D3.3 European Framework for Training and Assessment (using VR) of DMA-SR Behaviour of Professionals

Deliverable	D3.3
Deliverable Lead	VUA
Related work package	WP3
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Versions

Vers.	Date	Author	Description
V0.1	21/06/21	Lisanne Kleygrewe (VUA)	First draft structure
V0.2	20/07/21	Matthijs Koedijk (VUA)	First draft additions
V0.3	27/07/21	Matthijs Koedijk, Lisanne Kleygrewe (VUA)	Content for macro, meso, micro level
V0.4	28/07/21	Raôul Oudejans (VUA)	Feedback and additions to first draft
V0.5	01/08/21	Matthijs Koedijk (VUA)	Integration of feedback
V0.6	10/08/21	Lisanne Kleygrewe (VUA)	Integration of input from LEAs (after LEA presentation)
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V0.75	17/08/21	Vana Hutter (VUA)	Feedback and additions
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V1.1	26/10/21	Vana Hutter, Raôul Oudejans, Matthijs Koedijk (VUA)	Additional reference in Executive Summary based on review feedback

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List of Acronyms and Abbreviations

Acronym / Abbreviation	
VR	Virtual Reality
LEAs	Law Enforcement Agencies
DMA-SR	Decision-Making and Acting under Stress and in High-Risk Situations
AAR	After-Action Review
IAM	In-Action Monitoring
PTSD	Post-Traumatic Stress Disorder
HF	Human Factors
RAT	Risk Assessment Tool
NPC	Non-Player Character (computer-controlled avatar)
WP	Work Package
VirTra	VirTra V-300 Firearms Training Simulator for Law Enforcement
HRV	Heart rate variability

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1 Executive Summary

Deliverable 3.3 – European Framework for Training and Assessment of Decision Making and Acting under Stress and in High-Risk Situations (DMA-SR) Behaviour of Professionals – provides an extensive **evidence-based** set of recommendations for implementing VR DMA-SR training in current police curricula based on:

- theory (see D3.2, conceptual human factors model of DMA-SR behaviour);
- input and information about current training practices across European Law Enforcement Agencies (LEAs) (see D3.1);
- results from scientific Human Factor (HF) studies and experiments with European LEAs (see *Table 12*)

We give recommendations for implementation of VR into existing training structures of European LEAs. In addition, D3.3 provides a training framework for police trainers and practitioners that allows them to follow scientifically informed didactical guidelines to successfully set-up and conduct VR training sessions.

Both the recommendations for implementation and the didactical VR guidelines will be further elaborated on in **D7.5 SHOTPROS Final Training Curriculum** (M41) and **D7.6 SHOTPROS Final Guidelines for VR Training** (M41).

Because training practices across LEAs in Europe differ in terms of duration, frequency, and components, D3.3 will provide generic implementation recommendations and didactical **training guidelines.** LEAs can use these training guidelines to implement VR training into their own training curriculum. This allows all LEAs — regardless of differences in training structure — to make use of the VR recommendations and to conduct VR training sessions to supplement their existing practices. D3.3 thus provides a European-wide approach in raising awareness for VR technology in the field of police training.

The DMA-SR **training framework** helps policy-makers make informed decisions regarding the relevance of VR training as addition to their current training curriculum. This deliverable equips them to make informed decisions regarding technical, logistical, didactical, and human resource requirements for VR training. Gender, legal, ethical, safety, and privacy perspectives are discussed in line with the VR training framework for policy-makers to consider for implementation of VR training.

The European Framework for Training and Assessment of DMA-SR Behaviour of Professionals comprises a structure of three distinct levels: a macro level, a meso level, and a micro level.

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The **macro level** provides an overview of what existing police training of European LEAs looks like in terms of training frequency and duration as well as didactical features of various training sessions. By highlighting the existing training structure, areas for which VR can add value to current practices could be identified. For instance, due to location limitations, a well-designed practice situation seldomly provided a realistic training context (see *Table 4*), a problem that VR could solve.

The **meso level** presents recommendations on how VR training can supplement, and be integrated into, current police practice. Various qualitative and quantitative results from SHOTPROS HF studies and experiments (see D6.1 for all SHOTPROS human factor studies) unveil the training areas for which VR is most useful in police, such as tactical training applied to a car procedure or complex AMOK situations. Practical recommendations such as appropriate training time in VR, how to supplement VR to real-life practice, and considerations for trainee characteristics demonstrate how VR can be implemented on a logistical level. Lastly, a protocol specific to the tasks of the trainer in VR summarises trainer's tasks in VR that are similar to trainer's tasks in real-life training and VR-specific training tasks like control of, and analysis with the After-Action Review system (AAR).

The **micro level** provides didactical guidelines on seven criteria that have been shown to compose good training and enhance learning and transfer (Beek, 2011):

1. Clear Assignment
2. Training Instruction
3. Well-designed Practice Situation
4. Model Learning
5. Variation and Differentiation
6. Self-Management of the Learning Process
7. Feedback

These **criteria** have been assessed during the training observations of current police practice where VUA researchers evaluated the use of didactics in real-life training sessions (i.e., skill training, car procedure training, shooting training, shooting training). Informed by real-life training shortcomings and results from SHOTPROS experiments (see *Table 12*), these criteria have been translated into didactical guidelines for VR training. For each criterion, the relevance of the overall concept for training is described. For instance, using variation and differentiation in training has been shown to enhance exploration, skill acquisition, and transfer of learning (Ranganathan & Newell, 2013; Wulf & Schmidt, 1997; Newell & McDonald, 1992). Next, didactical guidelines such as "provide a change in context of the virtual training environment for each repetition to achieve variation and differentiation" (see section 3.3.6)

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illustrate how each criterion can be applied in VR training. Lastly, a takeaway message for each criterion specifies the importance of applying the didactical guidelines in VR. For example, the takeaway message for the criterion "variation and differentiation" states that "location variation is the most distinguishable feature of VR and must [therefore] be implemented in VR training sessions" (see section 3.3.6).

With the objective to improve DMA-SR behaviour of European LEA professionals, this training framework provides constraints and prerequisites for DMA training in VR. Based on the conceptual human factors model for DMA-SR (see D3.2), trainers should use the criteria of a) **proportionality** and b) **subsidiarity** as primary objectives for their DMA assessment. Specific guidelines to instruct DMA training and assess DMA behaviour are outlined in the micro level (see section 3.3.8.1).

Taken together, the macro level, the meso level, and the micro level provide policy-makers and academy management with recommendations for implementing VR training into existing training structures, and police trainers and practitioners with didactical concepts as a guide for successfully conducting VR training sessions to enhance learning and DMA-SR behaviour of trainees.

This deliverable provides important information for introducing VR in law enforcement organisations. All findings will be used to enhance the requirements towards a VR solution (part of D4.6, M30) and feeding directly into the tasks of work package 5 (WP5), which will be validated within the field trials (WP7) and summarised into a final training curriculum and framework (in D7.5, M41) and training guidelines (in D7.6, M41).

Chapter 2 of this deliverable outlines how D3.3 is embedded in the SHOTPROS project as a whole. Readers (LEAs) that are mainly interested in the training framework itself can proceed to Chapter 3 ("The SHOTPROS VR training framework") directly if they wish. The information presented in Chapter 2 is not a prerequisite to understand the framework as presented in Chapter 3.

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2 Added Value

2.1 Relation to SHOTPROS WPs

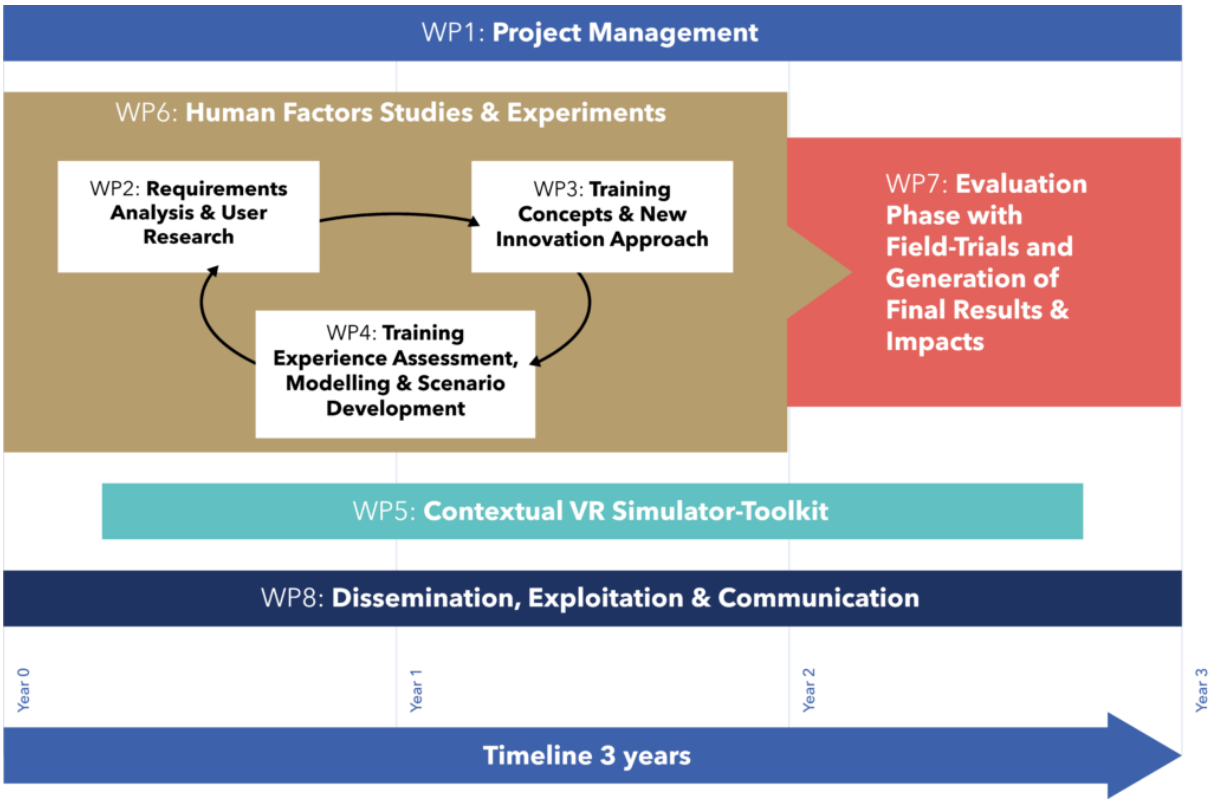

Figure 1. SHOTPROS workplan.

This deliverable is part of WP3, which builds (together with WP2 and WP4) the basis to set up the VR solution (WP5) that will be evaluated in WP7 (see *Figure 1*). WP3 hereby focuses on the training aspect and delivers information on the practical set-up from a didactical and organisational view.

D3.3 is informed by:

Deliverable	How did theses deliverables influence D3.3
D3.1	The overview of existing police training across LEAs in Europa was used to identify areas for which VR can add value to current practices. The deliverable revealed that training practices across LEAs in Europe differ in terms of duration, frequency, and components. Therefore, D3.3 will provide generic implementation recommendations and didactical training guidelines that LEAs can use to implement VR training into their own training curriculum.

