	1	Basic principles observed and reported	Scientific research begins with properties of a potential technology observed in the physical world. These basic properties are being reported in the literature.	☐Basic research activities have been conducted and basic principles have been defined ☐Principles and findings have been published in the literature (e.g., research articles, peer-reviewed papers, white papers)
	2	Technology and/or application concept formulated	Applied research begins with the identification of practical applications of basic scientific principles. There is an emphasis on understanding the science better and corroborating the basic scientific observations made during TRL 1 work. Analysis of the feasibility of speculative applications is being conducted and reported in scientific studies.	☐Applications of basic principles have been identified ☐Applications and supporting analysis have been published in the literature (e.g., analytical studies, small code units for software, papers comparing technologies)
Research and Development	3	Experimental proof of concept	Active research and development begins. The applications are being moved beyond the paper stage to experimental work. The feasibility of separate technology components is being validated through analytical and laboratory studies. There is not yet an attempt to integrate components into a complete system.	☐Proof of concept and/or analytical and experimental critical function has been developed ☐Separate components have been validated in a laboratory environment
	4	Validation of component(s) in a laboratory environment	Basic technological components are integrated "ad-hoc" to establish that they will work together in a laboratory environment. The "ad- hoc" system would likely be a mix of on hand equipment and a few special-purpose components that may require special handling, calibration, or alignment in order to function.	☐"Ad-hoc" integrated components, sub systems and/or processes have been validated in a laboratory environment ☐How "ad-hoc" integration and test results differ from the expected system goals is understood
	5	Validation of semi-integrated component(s) in a simulated environment	The integrated basic technological components are performing for the intended applications in a simulated environment. Configurations are being developed but can undergo fundamental changes. The technology and environment at TRL 5 is more similar to the final application than TRL 4.	☐Semi-integrated component(s)/ subsystems or processes have been validated in a simulated environment ☐How the simulated environment differs from the expected operational environment and how the test results compare with expectations is understood
Pilot and Demonstration	6	System and/or process prototype demonstrated in a simulated environment	A model or prototype, that represents a near desired configuration, is being developed at a pilot scale, generally smaller than full scale. Testing of the model or prototype is being conducted in a simulated environment.	☐Pilot scale model or prototype developed ☐Pilot scale model or prototype system is near the desired configuration in performance, and volume but generally smaller than full scale ☐Pilot scale prototype or model system has been demonstrated in a simulated environment ☐How the simulated environment differs from the operational environment, and how results differed from expectations is understood

	7	Prototype system ready (form, fit and function) demonstrated in an appropriate operational environment	A full-scale prototype is being demonstrated in an operational environment but under limited conditions (i.e., field tests). At this stage, the final design is very close to completion.	☐ Full-scale prototype with ready form, fit and function developed ☐ Full-scale prototype demonstrated in an operational environment but under limited conditions
	8	Actual technology completed and qualified through tests and demonstrations	Technology is being proven to work in its final form and under expected conditions. This stage commonly represents the end of technology development. At this stage, operations are well understood, operational procedures are being developed, and final adjustments are being made.	☐Final configuration of the technology developed ☐Final configuration successfully tested in an operational environment ☐Technology's ability to meet its operational requirements has been assessed and problems documented; plans, options, or actions to resolve problems have been determined
Early Adoption	9	Actual technology proven through successful deployment in an operational environment	Actual application of the technology in its final form is being conducted under a full range of operational conditions. Sometimes referred to as "system operations", this stage is where technology is further refined and adopted.	☐The technology has been successfully deployed and proven under a full range of operational conditions ☐Operational, test and evaluation reports have been completed
Commercially Available	-	Technology development is complete	Technology is openly available in the marketplace and/or has been sold directly to a buyer in the public or private sector, in its current state or service offering for non-testing or development purposes. The technology is commercial and competitive but may need further integration efforts for widespread adoption.	☐The technology is openly available in the marketplace and/or has been sold in its current state of service offering for non-testing or development purposes.

7.4.2 TECHNOLOGY ACCEPTANCE MODEL 3 (TAM3)

To examine the determinants of technology acceptance, a tailored TAM3 survey will be integrated into the pre- (Ex-Ante) and post-training (Ex-Post) questionnaires. This academically validated framework captures antecedents of perceived usefulness and perceived ease of use, providing a nuanced understanding of factors influencing adoption [12].

- Ex-Ante TAM3 (M14-M15): A pre-adoption version will be administered before XR sessions, focusing on expectations (e.g., Perceived Usefulness, Perceived Ease of Use, Computer Self-Efficacy). Participants must be provided with a detailed scenario or demonstration to respond meaningfully.

TABLE 28 - TECHNOLOGY ACCEPTANCE MODEL 3 (TAM3) EX-ANTE SURVEY

Constructs		Items
Perceived Usefulness (PU)	PU1	I expect that using the system would improve my performance in my job.
	PU2	I believe that using the system in my job would increase my productivity.
	PU3	Using the system would enhance my effectiveness in my job.
	PU4	I think I would find the system to be useful in my job.
Perceived Ease of Use (PEOU)	PEOU1	I believe my interaction with the system would be clear and understandable.
	PEOU2	Interacting with the system would not require a lot of my mental effort.
	PEOU3	I expect I would find the system to be easy to use.