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D3.2	The training framework presented in D3.3 is strongly affiliated with the conceptual human factors model for DMA-SR. The model emphasises action as the focus of training, which aligns well with the criteria for the micro level of this deliverable, which are based on insights for motor learning (see micro level in D3.3).
D2.2	The first requirements workshops with LEAs revealed various expectations regarding a VR solution and the attached training curriculum which was used to set up the HF studies in D6.1 and steered the focus of D3.3 to cater to the LEAs needs.
D6.1	Through the synthesis of evidence-based results of SHOTPROS experiments (D6.1), D3.3 provides practically relevant information to stakeholders (policy-makers, academy management, training coordinators, trainers) regarding the use and implementation of VR training.
D4.7	The Risk Assessment Tool supports the implementation and execution of several didactic guidelines described in D3.3; for instance, selecting a training environment with the proper levels of stress. The tool also enhances the safety of trainees as it gives trainers the possibility to provide constraints on a VR scenario from the beginning. This enhances safety by preventing information overload to the trainee and ensuring that the scenario does not exceed the trainee's development phase.

Table 1. Influence of SHOTPROS deliverables on D3.3.

D3.3 consequently feeds into:

Deliverable	How does D3.3 influence other Deliverables within SHOTPROS
D4.5	Considerations regarding psychological safety induced by audio-visual stress cues, privacy issues related to physiological measurements, and in-action monitoring, provide important criteria for technical implementation and didactic use of the Real Time VR Trainer Dashboard in VR training.
D4.6	The findings in D3.3 will be gathered and extracted to enhance the (technical) requirements of the SHOTPROS VR solution.
D5.1	D3.3 feeds into SHOTPROS VR solution and provides input for the set-up and tasks in VR System Design Document for development of SHOTPROS VR Environment for conducting the field trials (WP7).

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D7.1	The findings in D3.3 are input for the definition and validation aspects within the field trials.
D7.5	Input from D3.3 that is validated in the field trails (WP7) will be summarised into final training curriculum for DMA-SR. The training curriculum will in particular be evaluated with LEAs instructors while designing and conducting the training for the field trials. The conclusions of this further analysis will be peer reviewed by Re-Lion and shared in D7.5
D7.6	Input from D3.3 that is validated in the field trails (WP7) will be summarised into final guidelines for VR training. The current guidelines will be further substantiated with examples and experiences from LEAs at the field trials. The conclusions of this further analysis, and enrichment of the guidelines will be peer reviewed by Re-Lion and presented in D7.6

Table 2. Influence of D3.3 on SHOTPROS deliverables.

2.2 SHOTPROS Objectives Relation

Deliverable 3.3 – European Framework for Training and Assessment of DMA-SR Behaviour of Professionals – mainly contributes to SHOTPROS Objective 3 "(European Police) Training Framework and Curriculum for DMA-SR" by providing implementation recommendations and didactical guidelines for VR training (see *Figure 2*). These initial recommendations and guidelines will be further evaluated through field trials with SHOTPROS LEAs (planned in D7.1). To meet Objective 3, D3.3 comprises a training framework that incorporates different stakeholder requirements (see section 2.1 and 2.2) and considers relevant perspectives (gender, legal, ethical, safety, privacy, logistical; see section 4) for the use and integration of VR training. Furthermore D3.3 also contributes to objective 4, the Guidelines for VR training as those will also follow from results of this deliverable. The end user requirements that can be derived from D3.3 will be an important and valuable contribution to the product backlog (following the agile development process defined in D1.1) and the subsequent SHOTPROS VR solution. Additionally, the factsheets for LEAs that will be generated from D3.3, will also be an important knowledge source for all members in the European VR network and thus also feed objective 5.

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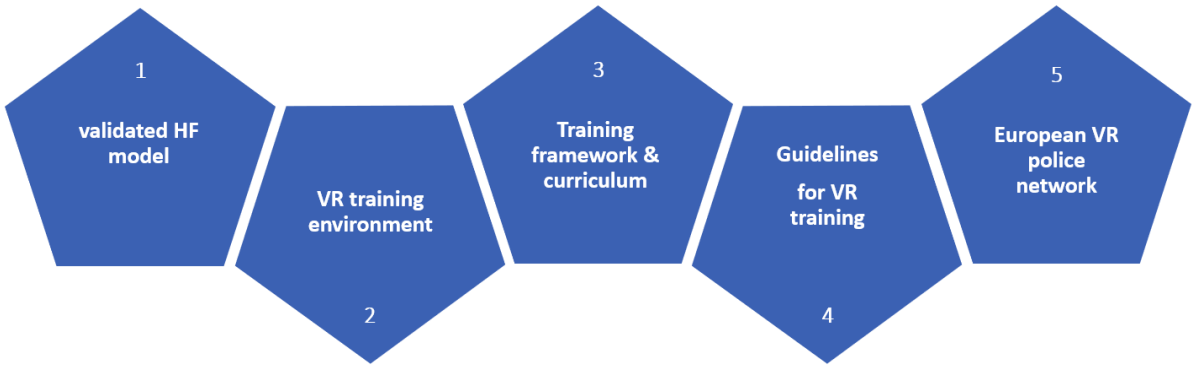

Figure 2. SHOTPROS objectives – overview.

2.3 Impact for LEAs

D3.3 impacts European LEAs in the following ways:

- Through evidence-based **recommendations**, LEAs have a **tool** that provides guidance on how to **implement** and govern VR training to supplement current practice;
- Through evidence-based **didactical guidelines**, police trainers have a practical tool that provides guidance on **how to set-up and conduct** a VR training session to enhance the learning process of trainees;
- Through the active involvement of trainees in their own learning process through the VR In-Action Monitoring (IAM) and After-Action Review (AAR), trainees can influence their **quality of learning and training transfer.**

To ensure that VR training adds value to the existing training structure, LEAs will have to critically evaluate their own training curriculum to determine where VR training is needed and best supplements existing training. This critical evaluation may follow similar steps as those taken by the researchers to develop this training framework: First, LEAs should identify real-life training limitations and pinpoint a specific training area for VR to supplement or improve current practice. This can be done with internal experts and conducting training observations (as described in macro level; see section 3.1). Secondly, LEAs should follow the evidence-based recommendations of the meso level (see section 3.2) which function as a guiding principle and a reference for implementation of VR into the training area that has been identified during the evaluation process.

2.4 Impact for Policy-Makers

D3.3 impacts policy-makers (and police academy management) in the following ways:

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- Through the evaluation of existing training structures and the recommendations for VR implementation, policy-makers can make informed decisions on VR training as addition to their current training curriculum;
- Through the presented insights into gender, legal, ethical, safety, or privacy perspectives, policy-makers can make informed decisions regarding the technical, logistical, didactical, and human resource requirements and needs for VR training as an addition to current training curriculum.

2.5 Impact on the Security in the EU

D3.3 strongly supports the internal security strategy for the European Union (cf. Guideline VIII - A Commitment to innovation and training) in the following ways:

- Through increasing alertness on innovative, effective training concepts;
- Through harmonizing the DMA-SR training for all European police forces;
- Through standardisation of exchangeable practical toolkits such as VR implementation recommendations and checklists for policy-makers and training coordinators, and didactical training guidelines for trainers that guide European police forces and organisations in the use of VR.

3 The SHOTPROS VR Training Framework

The SHOTPROS VR Training Framework is structured into three distinct levels: a macro level, a meso level, and a micro level (see *Figure 3*). The three levels illustrate:

- what **current police training** of European LEAs looks like by providing insights from interviews with LEAs and real-life training observations (macro level);
- how and where VR training can supplement current police training by providing **recommendations for VR implementation** for policy-makers and training coordinators (meso level);
- how a single VR training can enhance the **learning and transfer of trainees** by providing **didactical training guidelines** for police trainers (micro level).

Each level is described in detail and supported by theory from the conceptual human factors model for DMA-SR behaviour (see D3.2), input and information directly obtained from the LEAs (through the Site-Visits and EndUser FeedbackWeek 2, see D6.1), and results from scientific Human Factors studies within the SHOTPROS project (also see D6.1). The VR training framework will be used in the preparation of the field trials, and as such evaluated with LEAs

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and Re-Lion. The final, further elaborated, version will be presented in D7.5 SHOTPROS Final Training Curriculum

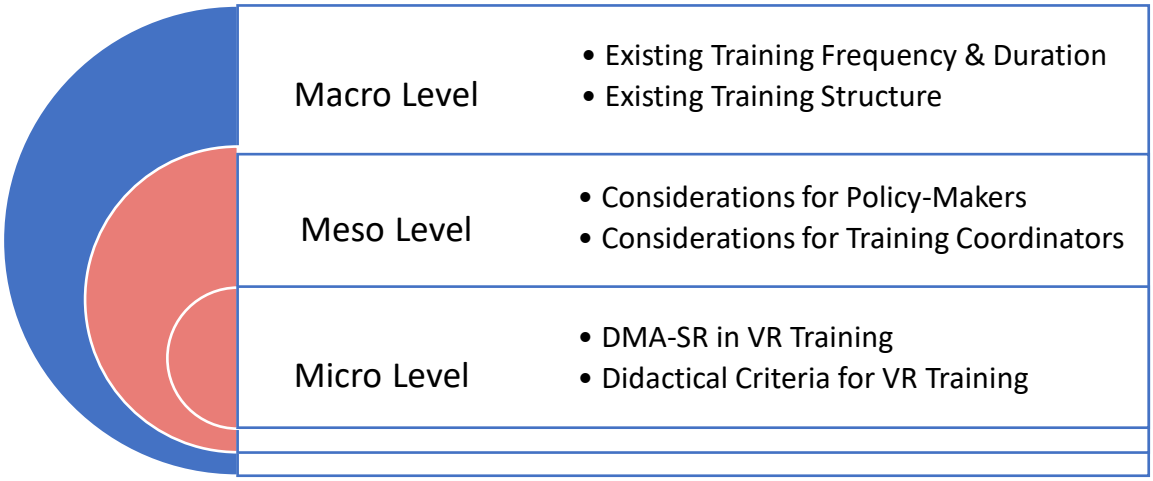

Figure 3. Overview of the D3.3 framework structure.

3.1 Macro Level

The macro level of the VR Training Frameworks **comprises the existing structure of police training of European LEAs**. The training frequency and duration, as well as the didactical features used during real-life training sessions yield insights into how and where VR training might supplement existing training. To this end, having an overview of the current state of training provides the backbone for the implementation of VR.

3.1.1 Training Frequency and Duration

The training frequency and duration of SHOTPROS LEAs was obtained from interviews during the site-visits with police practitioners who had a good overview of the training curriculum (TrainPrac study, see D6.1) and are reported in *Table 3* (for more site visit results, see *Table 12*). When examining the frequency and duration of training during basic training at the police academy and continued professional development, important differences across SHOTPROS LEAs become clear. Due to those differences (allocation of training frequency and duration to different training components), the VR training framework presented in this deliverable constitutes generic rather than specific recommendations and guidelines. These can be used by all LEAs and tailored to their own existing training structure and specific organisational needs.