	PEOU4	I think it would be easy to get the system to do what I want it to do.
Computer Self-Efficacy (CSE)	- - - - CSE1 CSE2 CSE3 CSE4	I am confident I could complete my job using this system... ...if there was no one around to tell me what to do as I go. ...if I had just the built-in help facility for assistance. ...once someone had shown me how to do it first. ...because I have used a similar system before to do the same job.
Perceptions of External Control (PEC)	PEC1 PEC2 PEC3 PEC4	I expect I would have control over using the system. I believe I will have the resources necessary to use the system. I think that, given the necessary resources and knowledge, it would be easy for me to use the system. I am concerned the system might not be compatible with other systems I use.
Computer Playfulness (CPLAY)	- - - - CPLAY1 CPLAY2 CPLAY3 CPLAY4	The following questions ask you how you would characterize yourself when you use computers *or similar technologies*: ... spontaneous ... creative ... playful ... unoriginal
Computer Anxiety (CANX)	CANX1 CANX2 CANX3 CANX4	Computers *or similar technologies* do not scare me at all. Working with a computer makes me nervous. Computers make me feel uncomfortable. Computers make me feel uneasy.
Perceived Enjoyment (ENJ)	ENJ1 ENJ2 ENJ3	I think I would find using the system to be enjoyable. I expect the actual process of using the system would be pleasant. I imagine I would have fun using the system.
Objective Usability (OU)	----	Not applicable in the Ex-Ante Survey
Subjective Norm (SN)	SN1 SN2 SN3 SN4	I believe people who influence my behaviour will think that I should use the system. People who are important to me will likely think that I should use the system. I expect the senior management of this business will be helpful in the use of the system. I believe the organization will support the use of the system.
Voluntariness (VOL)	VOL1 VOL2 VOL3	I expect my use of the system will be voluntary. My supervisor will not require me to use the system. Although it might be helpful, using the system will not be compulsory in my job.
Image (IMG)	IMG1 IMG2 IMG3	I believe people in my organization who use the system will have more prestige than those who do not. People who use the system will likely have a high profile. I think having the system will be a status symbol in my organization.
Job Relevance (REL)	REL1 REL2 REL3	In my job, I believe usage of the system will be important. In my job, usage of the system seems relevant. The use of the system appears to be pertinent to my various job-related tasks.
Output Quality (OUT)	OUT1 OUT2 OUT3	I expect the quality of the output I get from the system to be high. I don't anticipate problems with the quality of the system's output. I believe I will rate the results from the system as excellent.
Result Demonstrability (RES)	RES1 RES2 RES3 RES4	I don't think I will have difficulty telling others about the results of using the system. I believe I will be able to communicate to others the benefits of using the system. The positive results of using the system will be apparent to me. I might have difficulty explaining why using the system may or may not be beneficial.
Behavioural Intention (BI)	BI1 BI2 BI3	Assuming I had access to the system, I intend to use it. Given that I had access to the system, I predict that I would use it. I plan to use the system in the next <n> months
Use (USE)	----	Not applicable in the Ex-Ante Survey

- Ex-Post TAM3 (M14-M17 & M32-M35): The full post-adoption TAM3 survey, including Objective Usability (measured via task time ratios) and Use, will be administered after participants have interacted with the technology. For longitudinal insight, a follow-up survey is recommended after a period of actual use. Matrix: TAM3 Constructs and Items for Pre- and Post-Adoption (*This matrix would list the TAM3 constructs - PU, PEOU, CSE, ENJ, etc. - with their corresponding survey items for both pre and post-adoption contexts).*

TABLE 29 - TECHNOLOGY ACCEPTANCE MODEL 3 (TAM3) EX-POST SURVEY

Constructs		Items
Perceived Usefulness (PU)	PU1	Using the system improves my performance in my job.
	PU2	Using the system in my job increases my productivity.
	PU3	Using the system enhances my effectiveness in my job.
	PU4	I find the system to be useful in my job.
Perceived Ease of Use (PEOU)	PEOU1	My interaction with the system is clear and understandable.
	PEOU2	Interacting with the system does not require a lot of my mental effort.
	PEOU3	I find the system to be easy to use.
	PEOU4	I find it easy to get the system to do what I want it to do.
Computer Self-Efficacy (CSE)	- - - -	I could complete the job using this system...
	CSE1	... if there was no one around to tell me what to do as I go.
	CSE2	... if I had just the built-in help facility for assistance.
	CSE3	... if someone showed me how to do it first.
	CSE4	... if I had used similar technology before this one to do the same job.
Perceptions of External Control (PEC)	PEC1	I have control over using the system.
	PEC2	I have the resources necessary to use the system.
	PEC3	Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the system.
	PEC4	The system is not compatible with other systems I use.
Computer Playfulness (CPLAY)	- - - -	The following questions ask you how you would characterize yourself when you use computers *or similar technologies*:
	CPLAY1	... spontaneous
	CPLAY2	... creative
	CPLAY3	... playful
	CPLAY4	... unoriginal
Computer Anxiety (CANX)	CANX1	Computers do not scare me at all.
	CANX2	Working with a computer makes me nervous.
	CANX3	Computers make me feel uncomfortable.
	CANX4	Computers make me feel uneasy.
Perceived Enjoyment (ENJ)	ENJ1	I find using the system to be enjoyable.
	ENJ2	The actual process of using the system is pleasant.
	ENJ3	I have fun using the system
Objective Usability (OU)	- - - -	Measured as a ratio of time spent by the subject to the time spent by an expert on the same set of tasks.
Subjective Norm (SN)	SN1	People who influence my behaviour think that I should use the system.
	SN2	People who are important to me think that I should use the system.
	SN3	The senior management of this business has been helpful in the use of the system.
	SN4	In general, the organization has supported the use of the system.
Voluntariness (VOL)	VOL1	My use of the system is voluntary.
	VOL2	My supervisor does not require me to use the system.
	VOL3	Although it might be helpful, using the system is certainly not compulsory in my job.
Image (IMG)	IMG1	People in my organization who use the system have more prestige than those who do not.
	IMG2	People in my organization who use the system have a high profile.
	IMG3	Having the system is a status symbol in my organization.

Job Relevance (REL)	REL1 REL2 REL3	In my job, usage of the system is important. In my job, usage of the system is relevant. The use of the system is pertinent to my various job-related tasks.
Output Quality (OUT)	OUT1 OUT2 OUT3	The quality of the output I get from the system is high. I have no problem with the quality of the system's output. I rate the results from the system to be excellent.
Result Demonstrability (RES)	RES1 RES2 RES3 RES4	I have no difficulty telling others about the results of using the system. I believe I could communicate to others the consequences of using the system. The results of using the system are apparent to me. I would have difficulty explaining why using the system may or may not be beneficial.
Behavioural Intention (BI)	BI1 BI2 BI3	Assuming I had access to the system, I intend to use it. Given that I had access to the system, I predict that I would use it. I plan to use the system in the next <n> months
Use (USE)	USE1	On average, how much time do you spend or do you expect to spend on the system each day?

7.4.3 SYSTEM USABILITY SCALE (SUS)

The System Usability Scale (SUS) will provide a quick, reliable, and industry-standard measure of perceived usability. This 10-item questionnaire yields a single score on a 0-100 scale, providing a simple, global assessment of system usability that is easy to understand and compare across iterations and pilots. Its strength lies in its agility and wide adoption, which provides a vast set of benchmark data for interpretation [13] [14]. The SUS will be administered alongside the UEQ immediately following training sessions in both the beta and final phases. While the UEQ offers a rich, granular view of the user experience, the SUS serves as a key high-level usability KPI for tracking progress against project goals.

Question	1. Strongly Disagree	2.	3.	4.	5. Strongly Agree
1. I think that I would like to use this system frequently.	○	○	○	○	○
2. I found the system unnecessarily complex.	○	○	○	○	○
3. I thought the system was easy to use.	○	○	○	○	○
4. I think that I would need the support of a technical person to be able to use this system.	○	○	○	○	○
5. I found the various functions in this system were well integrated.	○	○	○	○	○
6. I thought there was too much inconsistency in this system.	○	○	○	○	○
7. I would imagine that most people would learn to use this system very quickly.	○	○	○	○	○
8. I found the system very cumbersome to use.	○	○	○	○	○
9. I felt very confident using the system.	○	○	○	○	○
10. I needed to learn a lot of things before I could get going with this system.	○	○	○	○	○

FIGURE 29 - SYSTEM USABILITY SCALE (SUS)

7.4.4 USER EXPERIENCE QUESTIONNAIRE (UEQ)

The User Experience Questionnaire (UEQ) is introduced as a standardised instrument to comprehensively assess pragmatic quality (e.g., perspicuity, efficiency) and hedonic quality (e.g., stimulation, novelty) of the interactive experience. It consists of 26 items rated on a 7-point scale between opposite adjectives [15]. The UEQ will be administered immediately after training sessions to capture fresh impressions. Its results are comparable to an extensive benchmark dataset, enabling the identification of strengths and weaknesses in the user experience.

TABLE 30 - USER EXPERIENCE QUESTIONNAIRE (UEQ)

		1 - 2 - 3 - 4 - 5 - 6 - 7	
1	annoying	○ ○ ○ ○ ○ ○ ○	enjoyable
2	not understandable	○ ○ ○ ○ ○ ○ ○	understandable
3	creative	○ ○ ○ ○ ○ ○ ○	dull
4	easy to learn	○ ○ ○ ○ ○ ○ ○	difficult to learn
5	valuable	○ ○ ○ ○ ○ ○ ○	inferior
6	boring	○ ○ ○ ○ ○ ○ ○	exciting
7	not interesting	○ ○ ○ ○ ○ ○ ○	interesting
8	unpredictable	○ ○ ○ ○ ○ ○ ○	predictable
9	fast	○ ○ ○ ○ ○ ○ ○	slow
10	inventive	○ ○ ○ ○ ○ ○ ○	conventional
11	obstructive	○ ○ ○ ○ ○ ○ ○	supportive
12	good	○ ○ ○ ○ ○ ○ ○	bad
13	complicated	○ ○ ○ ○ ○ ○ ○	easy
14	unlikable	○ ○ ○ ○ ○ ○ ○	pleasing
15	usual	○ ○ ○ ○ ○ ○ ○	leading edge
16	unpleasant	○ ○ ○ ○ ○ ○ ○	pleasant
17	secure	○ ○ ○ ○ ○ ○ ○	not secure
18	motivating	○ ○ ○ ○ ○ ○ ○	demotivating
19	meets expectations	○ ○ ○ ○ ○ ○ ○	does not meet expectations
20	inefficient	○ ○ ○ ○ ○ ○ ○	efficient
21	clear	○ ○ ○ ○ ○ ○ ○	confusing
22	impractical	○ ○ ○ ○ ○ ○ ○	practical
23	organized	○ ○ ○ ○ ○ ○ ○	cluttered
24	attractive	○ ○ ○ ○ ○ ○ ○	unattractive
25	friendly	○ ○ ○ ○ ○ ○ ○	unfriendly
26	conservative	○ ○ ○ ○ ○ ○ ○	innovative

7.5 ITERATION WORKSHOPS AND REFINEMENT CYCLE

Once beta pilot data are consolidated (within the M14–M18 window), each consortium member joins an iteration workshop to interpret results and agree on next steps. Activities cover data review, root-cause analysis of gaps, prioritization of curriculum / feature adjustments, and assignment of action items with owners and tentative timelines. Outcomes feed the refinement backlog that will be addressed from M18 onward and, if needed, revisited again during the final-phase validation (M32–M35).

The workshop agenda will explicitly include analysis of TRL progress, TAM3 results (comparing Ex-Ante and Ex-Post data), and UEQ benchmarks to ground all refinement decisions in empirical evidence on technological maturity and user acceptance.