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	LEA 1	LEA 2	LEA 3	LEA 4	LEA 5
Police Academy Training	3 years 16 training days at the police training centre	1-year basic formation (police inspector) 60 hr shooting training/600 rounds 30-40 hr tactical training 80 hr close combat training	3 years (bachelor's degree) Includes 1/3 theoretical training, 1/3 practical training at the training centre, 1/3 practical training shadowing patrol officers	3 years at the academy (6 semesters, after each semester 1-month internship at the police units); additional year for a bachelor's degree in law 1 year for non-commissioned officers (1-semester theoretical training, 1-semester internship at the police units)	2 years (4 semesters) + 6-month internship/ shadowing on the street
Continued Professional Development (Patrol Officers)	32 hours per year (4 days of 8 hours) 2 days of the 4 training days are assessment (shooting, physical testing, law & regulation exams)	Minimum of 16 hours a year (officers in bigger corps train more)	30 hours per year (5 days of 6 hours)	Minimum of 8 hours physical training per month - of this, a minimum of 6 hours is spent on practical training activities (handcuffing, self-defence, UOF, etc.) Training is carried out per unit: 2 hours every week Units can increase this number independently	48 hours per year

Table 3. Overview of existing training structures of SHOTPROS LEAs. Information was obtained from interviews with LEAs during the site visits. One LEA did not agree with sharing their information publicly and thus is not represented in this table.

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3.1.2 Existing Training Structure

Understanding the existing training structures of SHOTPROS LEAs helps to identify advantages and limitations of training areas in police training. Subsequently, training areas that are advantageous for the learning and performance of trainees in real-life can be translated to a VR environment and training areas that have a limited applicability in real-life (e.g., due to the replication of a highly complex scenario) might be supplemented with VR.

To map what real-life training looks like on session level, VUA researchers **observed various training sessions of all SHOTPROS LEAs** during the site visits as part of the Human Factor study TrainPrac (for more information, see *Table 12*). For the observation of the training sessions, the researchers used a training observation guide (see *Table 10*) with various criteria for an effective training session on a didactical level. The evaluation of the **criteria of the training observation** for skill training, car procedures training, tactical training, and shooting training can be found in *Table 4*. The 7 criteria (as distilled from Beek, 2011) are:

1. Is there a clear assignment?
2. Is there high-quality instruction?
3. Is there a well-designed practice situation?
4. Is model learning used?
5. Is there variation and differentiation?
6. Is there possibility for self-management of the learning process?
7. Is there constructive, motivating feedback?

Real-life practice situations demand a training environment that a) provides **realistic stress** and b) invites a **realistic solution**. Oftentimes, the skills to resolve a high-risk situation were segmented into specific tasks rather than holistic action. For instance, when asked to resolve a situation using a baton, the focus was on how to properly use the baton in that situation rather than a combination of de-escalation communication and use of force action. For VR training, training scenarios should invite and support the **entire range of actions and behaviours** (i.e., a situation should be resolvable using communication and use of force behaviours).

Model learning allows trainees to learn from others who model the appropriate behaviour to resolve certain situations (Gould & Roberts, 1981; Hebert, 2018). During the observation of existing training, a shortcoming regarding **model learning** was the lack of video feedback and viewing assignments that allows **trainees to learn from their own implementation and that of their peers**. Because most of the time trainers or experts were used as a model for a certain action or behaviour, the shown model exceeded the trainee's developmental phase and

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performance capacities. VR training, on the other hand, gives trainees the opportunity to review their own training performance during the After-Action Review (AAR), in which trainees can replay the training session from various perspectives and receive guidance and proper performance feedback from trainers.

For each of the evaluated seven criteria presented in *Table 4*, VR-specific didactical guidelines have been developed and are presented in the section "Micro level" (see section 3.3). These didactical guidelines will be further substantiated with input from the field trials and the final, enriched and evaluated version will be presented in D7.6 SHOTPROS Final Guidelines for VR Training.

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Criterion/Training Type	Skill Training	Car Procedures	Tactical Training	Shooting Training	Overall Evaluation
1. Is there clear assignment?	*Sometimes yes, sometimes no*	*More often than not*	*More often than not* (assignment offered no autonomy)	*More often than not* (assignment offered no autonomy)	**Trainers expressed the training assignment with intent**
2. Is there high-quality instruction?	*More often than not* (limited focus on the effect of the action; limited use of metaphors)	*Sometimes yes, sometimes no* (limited focus on the effect of the action; limited use of metaphors)	*More often than not* (limited focus on the effect of the action; few to no points for attention were stated; limited use of metaphors)	*More often than not* (limited focus on the effect of the action; too many points for attention were stated; limited use of metaphors)	**Scenarios were clearly instructed via clear communication; limited focus on the effect of the action; limited use of metaphors**
3. Is there a well-designed practice situation?	*Largely not* (situations don't invite realistic stress; practice context provides limited realism)	*Largely not* (situations don't invite realistic stress; practice with limited realistic solutions)	*Sometimes yes, sometimes no* (limited options for gaining self-efficacy; practice with limited realistic solutions; context provides limited realism)	*Sometimes yes, sometimes no* (limited options for gaining self-efficacy; context provides limited realism)	**Segmentation of context: skills and movements were trained apart of a realistic context (e.g., communication was left out of context)**
4. Is model learning used?	*Largely not* (peers are rarely used as a model for learning)	*Sometimes yes, sometimes no* (peers are rarely used as a model for learning)	*Sometimes yes, sometimes no* (the models used oftentimes exceed the learner's development phase)	*More often than not*	**Own implementation of trainee is rarely used as model (no video feedback); viewing assignments are rarely explicit**
5. Is there variation and differentiation?	*Largely not* (skills are rarely practiced randomly; no	*Sometimes yes, sometimes no*	*Largely not* (skills are rarely practiced randomly)	*Sometimes yes, sometimes no* (skills are rarely practiced randomly; no	**Error-free learning rarely used as a didactical concept; rather, trainees are**

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	differentiation within participants)			differentiation within or between participants)	**often urged to fail and learn from their mistakes**
6. Is there possibility for self-management of the learning process?	*Sometimes yes, sometimes no* (officers can't vary the difficulty in practice attempts; officers rarely decide when, where and how to receive feedback)	*Sometimes yes, sometimes no* (officers can't vary the difficulty in practice attempts)	*More often than not* (officers cannot decide or vary the number of practice attempts; officers rarely decide when to receive feedback)	*Largely not* (officers cannot vary the difficulty in practice attempts)	**Trainers are generally in charge of the learning process rather than trainees themselves (oftentimes due to safety measures)**
7. Is there constructive, motivating feedback?	*Mostly yes*	*Mostly yes*	*Mostly yes* (feedback was rarely given after successful attempts; effort was rarely named)	*Mostly yes* (good training results were rarely named; effort was rarely named)	**Trainers provide practical feedback effectively and actively involve trainees in the process**

Table 4. Training observations during site visits. VUA researcher observed various training practices during the site visits (see Table 10). The findings for skill training, car procedure training, tactical training, and shooting training are summarised in this Table for each of the didactical criteria.

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3.2 Meso Level

Based on various qualitative and quantitative results from SHOTPROS HF studies and experiments (see D6.1), the Meso level presents recommendations on how VR training can supplement, and be integrated into, current police practice. It addresses the usefulness of VR for police training areas and how VR can be implemented on a logistical level.

Policy-makers are responsible for making informed decisions regarding the relevance and technical, logistical, didactical, and human resource requirements of VR training and for translating their organisation's vision into the needs for VR training. Training coordinators are responsible for exploring how the VR training can be successfully and effectively implemented based on their expertise in police training and knowledge of (didactical) features of VR. It is important that VR policies are agreed upon within training coordinators and can be implemented.

For example, if on the policy level it is decided that only a limited number of trainers for VR training will be deployed, this can have consequences on the number of VR trainings that can practically be prescribed in the training module. Conversely, training coordinators must continuously check with policy-makers to test their ideas or adjustments in training to the (organisational) vision of the policy-makers. For example, if training coordinators would like to store and save data from trainees to monitor individual progress, they will have to check this with the safety and privacy perspectives of the policy-makers concerning data storage and anonymity of data. Thus, Meso-level decisions are made through an interactive and iterative process of policy-makers and training coordinators (see *Figure 4*). In the following pages, we will present a checklist for policy-makers and training coordinators with essential considerations to be reviewed to implement VR in the current training.

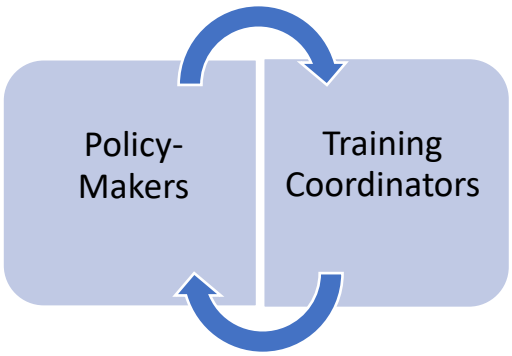

Figure 4. The interactive role of policy-makers and training coordinators.

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3.2.1 Policy-Maker Checklist for VR

To include VR training into existing training structures, policy-makers play a vital role in the decision-making process. Below, policy-makers can find a list with factors that need to be considered from a training implementation perspective. All factors are described in more detail in section 4 and can be reached directly by clicking the link to the specific section. Details on the policy-maker guidelines for VR will be part of D8.5 (M42).

- Factors from a gender perspective (see section 4.1 for more detailed information)
- Factors from a legal perspective (see section 4.2 for more detailed information)
- Factors from an ethical perspective (see section 4.3 for more detailed information)
- Factors from a safety perspective (see section 4.4 for more detailed information)
- Factors from a privacy perspective (see section 4.5 for more detailed information)
- Factors from a logistical perspective (see section 4.6 for more detailed information)

3.2.2 Training Coordinators Checklist for VR

Training coordinators have the responsibility of determining where and how VR training can supplement or improve the existing training curriculum. In the following, guiding questions are presented to help training coordinators make decisions regarding the implementations of VR.

- **Which training areas are useful to train with VR?**

  VR is particularly useful for tactical training and perception and action training, such as exposure to armed perpetrators, tactical approach, room scanning, etc., and less useful for physical training, such as combat and fitness training (see section 3.2.2.1 "VR Training Areas", *Table 5* for more detailed information).

- **How often should a VR training be given?**

  Because training practices across LEAs in Europe differ in volume (duration, frequency, and components) (see section 3.1.1 “Training Frequency and Duration”), this question cannot be answered unequivocally. There are, however, indications to implement VR training more frequently at the end of an existing training program because more experienced trainees are more engaged and have a higher learning transfer (see results Rotterdam, *Table 12*). Furthermore, it is easier for already experienced officers to combine different skills in scenario-based approaches like in the VR.

- **Should VR training be given before or after real-life training?**

  At this point, there is no substantial evidence that conducting VR training before or after real-life training affects training activities or quality of learning in VR (see results

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TrainCompar, *Table 12*). When planning to set-up a VR training, police practitioners can develop a training block of VR- and real-life training independent of order and based on the availability of training spaces and resources. We suggest circuit type of trainings to save on resources. For example, a training day that includes physical sessions, a law and regulations lecture, and VR training on the same location to save time of the trainees.