The flowchart below illustrates the continuous loop: pilot data are consolidated and reviewed, gaps are analysed, improvements are prioritized and implemented, and the updated curriculum is validated before new evidence is folded back into the data pool. Blue nodes indicate steps carried out during the beta window (M14–M18), while green nodes show the final-phase activities (M32–M35). This keeps the process agile, focused on pragmatic fixes in beta and deeper enhancements before the final release, while ensuring decisions remain grounded in empirical feedback and comparable metrics.

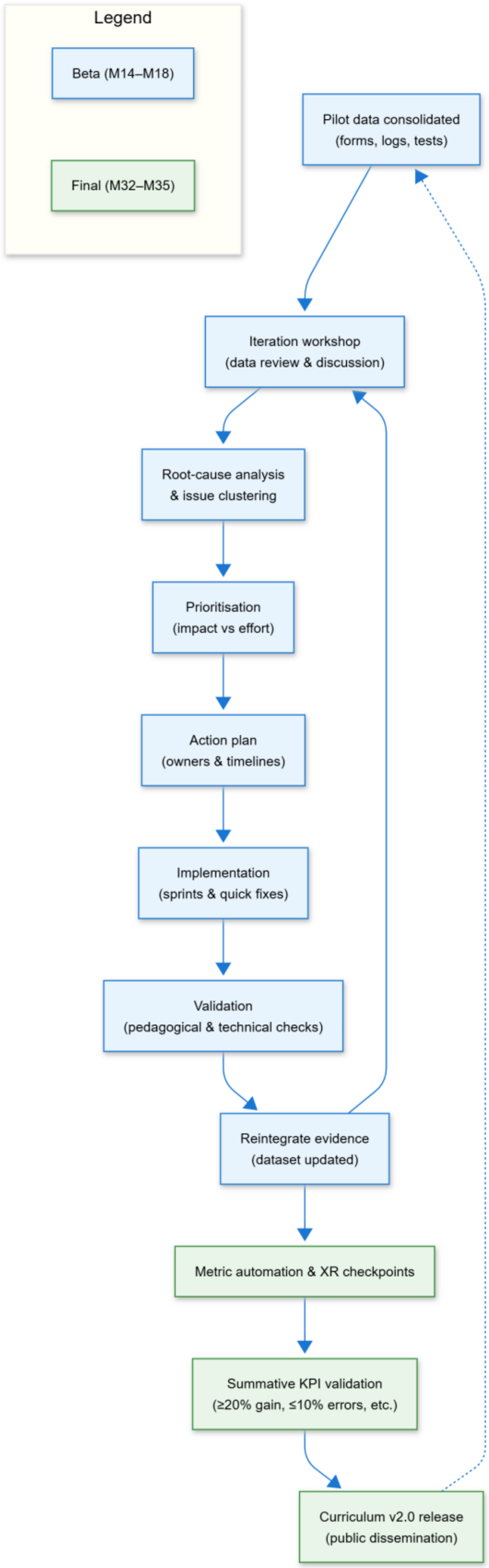


FIGURE 30 - STATE DIAGRAM OF THE CURRICULUM EVALUATION AND ITERATION PROCESS

Blue boxes represent the **beta window (M14–M18)** steps—data capture, analysis, workshops, quick fixes, and validation. Green boxes represent the **final phase (M32–M35)**—automation of metrics, KPI-level validation, and the v2.0 curriculum release. The dotted arrow shows that improvements feed back into future data cycles. The small legend clarifies colours if your renderer doesn't show them clearly.

8 CURRICULUM OVERVIEW AND DISSEMINATION ASSET

In this chapter we present an overarching view of the MotivateXR training curriculum and describe how it will be shared both within the consortium and with a wider open community. Differentiating between the **beta phase** and the **final release**, we outline how the curriculum will evolve and become a key dissemination asset.

During the **beta phase** (training in M14–M17; stakeholder use in M17), the curriculum focuses on foundational and operational modules delivered through a limited set of XR environments, authoring tools, and assessment methods based on structured questionnaires and logs. Instructional designers and technology partners complete guided tutorials and workshops to configure 3D assets, animations, and controller-based interactions. Pilot participants follow preconfigured learning paths and provide both qualitative and quantitative feedback via the data-collection instruments described in the Appendix ("Document Templates").

All beta resources are housed in an internal repository accessible to designers, developers, and trainers. This repository contains the detailed curriculum document, digital XR asset packages (scenes, models, interaction scripts), assessment templates (questionnaires, pre/post tests, observation logs), a PDF user guide, and a set of rapid-onboarding videos.

In the **final release** (M32–M35), the curriculum will expand to include advanced modules on social interactivity, learner agency, and next-generation mixed reality. It will be disseminated more broadly through a public web portal, connected to the project website, where anyone can download the curriculum, explore interactive demos, and contribute user-generated scenarios. An open-source package will also be made available, containing automation scripts, analytics templates, and co-design guidelines. Finally, a series of public webinars and recorded workshops will showcase best practices and invite participation from developers, researchers, and XR educators beyond the project consortium.

The table below summarises the key differences between the beta and final phases of the MotivateXR curriculum, highlighting how each aspect will mature over time.

TABLE 31 - CURRICULUM OVERVIEW: BETA VS FINAL RELEASE

Aspect	Beta (M14-M17)	Final (M32-M35)
Modules Delivered	Foundational and Operational	+Advanced, Social Interactivity, Learner Agency, Mixed Reality
Resource Repository	Internal access for partners	Public web portal
Assets and Templates	XR asset packages, PDF guides, on boarding videos	Open-source package with scripts, analytics, guidelines
Dissemination	Internal workshops and pilot reports	Public webinars, community contributions

Feedback Integration	Manual iteration via pilot reports	Continuous updates via integrated analytics

9 CONCLUSIONS & NEXT STEPS

The development of D7.1 has established a solid foundation for the MotivateXR training curriculum, aligning pedagogical principles with the technical capabilities of the platform and the needs of the pilot partners.

Through the integration of user requirements, co-design processes, and initial beta functionalities, the document captures both the current state of readiness and the roadmap towards the final release.

The beta phase, conducted within the M14–M18 window, will provide the first empirical evidence of how the curriculum supports authors and learners, while also exposing limitations and areas for refinement.

The subsequent iteration cycle will build on this evidence, ensuring that advanced features and dimensions of XR learning are progressively integrated and validated before the final phase.

Looking ahead, the consortium will focus on consolidating pilot contributions, harmonising evaluation approaches, and sustaining a flexible methodology that allows each partner to adapt activities to their operational context.

By maintaining this iterative and collaborative approach, the project will not only achieve the objectives defined in the proposal but also generate a training framework that remains relevant beyond the project's duration, contributing to the wider open community and supporting the uptake of XR technologies across sectors.

REFERENCES

[1] Retz C., Klotzbier T. J., Ghellal S., Schott N., "CIEMER in action: from development to application of a co-creative, interdisciplinary exergame design process in XR", Front. Virtual Real., Vol. 5, Sec. Virtual Reality and Human Behaviour, May (2024), https://doi.org/10.3389/frvir.2024.1376572.

[2] Yang K., Zhou X., Radu I., "XR-Ed Framework: Designing Instruction-driven and Learner-centered Extended Reality Systems for Education", (2020) https://doi.org/10.48550/arXiv.2010.13779.

[3] Paulsen L., Dau S., Davidsen J., "Designing for collaborative learning in immersive virtual reality: a systematic literature review", Virtual Reality 28, 63 (2024). https://doi.org/10.1007/s10055-024-00975-4

[4] Kee, T., Zhang, H. & King, R.B. "An empirical study on immersive technology in synchronous hybrid learning in design education", Int J Technol Des Educ 34, 1243–1273 (2024). https://doi.org/10.1007/s10798-023-09855-5

[5] Dorta T., Safin S., Boudhraa S., Beaudry Marchand E., "Co-Designing in Social VR. Process awareness and suitable representations to empower user participation", CAADRIA 2019: Computer assisted architectural design research in Asia, Apr 2019, Wellington, New Zealand, https://arxiv.org/abs/1906.11004

[6] Sung, H.; Kim, M.; Park, J.; Shin, N.; Han, Y. "Effectiveness of Virtual Reality in Healthcare Education: Systematic Review and Meta-Analysis", Sustainability 2024, 16, 8520, https://doi.org/10.3390/su16198520

[7] Woon APN, Mok WQ, Chieng YJS, Zhang HM, Ramos P, Mustadi HB, Lau Y. "Effectiveness of virtual reality training in improving knowledge among nursing students: A systematic review, meta-analysis and meta-regression." Nurse Educ Today. 2021 Mar;98:104655. doi: 10.1016/j.nedt.2020.104655. Epub 2020 Nov 28. PMID: 33303246.

[8] Stracke, C.M., Bothe, P., Adler, S. *et al.* "Immersive virtual reality in higher education: a systematic review of the scientific literature", *Virtual Reality* 29, 64 (2025). https://doi.org/10.1007/s10055-025-01136-x

[9] Tene T, Bonilla García N, Coello-Fiallos D, Borja M and Vacacela Gomez C (2024) "A systematic review of immersive educational technologies in medical physics and radiation physics", *Front. Med.* 11:1384799. doi: 10.3389/fmed.2024.1384799

[10] Mankins, J. C. Technology readiness levels: A white paper. NASA, Office of Space Access and Technology. (1995).

[11] European Commission. Technology Readiness Levels (TRL). HORIZON 2020 – WORK PROGRAMME 2014-2015. (2014).

[12] Venkatesh, V., & Bala, H. "Technology acceptance model 3 and a research agenda on interventions", Decision Sciences, 39(2), 273–315 (2008). https://doi.org/10.1111/j.1540-5915.2008.00192.x

[13]Brooke, J. (1996). SUS: A quick and dirty usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & I. L. McClelland (Eds.), Usability Evaluation in Industry (pp. 189–194). Taylor & Francis.

[14] Brooke, J. "SUS: a retrospective", Journal of Usability Studies, 8(2), 29-40 (2013).

[15]Schrepp, M. "User Experience Questionnaire Handbook. All you need to know to apply the UEQ successfully in your project", (2015). https://doi.org/10.13140/RG.2.1.2815.0245

APPENDIX – DOCUMENTS TEMPLATES

PILOT EVALUATION PROTOCOL TEMPLATE

This document clearly defines your pilot's objectives, schedule, participants, evaluation methods, and XR scenarios.

Instructions: Complete all sections precisely. Clearly state your pilot's context, timeline, and key milestones, and specify your data collection methods and equipment clearly. This document ensures that everyone involved understands the pilot's goals and processes.

____

Pilot Name:

Pilot Owner:

Technology Providers:

Dates of Pilot Test:

Objectives

Briefly define specific goals of pilot testing:

- Objective 1
- Objective 2
- Objective 3

Participants

- Number of participants:
- Roles and background:
- Selection criteria:

Schedule & Milestones

Activity	Date(s)	Location	Responsible
Activity description	YYYY-MM-DD	Location	Partner

Evaluation Context

- Describe clearly the XR scenarios and tasks.

- Specify expected learning outcomes.