- **How long should the VR training session last?**

  The duration of a high-quality and effective VR training session should be a minimum of 1.5 hours to provide the training time needed to ensure sufficient training of DMA-SR behaviours and allow for sufficient execution time in VR (see section 3.2.2.2 "Format of a VR Training Session", *Table 6* for more detailed information). To make extensive use of the VR AAR tool, the duration of a VR session should be extended to a minimum of 2 hours.

- **What type of activities do trainees spend time on in VR training?**

  Based on experiments conducted within WP6 (see *Table 12*), a VR training comprises of the following training activities:

  - Preparation (putting gear on, calibrating, VR tutorial, material check)
  - Instruction (instruction of exercise, role-player and officer, tutorial scenario)
  - Execution (actively engaged in a training scenario as a role-player or officer)
  - Feedback (from the trainer, from other trainees, self-reflection, AAR).
  - Waiting (trainer is busy, operator is busy, social time)

  Execution and feedback typically form repeating loops within a training session to train different levels of stress or provide scenario repetitions with variations. See section 3.2.2.2 "Format of a VR Training Session", and *Table 6* for specific observations and recommendations per training activity.

- **How to match VR training to (characteristics of) the trainee?**

  LEAs should consider the level of experience of the trainee, the adjustment of an instruction protocol to the trainee, and the creation of virtual environment that influences the quality of learning and stress experience of the trainees (see section 3.2.2.3 "Role of Trainees in VR", *Table 7* for more information concerning trainee characteristics).

- **What are the tasks of the trainer in VR?**

  Evidence (from TrainCompar study, see *Table 12*) suggests that the influence a trainer has on training is even more prominent in VR compared to real-life training. A trainer should be experienced in providing scenario-based trainings, possess some level of technological skill, and has tasks specific to VR (see section 3.2.2.4 “Trainers' training tasks in VR that

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are similar to real-life and VR-specific training tasks" and section 3.2.2.5 "Tools Available for Trainers in VR"). For more information on the role of the trainer, see *Table 13*, "description of roles".

3.2.2.1 VR Training Areas

VR Training areas are derived from usefulness ratings of VR for various training areas by police trainers (see Rotterdam study, *Table 12*), interviews with police trainers (see Zurich study and TrainCompar, *Table 12*) and EndUser FeedbackWeeks 2&3 (see D6.1). *Table 5* shows an overview of the training areas, including usefulness ratings (up to 5 stars) and associated observations and recommendations for VR.

With the information presented in *Table 5*, LEAs can evaluate whether VR can support their training needs. They can, based on the observation and recommendation, evaluate how VR training can supplement real-life practice but also what they need to provide in real-life training to support VR (for instance, when the aim is to train communication in VR, LEAs should also provide additional real-life training with actors to ensure the full range of communication subtleties are considered in practice).

Training Area	Usefulness	Observation and recommendation
Tactical training	*****	The possibility of quickly varying location and scenario context in VR creates the groundwork for the training of tactical strategies in many different situations, from training tactical basics to applying these basics in a car procedure scenario or AMOK situations (based on input from EndUser FeedbackWeek 2, see D6.1).
Perception and action	*****	In real-life, trainers must adapt their training to the training location's infrastructure. VR does not have this limitation, making VR extremely useful for perception and action training (see Interviews TrainCompar and Rotterdam Study, *Table 12*). VR offers different environments where a trainer can adjust and create cues quickly and on the spot, such as breaking a window, adding a door or an extra bystander walking in from behind. The trainees must perceive and respond to the changes that the trainer makes. Training tactical strategies and perception and action seems more effective if the trainee already possesses basic skills, such as handcuffing and using a weapon (Interviews TrainCompar, *Table 12*). This argues in favour of conducting

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		these trainings primarily with trainees with more experience.
Law and regulations training	****	The AAR review is an excellent VR-specific feature to provide feedback on information regarding law and regulation that cannot be monitored and reviewed in real-life training; for example, provide information about correct hits after weapon use and how many civilians were flagged (i.e., in the line of fire) and therefore endangered, which is important for law and regulations education (see Rotterdam Study, *Table 12*).
Communication training	***	VR is helpful for communication training because it allows quick customization of the avatar's appearance (gender, skin, cultural aspects) and how trainees respond to and communicate with the avatar. A point of attention is that emotions must be appropriately interpreted. In VR, this is still a shortcoming. Where trainees see legs and arms moving, they do not see subtle differences in facial expressions, such as eye movements and human features. Trainees may make a different assessment of the situation if they cannot perceive these subtleties. It is recommended to work with a professional actor as a role-player to optimise the display of adequate emotions for role -played avatars (see Interviews TrainCompar, *Table 12*). This topic was one of the major feedbacks during the EndUser FeedbackWeeks. Therefore, a concept regarding realistic behaviour of role-player avatars and non-playing characters (NPCs) in the VR was included in the product backlog and is part of the requirements in D4.6.
Shooting and weapon handling training	**	The AAR review provides information about hit rates, shooting lines, cross-fire and other performance measures (see D4.5 and D4.6) that cannot be monitored easily in real-life, and makes VR useful for training positioning in reference to the suspect and colleagues when using weapons. VR and its current technology has shortcomings for training the technique/action of shooting. Exact tracking (which would be necessary for exact shooting like in a shooting range) is a trade-off regarding mobility, size of the training field and size and power of the VR backpacks. Pistol aiming

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		is therefore often not precise, there is a delay in movement, and reloading the weapon is not completely realistic (input from EndUser FeedbackWeek 2, see D6.1). All feedbacks regarding this topic are also comprised by the product backlog and D4.6. We do not see VR as a supplement for detailed technique training but as a training where different skills are combined, sometimes abstracted (e.g., less exact aiming) to follow the higher goal of scenario-based model learning and a focus on decision-making.
Physical training (combat, fitness training)	*	All actions involving physical contact (e.g., handcuffing, controlling and restraining of suspect, use of weapon) are not suitable for VR training due to safety for trainees and fragility of materials. They can only be a symbolic part of the VR training and have to be trained separately for gaining expertise.

Table 5. Police training areas derived from usefulness ratings by police trainers. The usefulness scale specifies a range from 1 to 5 stars where 1 star indicates a minimum usefulness, and 5 stars indicates a maximum usefulness.

3.2.2.2 Format of a VR Training Session

The TrainCompar study (see results TrainCompar, *Table 12*) provided insight into the average time spent on the different training activities in real-life and in VR. *Figure 5* shows the time spent on real-life training activities during a 1.5-hour training session. In comparison, *Figure 6* shows the time spent on training activities as observed in the TrainCompar study, displayed in percentage of total duration of the VR training session. The distribution of time spent on activities in real-life and VR training clearly differs, indicating that trainers should be attentive to a different division of time when planning a VR training. For instance, in VR training more time is spent on preparation (i.e., putting on VR gear, calibrating the VR system, etc.) compared to real-life training. Despite spending more time with preparation, trainers can still achieve a lot of execution time in VR. The comparison in the time spent on training activities in VR and real-life needs to be interpreted with caution because the distribution of time depends on many factors (e.g., much or little use of AAR in VR, shorter or longer scenarios, system recalibration, etc.) and thus may also slightly differ from training to training.

The logged experience presented in *Figure 6* can be used by trainers to plan their training, or to give them an indication of time that is normally spent on training activities in VR, based on the experience of 1.5-hour VR training sessions conducted during the TrainCompar study (see *Table*

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12). *Table 6* presents specific observations and recommendations for each of the training activities.

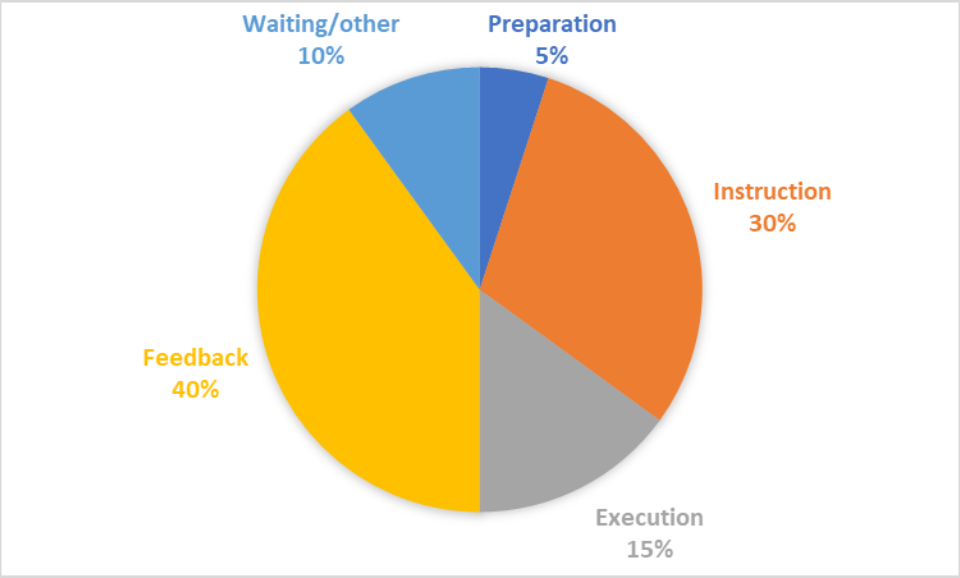

Figure 5. Time spent on training activities in real-life training, as recorded in 1.5-hour training sessions during the TrainCompar study, displayed in percentage of total duration of the real-life training sessions.

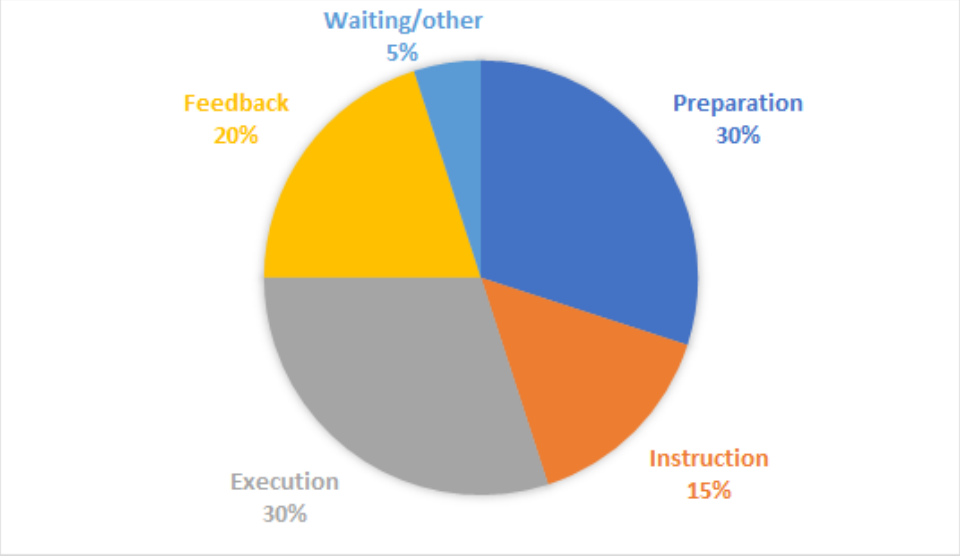

Figure 6. Time spent on training activities in VR, as recorded in 1.5-hour training sessions during the TrainCompar study, displayed in percentage of total duration of the VR training session.