Data Collection Methods

- Questionnaires: Ex-ante & Ex-post
- Knowledge tests (Pre/post-training)
- System log analytics
- Observational methods
- Interviews (post-training)

Equipment and Technical Environment

- List of XR equipment used:
- Technical specifications required:
- Safety precautions or setup instructions:

Example

Pilot Name: Aerospace Maintenance Pilot

Pilot Owner: Aerospace Valley (AV)

Technology Providers: CS GROUP, Sopra Steria

Dates of Pilot Test: 1-23 October 2025

Objectives

Briefly define specific goals of pilot testing:

- Validate XR training for A320 air conditioning maintenance procedures
- Assess technician confidence and error reduction using XR
- Evaluate usability and operational impact of the MotivateXR platform

Participants

- Number of participants: 10
- Roles and background: Certified maintenance technicians (5), supervisors/trainers (5)
- Selection criteria: Minimum 3 years of experience on A320 systems

Schedule & Milestones

Activity	**Date(s)**	**Location**	**Responsible**
Instructor Training	2025-08-28	AA Bordeaux	AA, CS
Technician XR Training	2025-10-01/17	AA Bordeaux	AA
Authoring Evaluation	2025-10-20/23	CS Toulouse	CS
Data Analysis & Reporting	2025-10-24/31	AV offices	AV, CS

Evaluation Context

- Scenarios: Primary Heat Exchanger Inspection, Plenum Inspection (A320 systems).
- Learning outcomes: Technicians complete tasks faster, with fewer errors, and show increased confidence and independence.

Data Collection Methods

- Questionnaires: Ex-ante & Ex-post
- Knowledge tests (Pre/post-training)
- System logs
- Observational logs
- Interviews (post-training)

Equipment and Technical Environment

- Equipment: Microsoft Hololens, PCs, XR controllers
- XR environment: Prepared by CS (Inscape VTS platform)
- Safety precautions or setup instructions: XR headset use limited to 1 hour/session, ergonomic checks

PRE-POST KNOWLEDGE TEST TEMPLATE

The Pre-post Knowledge Test evaluates learning effectiveness and performance improvements related to XR training. Considering the two main MotivateXR components (Authoring and Experiencing), two distinct versions of this test must be used:

- **Authoring Knowledge Test**: assesses how well participants learn to use the no-code authoring tools of MotivateXR for creating XR training materials. Since there are currently no XR authoring systems in use, the pre-test measures general theoretical knowledge about instructional design and scenario creation, while the post-test evaluates practical competencies gained through MotivateXR.

- **Experiencing Knowledge Test**: measures the improvement in actual performance, speed, and accuracy in operational tasks (maintenance, assembly, etc.) by comparing traditional non-XR methods (pre-test) with XR-assisted tasks (post-test).

Partners must clearly record participants' answers before and after the training sessions, ensuring a precise match between pre-test and post-test answers to allow accurate measurement of improvement.

For Authoring phase:

Participant ID	Question ID	Question Text	Pre-test Answer	Post-test Answer	Competence Gained
P1	Q1				
P2	Q2				

For Experiencing phase:

Participant ID	Question ID	Question Text	Pre-test Answer	Post-test Answer	Performance improvement
P1	Q1				
P2	Q2				

Example

Authoring

Participant ID	Question ID	Question Text	Pre-test Answer	Post-test Answer	Competence Gained
P1	A1	"What elements are essential in a maintenance training manual?"	Generic/basic answer	Clearly described steps to create an XR maintenance scenario	Significant
P2	A2	"How would you design a step-by-step procedure for an inspection?"	Unclear, incomplete	Complete XR-based scenario clearly structured using MotivateXR	High

Experiencing

Participant ID	Question ID	Question Text	Pre-test Answer	Post-test Answer	Performance improvement
P1	E1	"Describe steps and timing for inspecting PHX manually"	30 minutes, moderate error rate	Completed in 15 minutes, zero errors (XR-guided inspection)	Very high
P2	E2	"How do you currently identify problems during	Visually, relying on manuals, errors likely	Automatic alerts, visual guidance in XR, fewer errors	High

		maintenance tasks?”			

EX-ANTE QUESTIONNAIRE TEMPLATE

This survey collects demographic data, previous XR experience, expectations, and anticipated challenges before using MotivateXR.

Note: In addition to basic demographic and prior-experience questions, the ex-ante survey integrates a **tailored TAM3 instrument** to assess participants' expectations and readiness. Constructs such as perceived usefulness, ease of use, self-efficacy, and behavioral intention are covered by the TAM3 items, ensuring alignment with validated models of technology acceptance and avoiding redundancy.

Instructions: Distribute this questionnaire online to all participants prior to XR training. Ensure participants understand the anonymous nature of responses. Aim for completeness and encourage honest, detailed answers.

---

1. INTRODUCTION BLOCK (IN THE FORM)

Thank you for participating in this survey. Your responses are anonymous and will be used for research purposes within the MotivateXR project. This questionnaire collects your opinions, expectations and background before the use of the XR platform in your organization. It takes approximately 10 minutes to complete.

2. GENERAL SECTION (for all pilots)

Question Type	**Question**
Demographics (closed)	Age range / Gender / Role in the company / Department / Years of experience
Prior experience (Likert)	I have used XR tools in the past (1-5: Strongly disagree → Strongly agree)
Prior experience (multiple choice)	Which XR tools or platforms have you used before? (list options + Other)
Technology Acceptance (TAM3 – Ex-Ante)	Items covering Perceived Usefulness (**PU1–PU4**), Perceived Ease of Use (**PEOU1–PEOU4**), Computer Self-Efficacy (**CSE1**), Computer Anxiety (**CANX**), and Behavioural Intention (**BI1–BI3**)

Expectations (open)	What are your expectations regarding the use of XR in your work context?
Technical environment (open)	Do you foresee any challenges (technical, organisational) that could affect your training experience?

3. PILOT-SPECIFIC SECTION

Pilot owners are invited to co-author these questions. Examples:

Pilot	Example question
Aerospace	What types of technical manuals or instructions do you currently use during maintenance tasks?
Home appliance	Do you perform most repair tasks independently or with guidance?
Aluminium industry	How frequently do you need training on new components or assemblies?
Energy distribution	What is the main safety-related challenges during field maintenance?
Human-robot	Have you been trained before in collaborative tasks involving robots?

Each pilot section could include:

- 2–3 closed questions (Likert scale or multiple choice)
- 1–2 open-ended context questions (optional)

CONTRIBUTION REQUEST

For each pilot owner:

- Provide 3–5 tailored questions (2–3 Likert, 1–2 open-ended) relevant to your use case
- Validate the wording of general questions if needed for clarity in your domain
- Suggest any terminology adjustment (e.g. “procedure”, “task”, “module”)

For technology providers:

- Indicate whether additional platform-specific questions should be added (e.g. ease of using KAYROX, clarity of AI suggestions, headset performance)
- Suggest technical terminology clarification if needed

Example

Question	**Participant Response**
Age range	30-40
Role	Maintenance technician
XR experience	Strongly disagree (1)
Previously used XR tools?	None
Believe XR can improve training?	Strongly agree (5)
Anticipated challenges?	Concerned about headset comfort during tasks

EX-POST QUESTIONNAIRE TEMPLATE

This questionnaire gathers participant feedback, satisfaction ratings, usability insights, and overall impact after using the MotivateXR platform.

Note: The ex-post questionnaire combines standard satisfaction and learning items with the **post-adoption TAM3 constructs**. This design ensures comparability with ex-ante data while capturing changes in perceived usefulness, ease of use, behavioral intention, and objective usability after hands-on interaction with MotivateXR.

Instructions: Administer immediately following the training sessions. Ensure participants clearly understand each question. Stress anonymity to gather honest, detailed feedback.

———

1. INTRODUCTION BLOCK (IN THE FORM)

Thank you for completing the training with the MotivateXR platform. This survey collects your impressions, satisfaction and perceived impact of the XR-based training. Your answers are anonymous. Estimated time to complete: 10–12 minutes.

2. GENERAL SECTION (for all pilots)

Question Type	**Question**
Technology Acceptance (TAM3 – Ex-Post)	Items covering Perceived Usefulness, Perceived Ease of Use, Behavioral Intention, Objective Usability, and Actual Use
Training satisfaction (Likert)	The XR training met my expectations (1–5: Strongly disagree → Strongly agree)
Perceived learning (Likert)	I improved my knowledge and skills through this training (1–5)
Open reflection (open)	What aspects of the XR platform did you find most useful or challenging?
Improvement suggestions (open)	What improvements would you recommend for the XR training or platform?

3. PILOT-SPECIFIC SECTION

Again, to be co-authored with each pilot owner. Examples:

Pilot	**Example question**
Aerospace	Did the XR scenario provide you with a clearer understanding of step-by-step procedures?
Home appliance	Would you use the MotivateXR solution during actual repair work?
Aluminium industry	Did the XR training improve your confidence in operating tools or assembling components?
Energy distribution	Did the XR training help you identify and avoid safety risks more effectively?
Human-robot	Do you feel more confident in interacting with robots after the XR session?

Suggested structure per pilot:

- 2–3 Likert scale questions
- 1–2 open questions about usability or perceived improvement

CONTRIBUTION REQUEST

For each pilot owner:

- Provide 3–5 tailored questions (2–3 Likert, 1–2 open-ended) relevant to your use case
- Validate the wording of general questions if needed for clarity in your domain
- Suggest any terminology adjustment (e.g. "procedure", "task", "module")

For technology providers:

- Indicate whether additional platform-specific questions should be added (e.g. ease of using KAYROX, clarity of AI suggestions, headset performance)
- Suggest technical terminology clarification if needed

Example

Question	**Participant Response**
Training met expectations	Agree (4)
XR platform easy to use	Agree (4)
Found XR engaging and immersive	Strongly agree (5)
Feel more prepared after training	Strongly agree (5)
Encountered technical issues	Disagree (2)
Scenario was realistic	Agree (4)
Recommend XR training to colleagues	Strongly agree (5)
What did you like the most?	"Realistic scenarios improved understanding."
Suggested improvements?	"Would prefer lighter headset for comfort."

UX QUESTIONNAIRE REPORT TEMPLATE

This document summarises UX questionnaires (e.g., SUS, UEQ), providing usability data, participant satisfaction, and user-experience insights.

Instructions: Aggregate and summarise participant ratings clearly. Include key quotes or insights in the comments field. Provide a concise summary of findings, highlighting main strengths, identified issues, and recommended improvements.

Pilot Name:
Session Date(s):
Technology Provider:

Questionnaire Used:

- [ ] SUS (System Usability Scale)
- [ ] UEQ (User Experience Questionnaire)
- [ ] Custom (specify):

Participant Feedback Summary

Participant ID	Questionnaire Item	Rating (1-5)	Participant Comments (optional)
P1	Ease of Use		
P1	Clarity of UI		
P1	Engagement Level		

(*Repeat rows for each participant and item*)

Aggregated Results

Questionnaire Item	Average Score (1-5)	Notes (key insights)
Ease of Use		
Clarity of UI		

Engagement Level		

General Observations and Recommendations

(Provide a short summary of main UX strengths, issues identified, and suggested improvements.)

____

Example

Pilot Name: Aerospace Maintenance Pilot
Session Date(s): 15-10-2025
Technology Provider: CS GROUP

Questionnaire Used:

- [X] SUS (System Usability Scale)
- [ ] UEQ (User Experience Questionnaire)
- [ ] Custom (specify):

Participant Feedback Summary

Participant ID	Questionnaire Item	Rating (1-5)	Participant Comments
P1	Ease of Use	4	"Generally intuitive."
P1	Clarity of UI	5	"Very clear, easy navigation."
P1	Engagement Level	5	"Enjoyable and immersive."