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Observation	Recommendation
Preparation: Time spent on preparation was higher in VR than in real-life and could reduce the actual training time (i.e., the time a trainee is actively engaged in a scenario) (see results TrainCompar*, Table 12*). Trainers who had previous experience with the VR system and training had up to 10 minutes shorter preparation time than less experienced colleagues (see results TrainCompar, *Table 12*). So**,** with experience with VR, preparation time will decrease. This was also observed during the EndUser FeedbackWeeks and showed the importance of train-the-trainer methods regarding VR.	When planning to integrate VR training into existing training structures or schedules, be aware of the higher preparation time that VR training requires at the beginning. When planning VR training blocks, the duration of a session should be a minimum of 1.5 hours to provide the training time needed to ensure sufficient training of DMA-SR behaviours. Allow trainers to try out and familiarise themselves with the VR set-up beforehand or attend a class taught by an experienced trainer to reduce preparation time in a VR session (train-the-trainer principles).
Instruction: Time spent on instruction and number of episodes of instruction were lower in VR than in real-life. Trainers indicated that a relatively large amount of instruction was part of VR-specific instruction (how to use VR, risk of gamification, etc.) and less time was spent on task-oriented instruction (instructing task).	Divide instruction into specific areas: VR-specific instruction and training-specific instruction. LEAs should consider developing a protocol so that the time spend on VR-specific instruction remains short and does not impede on execution time (see section 3.3.3 “Instruction”). Furthermore, VR-specific instruction time will decrease with the increase of experience also by the trainees.
Execution: Frequency and time spent on execution was higher in VR than in real-life, indicating that in VR training trainers were able to achieve more practice in the available time than real-life training.	Training time is a precious asset amongst European LEAs, so it is essential to achieve as much execution time as possible in the available time. If LEAs plan to set up a training of a specific training area, LEAs should consider VR as the most useful training tool for that particular training if it: a) coincides with a high usefulness rating in VR (see *Table 5*) and b) benefits from as much execution time as possible, in other words learning is mainly grounded in action and less in instruction or reflection (i.e., cognition).

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Feedback: Trainers at the TrainCompar study experienced using the AAR as time-consuming and less useful in time-pressed training situations as they focused on execution time and a high number of repetitions and variations. The higher the number of repetitions and variations in scenarios, the less time was spent on feedback by the trainer (see results TrainCompar, *Table 12*). During interviews with police trainers from the city police Zurich and within the EndUser FeedbackWeeks, trainers referred to VR as a superior tool for providing objective and accurate feedback. Thus, making use of AAR requires specific attention, enough time, training, and experience of trainers.	A clear advantage of VR feedback is that time does not have to be spent on discussions about if something happened during a scenario but only about why it happened. This allows trainers and trainees to focus on learning from the situation instead of debating it. This may be particularly helpful in groups of trainees with some resistance to feedback or learning. VR offers unique additional feedback opportunities such as playback from different perspectives, pausing critical moments and reviewing performance indicators (see also D4.5) Trainers should take time to become competent in using the AAR options, so they self-efficacious in using the system when they see fit and are not held back by insecurity or lack of competence. If trainers plan to make good use of the feedback options of AAR , they should include time for it in their training session. In that case it is recommended to have a minimum time of training of 2 to 2.5 hours (instead of the minimum effective duration of 1.5 hours observed in the TrainCompar study, see *Table 12*).

Table 6. Considerations for various training activities in VR.

3.2.2.3 Characteristics of the Trainee in VR

When looking to integrate VR into existing training structures, LEAs should consider the characteristics of the trainees and how VR can support them. *Table 7* provides recommendation based on the results retrieved and observations made during WP3 experiments (see *Table 12*). For a specific description of the role of the trainee in VR, see *Table 13*.

Observation	Recommendation
Quality of learning increased in VR for trainees who had prior practical experience (regarding police work) instead of only theoretical practice (see Rotterdam results, *Table 12* and during the	When planning to integrate VR training into existing practice, consider using VR as a teaching tool for more experienced officers and carry out the VR training with more

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course of the EndUser FeedbackWeeks with different experienced officers).	experienced trainees who already possess the basic skills, such as handcuffing and weapon use to enable them to use the skills in an integrated fashion in scenarios and not practice segmented skills only.
Learning experience and engagement with the VR training tool was highest for more experienced police students who received closed training instructions (see Rotterdam results, *Table 12* and during the EndUser FeedbackWeeks with people attending more than 1 of the FeedbackWeeks).	When developing an instruction protocol for VR, provide very specific instructions to trainees containing what the VR scenarios will look like (e.g., estimation of the number of repetitions, insights into the VR scenario environments, etc.) and what level of difficulty they will train at (e.g., the level of threat that will be encountered). This is particularly important when training with more experienced trainees.
The higher the number of variations in scenarios, the higher trainees evaluated their quality of learning and perceived the quality of feedback in VR training (see TrainCompar, *Table 12*).	The trainee's experience of VR training seems to be strongly related to the amount of scenario variation. Hence, focus on creating as much variation in a scenario and from repetition to repetition as possible. For achieving this the Real Time VR Trainer Dashboard (see D4.5) will be a very useful tool but also the RAT (see D4.7) can help deciding on variations.
There is evidence that the longer the preparation time and waiting time in VR, the less stress and mental effort trainees experienced (see TrainCompar, *Table 12*).	Use a strict protocol to reduce preparation time and waiting time of trainees (see section 3.3.3 “Training Instruction”). In addition, LEAs can consider having a familiarisation session for the preparation part in VR (tutorial scenario to get used on how to handle objects or the VR environment in general) to enhance trainees' focus on execution instead of novelty of the VR material and habituation. In the course of the EndUser FeedbackWeeks the tutorial scenario was very valuable and thus was adapted to the LEA needs. The final version will be used in the field trials (WP7).

Table 7. Consideration of characteristics of trainees in VR.

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3.2.2.4 The Tasks of the Trainer in VR

When looking to integrate VR into existing training structures, LEAs need to consider the role of the trainer. Evidence (from TrainCompar study, see *Table 12*) suggests that the influence a trainer has on training is even more prominent in VR compared to real-life. Thus, a VR training trainer should be experienced and possess some level of technological skill. *Table 8* describes the tasks that trainers encounter during real-life training which are similar in VR and tasks that are specific to VR training. For a specific description of the role of the trainer in VR, see *Table 13*.

Trainers' tasks in VR that are similar to real-life training:
Providing clear assignment of the training: learning objective
Providing instruction for the exercise and scenario instruction to officer(s) and role-player(s)
Checking material and equipment, such as weapon change and personal property of trainees
Providing a clear start and end point of a scenario
Monitoring trainee execution and progress of scenarios
Providing feedback after scenario execution
Trainers' tasks that are specific to VR training:
Providing guidance and support to the operator while trainees put VR gear on
Providing guidance through the tutorial scenario
Selecting a training environment and scenario that fit the learning objective: make use of the risk assessment tool (see D4.7) and provide information material before the training to the trainees, role-players or fellow trainers
Cooperating with VR system operator and/or using the Real Time VR Trainer Dashboard (see D4.5) to adjust scenario, stress level, and tools
Changing the behaviour of the role-player during the scenario through adjusting their movements by guiding them directly via headset without trainees being able to notice. NPCs that are animated and controlled automatically need to react more realistically according to feedback from LEAs. Therefore, also direct reactions executed by the trainer in the Executive Control Station are a necessary requirement towards a VR solution and offer the trainer direct and indirect steering of the scenario by changing the NPC reactions (see D4.6)
Operating and analysing with AAR system

Table 8. Tasks of trainers in real-life and VR training.

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3.2.2.5 Tools available to Trainers for VR Training

When conducting a VR training, trainers have various tools available to support them. Listed below are tools that trainers should familiarise themselves with before they conduct a VR training:

- Risk Assessment Tool to select proper stress-level for trainees (see D4.7)
- SHOTPROS VR solution to decide on scenario and environment and execute the training (WP5)
- Real Time VR Trainer Dashboard for live performance assessment (see D4.5 & D5.4, M33) including the Stress Cue Control Panel within the solution to adapt the scenario according to performance and stress-level (see D4.5), the Stress Level Assessment Panel (see D4.5) to assess the level of stress by each trainee (measured by body sensors and calculated by the SHOTPROS VR solution) and the In Action Monitoring Panel (see D4.5) to have an overview on current performance indicators.
- After-Action Review (see D4.6) to execute a de-briefing of the training session.

3.2.3 Logistical Set-up of a VR Training Session

To take advantage of the benefits of VR training fully, the training should be organised and set up efficiently. *Table 9* provides an example of what an efficient VR training set-up requires.

VR requirement	Set-up and organisation
Location	To ensure efficiency, the VR training location should be separated into three distinct areas: 1) **Preparation**: This area should contain the VR suits and equipment (like tactical belt, power stations for gear, etc.) and is solely dedicated to preparing the trainees for VR. If certain body sensors (as used in the SHOTPROS VR solution) are part of the training, a mobile wall has the advantage to provide a more private area to get the sensors attached to the trainee's body, as the sensors need to be worn on bare skin and thus putting them on involves undressing. 2) **Execution**: This area (e.g., a gym hall) should contain the floor space suitable to the scenarios planned and meet the technical requirements to accommodate the VR system. This area is dedicated to the calibration of the VR system and execution of the training scenarios. This also includes space for the operating

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	station for a technical operator of the system (exercise control station) 3) **In- and After-Action monitoring**: This area should contain the AAR station and sufficient space for the trainer to monitor the scenario during action (IAM) and also for trainees to view the screen after the execution and is solely dedicated to viewing scenarios.
Group setting	Due to the specific AAR feature of VR, each training session lends itself to be set up in such a way that two groups can train simultaneous (i.e., while one group performs a scenario in VR, the other group receives feedback with at the AAR station, when both groups are finished, they switch tasks). In this set-up, one ideal group consists of: • 1 operator • 1-x role-players (depending on the scenario needs) • 1 trainer • 2 - 4 trainees (The number of trainees should resemble the real-life duty on patrol. For example, in Berlin first responder police typically patrols with a group of 3 officers, therefore we trained in the VR with 3 trainees. In North Rhine Westphalia it is typical to patrol with 2 officers plus 2 more for reinforcement, so we trained in this set-up). In general, the number of people in the training must fit the number of available smart vests and computer power to track the smart vests. At the moment, we have experimented with up to 6 smart vests. Operator and role-players can be the same persons each day (see definitions further down in the table). Should the number of trainees exceed the number that resembles the real-life duty on patrol, trainers can decide to assign trainees with role-player tasks (see information on role-players below). If professional/trainer role-players are needed for the scenario, trainers can provide the additional trainees (those that do not have an active role as an officer) with a specific viewing assignment using the external monitor.