Aggregated Results

Questionnaire Item	Average Score (1-5)	Notes (key insights)
Ease of Use	4.2	Most participants found it user-friendly.
Clarity of UI	4.7	High satisfaction across participants.
Engagement Level	4.9	Consistently engaging and immersive.

General Observations and Recommendations

Participants enjoyed high engagement and intuitive navigation. A lighter headset is recommended to enhance comfort during longer sessions.

OBSERVATION LOGBOOK TEMPLATE

This logbook records observations and incidents during pilot sessions, providing valuable qualitative context to support quantitative data.

Instructions: Maintain accurate, detailed records of significant behaviours, events, or issues observed during training sessions. Clearly indicate date, time, observer name, and severity level. Use objective, clear language in notes.

Date	Time	Session ID	Observer Name	Observed Behaviour/Incident	Severity (1-5)	Additional Notes
YYYY-MM-DD	09:30	S1				

Example

Date	Time	Session ID	Observer Name	Observed Behaviour/Incident	Severity (1-5)	Additional Notes
2025-10-10	09:45	S1	John Doe	Participant struggled briefly with controls	2	Adjusted after 5 min

SYSTEM LOG EXPORT SPECIFICATION TEMPLATE

This document defines the precise system log data that must be captured, including event types, parameters, formats, and export procedures.

Instructions: Clearly specify which system log events to record, their formats, and export frequency. Ensure clarity about data storage location and maintain consistent formatting across all pilot sessions.

Pilot Name:
Technology Provider:

Required Log Events

Event Name	Timestamp Format	Parameters Captured	Notes (clarifications/examples)
Session Started	YYYY-MM-DD HH:MM:SS	session_id, participant_id	"Session initiated by participant P1"
Task Completed	YYYY-MM-DD HH:MM:SS	participant_id, task_id, duration_sec, errors_count	"Participant P1 completed Task 5 in 120 sec"
Error Occurred	YYYY-MM-DD HH:MM:SS	participant_id, error_code, error_description	"Error E101 triggered by Participant P2"

Export Details

- **Format**: JSON (recommended), CSV also acceptable.
- **Export Frequency**: Daily (end-of-day).
- **Repository Location (upload URL)**: [insert URL or repository address here]

Additional Notes

(Any additional technical notes or specific instructions to partners.)

Example

Event Name	Timestamp Format	Parameters Captured	Notes (clarifications/examples)

Session Started	2025-10-01 09:00:00	session_id:001, participant_id:P1	Session started by technician P1
Task Completed	2025-10-01 09:20:05	participant_id:P1, task_id:T1, duration_sec:120, errors_count:0	Technician completed inspection quickly
Error Occurred	2025-10-01 09:12:03	participant_id:P2, error_code:E103, description:"Incorrect step"	Technician performed incorrect step

- Format: JSON
- Export Frequency: Daily
- Repository Location: [repository.example.com/aerospace/logs]

INTERVIEW GUIDE & TRANSCRIPT TEMPLATE

This guide standardises the structure and documentation of qualitative interviews conducted post-training, capturing detailed participant feedback.

Instructions: Follow the guide closely to maintain consistency across interviews. Record accurate and representative summaries and key quotes. Clearly attribute responses to participant IDs while ensuring anonymity.

Pilot: [Pilot Name]
Interviewer:
Interview Date:

Interview Guide Questions

- How do you assess your overall experience with the MotivateXR training?
- What did you find most beneficial about the XR platform?
- What issues or challenges did you encounter?
- How has this XR training impacted your skills or job confidence?
- What improvements would you recommend?

Transcript

Question ID	Participant ID	Response Summary	Verbatim Excerpts
Q1	P1	Brief summary of main points	"Exact quote"
Q2	P1		

Example

Pilot: Aerospace Maintenance Pilot
Interviewer: Jane Smith
Interview Date: 17-10-2025

Interview Guide Questions

1. Overall experience with MotivateXR training?
2. Most beneficial aspects of XR platform?
3. Challenges faced during training?

4. Impact on skills/confidence?
5. Recommendations?

Transcript

Question ID	Participant ID	Response Summary	Verbatim Excerpts
Q1	P1	Very positive overall	"Extremely useful, enjoyed learning tasks."
Q3	P1	Minor discomfort with headset	"Headset became uncomfortable after a while."

ANALYTICS DASHBOARD TEMPLATE

This template defines the standard analytics dashboard configuration, providing a visual summary of performance metrics across pilots.

Instructions: Clearly configure each widget according to the specified data sources and fields. Maintain consistency across pilots to enable comparative analysis. Ensure dashboards update regularly and automatically upon new data uploads.

Dashboard Title: Pilot Performance Dashboard
Pilot Name:
Technology Provider:

Dashboard Widgets Configuration

- Task Completion Time per Session
    - **Widget Type:** Line chart
    - **X-Axis:** Session Number
    - **Y-Axis:** Avg. Task Completion Time (sec)
    - **Data Source:** System Logs (task_completed event)

- Error rates per task
    - **Widget Type:** Bar chart
    - **X-Axis:** Task ID
    - **Y-Axis:** Total Errors Recorded
    - **Data Source:** System Logs (task_completed event)

- Participant satisfaction ratings
    - **Widget Type:** Pie chart
    - **Data Source:** Ex-post UX Questionnaires
    - **Value Field:** Count of ratings
    - **Category Field:** Satisfaction Rating (1–5 scale)

- Knowledge gain summary
    - **Widget Type:** Data Table
    - **Columns:** Participant ID, Module, Pre-test Score, Post-test Score, Improvement %
    - **Data Source:** Pre-post Knowledge Tests

Additional dashboard notes

- Data should refresh automatically upon new daily log uploads.
- Ensure data anonymisation and GDPR compliance.