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Trainees	To take advantage of the VR features efficiently, training groups can be split into subgroups, for example one subgroup can execute the training scenario, while the other subgroup receives feedback with the AAR tool. Depending on the goal of the training, trainees can take on various roles in VR: the officer, the suspect, bystanders, or a "ghost" observing the scenario. Trainers should ensure that trainees have an active role in the scenario and avoid waiting times of trainees without any tasks. Therefore, the attending groups and the planned scenarios should fit together and be planned properly in advance. A training schedule also considering group size and roles is important to be prepared in advance by the trainer and provided to the trainees. As VR training can be as exhausting as physical training, trainees should be prepared to bring enough water and clothes to change into after training.
Trainers	To ensure that trainees receive sufficient training time in execution, instruction and feedback/coaching, the roles of the trainers should be set-up as follows: As soon as the first training group finishes the execution of a training, this group moves on to the final AAR. At this time the next group should already start with the execution to save trainee-time. This implicates that there is a trainer for each group within the VR context. • Thus, the roles of the trainer are to supervise and direct the preparation and execution and then supervise and execute the AAR feedback phase. Ideally, both is done by the same trainer for the same group of trainees as the trainer will already be familiar with the individual trainees and their performance within the training and is aware of what needs to be addressed in the AAR after the execution. For more information on the role of trainers see section 3.2.2.4 and tools available to trainers in VR, see section 3.2.2.5
Role-Players	Depending on the learning objectives and the selected scenario, a role-player might be necessary to enrich the realism of a scenario.

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	Executing a VR scenario training with NPCs only, might reduce the training areas that are suitable for VR as the interaction with NPCs is limited and not all trainings can be done with this limitation (also see D4.6 – detailed description of NPC requirements for a VR solution). Multiple options for role-players exist: 1) Trainers act as role-player 2) Trainees act as role-player 3) (Professional) actors act as role-players Furthermore, it must be clarified if and to what extent the selected scenario needs a dispatcher to whom the trainees can communicate during the training. Depending on the extent of dispatcher communication (more for extensive scenarios and less [dispatcher information via radio only] for simple scenarios) it can be decided if the trainer takes over the dispatcher communication or another role-player is needed for this purpose. To establish a reliable training environment with reliable and recurring role-player reactions for all trainees of the training day, the role-player needs detailed instruction and options to react on certain trainee actions. This supports the notion of using a trainer or at least an experienced officer for role-playing as this person can – in real time and on the fly - change the interaction with a trainee and react on their behaviour to increase the learning effect. To ensure sufficient active training time for trainees and avoid waiting time of trainees in larger training groups, trainees that have not been assigned with an active officer role in the scenario can act as role-players. Using trainees as role-players allows trainees to experience a scenario and officer behaviour from a different perspective. This perspective allows the trainee role-player to provide specific feedback to the trainee that played the officer based on their experience of the officers' actions. When using role-players only for this purpose and throughout multiple training sessions on the same day, it needs to be considered that acting as a role-player in VR requires a large amount of cognitive effort. Thus, when setting up a VR training with role-players (other than trainees of the same session), it should be ensured that a) role-

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	players have a sufficient break between sessions and/or b) multiple role-players are available to take turns. For a specific description of the role of the role-player in VR, see *Table 13*.
Operators	The operator of a VR system is responsible for the technical guidance of the VR set-up and the scenario. In general, the operator of the VR system is provided by the VR system provider. Alternatively, an experienced trainer can operate as an operator after receiving sufficient training in using the software and managing the course of the scenarios. For a specific description of the role of the operator in VR, see *Table 13*.

Table 9. Logistical requirements for the set-up of a VR training

3.2.3.1 Operator-Trainer Communication and the Role of the Real Time VR Trainer Dashboard (D4.5) in the VR

Compared to real-life training, VR offers the opportunity to steer the development of a scenario on the fly without interrupting the course of the training. To ensure that the scenario remains realistic and supports the learning experience of the trainees, the operator and trainer must cooperate and communicate well during the steering of the scenario. Regarding language it is necessary that the operator understands the language (including specific jargon) the trainees use while acting in the VR to react to their commands faster and provide more realistic reactions of the NPCs and the environment itself. Hence, operators and trainers need to be familiar with the process of the live-editing of a VR scenario (see D4.5). Recommendations to further enhance the cooperation between operator and trainer are:

- Prior to the training session, trainers should communicate the training aim and learning objective with the operator to ensure that the scenarios and NPC reactions are in agreement with the aim and objective of the training
- Prior to the training session, operators should communicate the possibilities the VR live-editor offers trainers in changing and steering the context of the scenario so that trainers know what they can and cannot control during the course of a scenario by themselves.
- Prior to the training session, select short cue words that help in steering the scenario (e.g., “360” to send in an unexpected NPC from behind when the officers do not check their backs).

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During the course of the SHOTPROS project it became even more evident that besides the Real Time VR Trainer Dashboard, the Stress Cue Control Panel (will be described in D4.5) becomes a vital feature for the trainer during the training. After validation in the field trials, this VR feature and its advantages will become part of the final VR training guidelines in D7.5.

3.3 Micro Level

The micro level depicts the structure of a VR training at the session level. Based on current training practices of European LEAs (see D3.1) and the site visit training observations (see *Table 4 – TrainPrac D6.1*), the micro level provides police trainers with evidence-based didactical guidelines to facilitate the training of DMA-SR behaviour in VR. To this end, a standard practice for the evaluation of DMA-SR behaviour is presented. Additionally, the micro level presents the seven didactical criteria of clear assignment, high-quality instruction, well-designed practice situation, model learning, variation and differentiation, self-management of the learning process, and feedback by:

1. stating the relevance of the criterion for training;
2. providing didactical guidelines to consider for VR training;
3. summarizing a "takeaway message" of the criterion.

3.3.1 DMA-SR Training in VR

In correspondence with the aim of SHOTPROS and based on the conceptual human factors model for DMA-SR behaviour (see D3.2), this training framework intends to provide the constraints and prerequisites for DMA-SR training in a VR setting. Within SHOTPROS, the aim for appropriate DMA-SR skills is described as the following:

> *"Relying strongly on a **robust set of knowledge and skills**, the trainee should be able to **decide** upon the best course of action given the specific situation and **act** upon it confidently and swiftly, regardless of the level of stress the trainee is experiencing"* (see D2.3)

Thus, regarding the training of DMA-SR, the objective for each trainee should be to solve a situation safely and without injuring self or others and ideally without the use of a firearm. Since some situations, particularly high-risk situation, require the use of force and other de-escalation tactics, we propose the following two criteria as **principles** for DMA-SR training:

1. **Proportionality**: meaning that the action of the trainee should not be more (or less) severe than the situation requires and commensurate with the violation of the offender.

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2. **Subsidiarity**: meaning that the trainee chooses the appropriate actions and resources for the (ethically and legally) correct purpose.

In the following, we provide evidence-based didactical guidelines for VR training based on the criteria used to evaluate existing training. Trainers can use these guidelines to conduct a VR training session that facilitates learning and transfer of DMA-SR behaviours. Like the VR implementation recommendations presented in the meso level (see section 3.2), the VR didactical training guidelines are generic to be applicable to various (LEA-specific) learning objectives and scenarios.

3.3.2 Clear Assignment

Relevance of the criterion:

The training assignment communicates the purpose and relevance of the learning objective to the trainees. Providing clear assignments motivates trainees to engage with the training and provides clarity on the learning goals and enhances the training effects.

Didactical guidelines:

- Plan the assignment as communicated in the training beforehand and ensure that it aligns with the training schedule and lesson aim of the trainees
- Decide whether the learning objective of the training session requires the use or support of VR:
    - Is VR the right tool for the training assignment you want to practice? (For instance, if the intention is to include physical contact, handcuffing, training of communication with micro expression, a different training tool would support this practice better, see VR training areas, *Table 5.* Is the goal to bring together and apply different learnings in one scenario and to learn tactical behaviour VR might be the ideal solution to go for)
- Keep the training assignment and learning objective of the VR session small to enhance the opportunity for variation and repetition in the VR environment (see interviews TrainCompar, *Table 12*)
- Align the training assignment and learning objective with the VR environment and scenario selection:
    - Take advantage of the flexibility of the virtual environments and adjust the scenario infrastructure to the training assignment
    - Make use of the risk assessment tool (see D4.7) to create a VR scenario that aligns with the assignment

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- Provide limited autonomy (see glossary, *Table 11*) in the assignment for VR training as trainees may initially struggle with the newness of the tool itself and thus may get disengaged (see Rotterdam study, *Table 12*). Limited autonomy can be achieved by delivering the assignment concisely and in a very directive manner.

Takeaway Message: Clear Assignment

- Preparing a clear assignment is immensely important for VR training because practical consideration for the learning objective, training set-up, and scenario selection influence the user experience of VR as a training tool
- VR training allows trainers to adjust the environment and infrastructure of a training scenario to the training assignment, whereas in real-life training, trainers have to adjust the assignment to the environment of the scenario depending on what the training location facilitates.

3.3.3 Training Instruction

Relevance of the criterion:

Good training instruction provides trainees with a task goal and sets the tone for the training. Through concise instruction, the trainee obtains information about the nature of the training and the relevant points that he or she needs to pay attention to. Good training instruction has been shown to facilitate skill acquisition (Hodges & Franks, 2002).

Didactical guidelines:

- Provide tool-specific instruction before the VR training:
    - Provide a clear overview of what students can expect from a VR training, possibly in form of a short meeting before the actual VR training starts (include what to expect from a VR environment, how to move within a virtual environment, what tools are available in the VR environment etc.)
    - Provide step-like, protocolised instructions on how to put the VR gear on to reduce the time spent on VR preparations and provide a clear step by step calibration and tutorial scenario already accompanied by a trainer. These measures can be reduced depending on the expertise level of the trainees (also see 3.2.2.3 Characteristics of the Trainee in VR)
- Provide practice-specific instruction before the VR training:

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- Provide closed training instructions that let trainees know what scenarios they have to complete, what level of difficulty they can expect (as this has been shown to increase the quality of learning and engagement in VR, see results Rotterdam study, *Table 12*)
- Keep the number of points for attention very limited as trainees have to invest a large amount of their mental capacity to navigate the virtual environment (see results Twente and Zurich study, *Table 12*)

- Provide task-relevant instruction during the VR training:
  - Instruct the role-player to adapt the course of the scenario on the fly to take advantage of the opportunity to not be visible or audible to trainees as a trainer. Because the trainer's instructions to the role-player are invisible and inaudible to the trainees even during the scenario, trainers have the freedom to adjust role-player behaviours to their liking (whereas in real-life, trainers can only instruct role-players prior to the scenario). Adjusting role-player behaviour on the fly can be done through wireless headset/microphone communication between trainer and role-player or by physically moving or guiding the role-player to the intended position.

Takeaway Message: Training Instruction

- Providing concise and relevant instruction is immensely important in VR as the novelty of the training tool requires special attention
- Compared to real-life training, VR training provides additional opportunities for instruction, particularly as the trainer is not visible in the virtual training environment

3.3.4 Well-designed Practice Situation

Relevance of the criterion:

In police training, a well-designed practice situation is defined by the level of realism it offers to the trainee. The practice situation should therefore invite realistic stress, present a realistic problem, and provide room for realistic solutions. A well-designed practice situation has been shown to enhance transfer of knowledge and performance under pressure (Nieuwenhuys & Oudejans, 2011; Oudejans, 2008; Oudejans & Pijpers, 2009).

Didactical guidelines:

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- Trainers can make use of the risk assessment tool (see D4.7) to create a realistic training context. The tool may help to elicit the required level of stress for trainees (VR training has been shown to elicit adequate levels of experienced stress, see results Twente, Zurich, and TrainCompar, *Table 12*).
- Ensure that the training environment in VR confronts trainees with realistic problems they could encounter on duty, through the help of VR this can be accomplished and designed almost at will.
- When developing realistic problems in the VR environment, consider that the virtual environment is not equal to the physical environment (for instance, a small room in VR is not really a physically confined room, and officers cannot "leave" the VR premise, as they could in real life).
- Consider that training realistic solutions is more challenging in VR because the realistic physical feedback from the virtual environment is missing and motor performance is altered or hindered; thus, ensure that the solutions provoked are as realistic as possible and actually achievable in VR. For instance, having a role-player acting as a suspect and giving the instruction to use physical force or resistance would not be useful as this requires a solution that cannot be performed by the officer in VR such as self-defence and physical arresting skills.
- To train in a realistic context, consider whether certain pitfalls of VR can be prevented in the training; for instance, are stairs a necessary component of the training? (Since the execution of the stair movement in VR is not realistic and does not bring an advantage for typical first responder training).
- Ensure options for gaining self-efficacy by controlling the responses of role-players and NPCs on the fly and in correspondence with the behaviour of the trainee: when the trainee performs well (in correspondence with the DMA-SR standards, see section 3.3.1), make sure the role-player or NPC rewards the behaviour of the trainee thus providing the experience of success to the trainee.
- Avoid familiarization with the training environment for the trainee by altering the VR environment regularly.
- To ensure a constraint-led-approach (see glossary, *Table 11*) to VR training, manipulate the following constraints:
    - change the environmental constraints through a) adjusting the scenario and environment from repetition to repetition (e.g., from an outdoor scenario in the parking lot in the daylight to an outdoor scenario on a busy road at night-time), b) role-player instructions (e.g., instructing the role-player to increase the level of threat from repetition to repetition), c) by communicating with the operator to

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add or remove constraints in the virtual environment on the fly (e.g., by placing NPC out of the field of view of the trainees to increase complexity or by making communication between officers harder by adding noise to the environment) and d) using the Stress Cue Control Panel (see D4.5) to adjust stress cues to increase or decrease the stress load of a trainee.

- change the task constraints through providing different instructions and tasks from repetition to repetition (e.g., instructing the role-player to act with weapon in one scenario and without a weapon in the next repetition)
- change the person constraints through influencing the level of stress, mental effort, and attentional capacities by changing the level of complexity and intensity of the scenarios within the Real time VR Trainer Dashboard and the Stress Cue Control Panel (see D4.5).

Takeaway Message: Well-designed Practice Situation

- Trainers should actively engage in the design of the VR environment and infrastructure before (Scenario Editing) and during (Stress Cue Control Panel) action to take advantage of the VR features that enhance the realistic context and create realistic problems for trainees in the training environment
- Compared to real-life practice, the trainer and operator can actively manage the course of a scenario through the Real Time VR Trainer Dashboard, (see D4.5) and allow various options for the trainee to gain self-efficacy

3.3.5 Model Learning

Relevance of the criterion:

Model learning refers to a teaching strategy that utilises demonstration of behaviour as instruction for skills or movements. The learner has an observational role in which he or she closely watches the model to acquire the modelled behaviour (Gould & Roberts, 1981). Model learning has been shown to facilitate skill acquisition, retention, and motor learning (Hebert, 2018; Hodges & Williams, 2007).

Didactical guidelines:

- Make use of trainees as peer observational models (instead of solely relying on expert models)

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  - For instance, during a training with four trainees (see TrainCompar study, *Table 12*), two trainees are executing the training scenario in VR while the other two trainees can observe the performance on an external screen using various viewing perspectives and a variety of abstract performance indicators (e.g., line of fire, movement paths, field of view, performance statics)
- Provide trainees with a clear and specific viewing assignment that relate to the training or learning objective (e.g., instruct them to pay attention to decisive DMA moments; or to evaluate a certain tactical skill)
- Ensure that trainees are familiar with the use of the different viewing perspectives and the controllers of the VR in the spectator view
- Use VR "Ghost Mode". Trainer or trainee can actively be part of the virtual environment as a "ghost" and observe the other trainees' performance in the scenario without being visible to them.
- Use AAR as video feedback to allow the trainee to learn from their own implementation as a model
- **Point of consideration**: If the trainer would like to serve as a realistic expert model for demonstration of certain skills or behaviours, the trainer has to be wearing a VR suit; otherwise, the trainer can only demonstrate sub-skills or sub-movements in an abstract way since he or she is not acting or visible in the virtual environment

Takeaway Message: Model Learning

- Compared to real-life training, VR provides a large variety of opportunities for model learning to enhance skill acquisition and retention even without actively executing a scenario
- Trainers should particularly take advantage of peer modeling through the **IAM** and the trainees' own actions as models of themselves through the **AAR**

3.3.6 Variation and Differentiation

Relevance of the criterion:

Variation and differentiation refer to the variability in a training environment or task (often from practical trial to practice trial) and allows the learner to explore various movement solutions for achieving a goal instead of repeating the same movement pattern to complete a task (Ranganathan & Newell, 2013). Including variation and differentiation into a training

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environment has been shown to enhance exploration, skill acquisition, and transfer of learning (Wulf & Schmidt, 1997; Newell & McDonald, 1992).

Didactical guidelines:

- Ensure to have a pre-defined selection database of VR environments available to you (e.g., a minimum of three different virtual environments, see results TrainCompar, *Table 12*)
- To achieve variation and create a new practice situation, change the context of the virtual environment for each repetition:
    - Through environmental changes: night-time vs. daylight of the same environment, additional objects in the environment, more or less visibility, etc.
    - Through different starting points for trainees and role-players in the same virtual environment
- To achieve differentiation, ensure a mix of various threat levels ranging from non-lethal to lethal situations differing per repetition:
    - Differentiation through NPC: change NPC level of aggression, change the appearance
    - Differentiation through role-players: change role-player behaviour instruction, change their appearance by giving them a different VR skin
    - Differentiation through manipulating objects: change presence and appearance of weapons (weapons "hidden under a pile of clothes on a desk, behind the back of an NPC, unusual weapons like a hammer etc.)
- To ensure an optimal training environment for the trainee, monitor the trainee's success by looking at the performance indicators (e.g., DMA-specific behaviours, tactical behaviours, etc.). Try to aim for maximum challenge and minimum errors ("error-free learning", see glossary, *Table 11*)
    - If the training seems too simple for the trainee, up-scale the level of complexity directly in the Stress Cue Control Panel by activating additional stress cues or changing the context (e.g., night-time, medium to high level of threat, presence of weapons).
    - If the trainee starts to make mistakes, down-scale the level of complexity (e.g., daytime, low to medium level of threat).
- During each training scenario, communicate with the VR operator or use the options you have as a trainer to adjust the scenario complexity on the fly (as this cannot be done easily in real-life)

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Takeaway Message: Variation and Differentiation

- Location variation is the most distinguishable feature of VR and **must** be implemented in VR training sessions (see results TrainCompar, *Table 12*)
- Because VR training offers an In-Action Feedback Loop to monitor trainee's performance, the complexity of scenarios can and **should** be adjusted on the fly to enhance learning

3.3.7 Self-management of the Learning Process

Relevance of the criterion:

Allowing a learner to self-manage their learning process provides the learner with the opportunity to actively engage and be an active agent in the process of skill acquisition. In a self-managed learning environment, the learner can, for example, self-regulate when and how to receive feedback instead of relying on the trainer's feedback choices. Self-management of the learning process has been shown to facilitate learning, engagement, transfer, and motivation (Janelle et al., 1995; Lewthwaite et al., 2015; Keetch & Lee, 2007).

Didactical guidelines:

- To provide trainees with the opportunity to self-manage their learning process, ensure that trainees have previous practical knowledge of the relevant skills to apply them in the VR training (students who did not have prior practical knowledge were less engaged with the VR tool, see Rotterdam study, *Table 12*)
- Prior to the start of the VR training, let trainees place the gear on the gear belt themselves, instead of having fixed positions (see Twente study, *Table 12*; input from EndUser FeedbackWeek 2, see D6.1)
- Allow participants in the AAR to have control over how and where they want to receive feedback (for instance, let trainees select parts they would like to review and the angles or perspectives they would like to review their performance from – let them "re-experience" the operation by giving them the controller for a walkthrough in the AAR)
- Let trainees choose to have their line of fire on or off during the execution and review of the scenario

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- **Point of consideration**: while handling the various feedback options and features that VR provides, be aware that just because these options are available, not all of them have to be used at all times; rather, ensure that the learning climate is at the centre of the training, provide a psychologically safe learning environment, make sure the trainees can experience autonomy and success or competence.

Takeaway Message: Self-Management of the Learning Process

- By using different technical VR features (such as the review perspectives in the AAR), VR offers a variety of options for trainees to self-manage their learning process
- VR training requires trainees to have previous practical knowledge to fully take advantage of the virtual training environment

3.3.8 Feedback

Relevance of the criterion:

Feedback informs the learner of their performance and supports the learner in evaluating and adjusting the performance behaviour in the future. Providing constructive and motivating feedback has been shown to increase the learner's motivation, self-confidence, self-efficacy (see glossary, *Table 11*), and benefits learning (Bandura, 1997; Chiviacowsky, 2020).

Didactical guidelines:

- During the VR After-Action Review (AAR), make use of the bird's eye view and suspect perspective (as this has been shown to enhance quality of learning: see results Zurich study, *Table 12*)
- To enhance the quality of learning and the perceived level of stress, add a pain stimulus to the VR training (see results Zurich study, *Table 12*) The pain stimulus provides instant feedback on performance when used correctly.
- Let trainees review the statistical feedback presented in the AAR such as number of shots fired and targets hit, bystanders flagged, etc.
- Review is a big advantage – what happened is replayable at any time from any perspective – the trainer can invest the time in explaining tactics to improve rather than loosing time finding out if it really happened (which is a large issue in real-life trainings where missing perspectives in video evidence lead to misinterpretations on both sides)

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- When training time is a concern, trainers can choose to focus on execution time and provide feedback like they would in real-life instead of relying on a more time-consuming AAR for feedback (see results TrainCompar, *Table 12*)

Takeaway Message: Feedback

- The quality of learning of trainees is most strongly associated with the perceived quality of feedback and should be an important pillar in VR training
- VR offers a variety of feedback tools (i.e., features of the AAR) that should be used in correspondence with the expertise of the trainer

3.3.8.1 DMA-SR Evaluation Guidelines

In police work, situations that require DMA can have multiple outcomes. Oftentimes, these outcomes are difficult to evaluate as they are seldomly inherently wrong or right. Thus, a situation can be solved with different actions that all yield appropriate outcomes. Metaphorically put, there are more ways that lead to Rome, and one is not necessarily better than the other.

To this end, and in line with the HF-Model (see D3.2), we propose that trainers evaluate the DMA behaviour of a trainees according to the following two criteria (also see 3.3.1 DMA-SR Training in VR):

1. Did the student resolve the situation with appropriate proportionality?
2. Did the student resolve the situation with appropriate subsidiarity?

To evaluate and provide proper feedback regarding these two criteria, police trainers can follow the points below:

- Use the After-Action Review to show the trainee the decisive situation
- Replay the situation from other perspectives (depending on which view holds most information) to reveal additional insights to the trainees
- Invite the trainee to think about their DMA process, for instance:
    - What did you notice in your environment (see/hear/etc.)?
    - What were your most prominent thoughts?
    - What actions did you perform and why?
- Evaluate the DMA behaviour according to proportionality and satisfactory resolution, for instance:
    - Did the situation require the use of force chosen by the trainee?

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- Were there cues in the environment that would have informed the trainee to decide and act differently?
- According to police standards, is there a more appropriate way to resolve the situation? If so, what does the trainee need to do or know to handle situations accordingly?
- Explore with the trainees which other actions would have been proportional and subsidiary in the given situation?

4 Relevant Perspectives

In accordance with SHOTPROS Objective 3 "(European Police) Training Framework and Curriculum for DMA-SR", D3.3 incorporates several relevant policy-maker perspectives (e.g., gender, legal, ethical, safety, privacy). In the following, each of the relevant perspectives are presented in their own section and linked to the policy-maker checklist for VR (see section 3.2.1). Further consideration and recommendation for policy-makers will be addressed and compiled in Deliverable 8.5, "Strategies & Toolkit for Policy-Makers".

4.1 Gender Perspective

Research methods from SHOTPROS experiments (for instance in WP3 experiments, see *Table 12*) and EndUser FeedbackWeek 2 (see D6.1) were designed in a way that they considered possible gender differences and similarities. The results from the studies and input from EndUser FeedbackWeeks (see D6.1) showed that VR is equally suitable for men and women. There are no notable gender differences in VR activities, (stress) experience and quality of learning. The VR training can further contribute to the advancement of gender equality by:

- Using scenarios focusing on gender-discrimination to reduce officers' implicit gender-biased behaviours
- Creating a large database of NPC skins representing all genders, that are also usable when training with human role-players to quickly change their appearance in VR
- Using proper suits and a versatility of material sizes, available in sizes suitable for men and women
- Providing trainees with the ability to select their own avatar during the calibration phase instead of the trainer selecting it for them

An additional consideration as part of the gender perspective concerns the behaviour of NPCs and their response to different officers (e.g., a team of two female officers, a team of two male officers, a team of one male and one female officer). To this end, a workshop capturing the end

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user experience and feedback with a focus on gender-sensitivity will be conducted in “EndUser FeedbackWeek 5” (see D6.1). The results of the workshop will be incorporated into the development process of the scenario builder (see WP5) and used as insights on skills for future VR trainers in police training (see T7.4).

4.2 Legal Perspective

Both VR providers and end users (police organisations) must think carefully about the internal legal agreement to ensure that they:

- Protect existing rights (copyright of software, pictures of material, publishing data, dissemination)
- Allocate future rights of any new creation (duty of confidentiality, test options)
- Determine legal settlement in the event of costumer failure or abuse of VR system
- Determine legal settlement of VR provider responsibility in the event of (technological) failure of VR system
- Determine legal settlement in the event of personal injury (motion control, epileptic seizures) and product liability (copycat-violence, trauma)

4.3 Ethical Perspective

On top of the prevailing ethical points (data-related issues, impact on the physical, social, and psychological well-being, see “privacy perspective” section 4.5 and “safety perspective”, section 4.4), policy-makers should be alert to:

- Ethnic profiling: “the risk of intentionally or unintentionally stigmatising or stereotyping certain groups, based on their ethnicity, culture, religion, gender or appearance” (see D2.3, section 4.2.1). As mentioned in the gender perspective (section 4.1), VR can contribute to train and reduce implicit biases of officers and raising awareness of ethnic profiling by rapid variation of environment, cultural perception, and changing appearances of bystanders.

4.4 Safety Perspective

Policy-makers should consider the normal safety precautions (as in real-life police training) and apply these precautions to VR training. Previously established rules of conduct for real-life training, such as interaction with fellow trainees and "no-play" provisions can be applied to VR. Nevertheless, there are some VR-specific points that policy makers should consider when it comes to physical and psychological/social safety of trainees.

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4.4.1 Physical Safety in Training

- As the physical aspect is less present, VR provides a safe environment to train high-risk situations with minimal risk of physical harm (injuries) to trainees (compared to FX training, for instance).
- Motion sickness can lead to dropout of trainees in training and negative experience with VR (see results Twente study, *Table 12*; evidence from EndUser FeedbackWeek 2, see D6.1). Specific protocols should be developed, possibly in collaboration with the VR provider (technical requirements) to reduce motion sickness.
- Hygiene should be considered because trainees wear VR-suits while being physically active and possibly sweating a lot (evidence from EndUser FeedbackWeek 2, see D6.1); specific protocols (such as using hygienic and odour-eliminating sprays like myrazine) should be developed to ensure proper hygiene measures
- When dressing or undressing body sensors with direct contact to the skin, an area should be provided to provide privacy for trainees.
- When using the live monitoring within the Real Time VR Trainer Dashboard, (see D4.5) during a VR training session, the possibility exists that trainers or operators might notice abnormalities in heart rate (irregular or too high) or chronic stress (low HRV baseline levels) of trainees. Policy-makers in cooperation with training coordinators should develop a protocol that addresses incidental medical findings and how these will be handled a) if noticed during a training session and b) if noticed after a training session, indicating possible medical risk to the trainee.

4.4.2 Psychological and Social Safety in Training

- VR can enhance safety in training with proper use and monitoring trainees with VR features such as the AIM and AAR. These features offer the trainers the possibility to conduct repetitions and manipulate complexity of scenarios to ensure the trainees end with positive experiences (i.e., resolving a situation appropriately).
- Trainers need to ensure that training, in particular certain scenarios, are not overwhelming and cause information overload for the trainee. The risk assessment tool (see D4.7) offers trainers a tool to familiarise themselves with trainees' possible previous encounters to avoid further triggering of incidents in training (see D2.3, section 4.2.2), the Trainer Dashboard offers options to assess and also to directly de- or increase stress cues during the actual training.
- In training, trainers need to ensure that the level of training does not exceed the trainee's development phase. This can be achieved through the proper use of the risk assessment

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tool (see D4.7) and the Stress Level Assessment panel of the Real Time VR Trainer Dashboard (see D4.5) to properly steer the scenario complexity.

- Gamification may increase the chance for compromised ethical/moral behaviour of trainees and could potentially reduce the focus on the learning objective in VR training. But gamification is not well-appraised in the context of police trainings (EndUser FeedbackWeeks 2 and 3). Thus, trainers need to pay particular attention during the VR training instruction to avoid gamification and monitor the behaviour of trainees during the use of VR to eliminate gamification behaviour as soon as it arises.
- Through the proper steering of the course of a VR scenario, VR training offers the possibility for safer PTSD reintegration (when compared to real-life training). Using the VR results dashboard for measuring and reviewing training session performance (see D5.4), experienced VR trainers can ensure a safe training environment for police officers who have suffered from PTSD syndrome and are working towards reintegration.

4.5 Privacy Perspective

VR systems offer great possibility to store valuable training information as VR features (IAM, AAR) are able to monitor how trainees move around in the virtual environment, store training data, and monitor progress and performance over time. These possibilities ask for proper policy development, particularly on data storage of VR training output. In particular, the following points need to be considered by policy-makers and LEA representatives:

- Anonymity of data (input from EndUser FeedbackWeek 2, see D6.1; see D2.3, section 4.2.4)
- Short vs. long-term storage (i.e., how long is the data stored for? ; see D2.3, section 4.2.4)
- Accessibility to stored data (i.e., if data is stored, who has access and how can the data be accessed?)
- Visibility of individual data when team viewing in the AAR or IAM (e.g.: Stress levels are visualised during the training – if individually influenced stress-level increases are visualised this might be a private issue for trainees and might only be discussed with a trainer and not with all peers – turning on and off might be an easy solution for that) (EndUser FeedbackWeek 2 – D6.1)
- VR system use: disconnect from public channels (i.e., use of a free radio channel)

4.6 Logistical Perspective

For VR training, logistical considerations comprise matters such as location, time, staff, and materials. Input from trainers (see TrainCompar study, *Table 12*) indicates that compared to real-life training, more technical knowledge (such as basic knowledge of computer controls) and skills

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(such as handling of the comptrollers of the VR AAR) are needed from trainers. Trainers need to be prepared and trained to master the (technological) skills for VR training, which takes time and may lead to specific choices for trainers that are technology-minded (i.e., have an affinity for technology such as playing video games or having worked with other police or military training simulators before).

Further input from the EndUser FeedbackWeeks 2 and 3 (see D6.1) provides points that may facilitate the logistical vision and choices for VR training. Accordingly, compared to real-life training, VR training allows:

- Training independent of physical location availability: "You only need an open field – any location is possible"
- Training independent of weather
- The use of less trainers per training
- The use of less role-players per training
- The use of less additional staff per training
- A reduction in preparation time for trainers
- A reduction in material for training preparation
- Depending on where training takes place and what type of training VR replaces, it lowers the environmental footprint due to less travel time (back and forth), less consumables used (FX ammunition, fuel, etc.).
- Replay a scenario without investing time and material in "re-building" the exact same situation (e.g.: put chairs on position again, replace broken glass, set all role players on the last position etc.)

For further specific logistical set-up requirements for VR training, see section 3.2.3, *Table 9*.

5 Attachments

The following material is additional information that supports the content presented above. All informational material presented in this attachment has been referred to in the main text.

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5.1 Training Observation Guide

1. Is there a clear assignment?
1.1 Is the purpose of the assignment clear?
1.2 Has the relevance of the assignment been named?
1.3 Is autonomy* offered in the assignment?

2. Is there high-quality instruction?
2.1 Is the effect of the action emphasised? (External attention*)
2.2 Limited number of points for attention?
2.3 Relevant points of attention?
2.4 Use of metaphors?
2.5 Explicit instruction* when needed/useful

3. Is there a well-designed practice situation?
3.1 Is practiced with realistic problems?
3.2 Is practiced on realistic solutions?
3.3 Is practiced under realistic stress?
3.4 Is practiced with realistic context?
3.5 Options for gaining self-efficacy*?
3.6 Does the practice situation require externally focused attention*?
3.7 Is constraint-led approach* used?

4. Is model learning* used?
4.1 With teacher as an example
4.2 With peers as an example
4.3 With experts as an example
4.4 With own implementation as a model (video feedback)
4.5 Is a viewing assignment given?
4.6 Is the model repeated?
4.7 Is the model visible to everyone?
4.8 Is it a good quality model?
4.9 Does the model fit the learner's development phase?

5. Is there variation and differentiation?
5.1 Does the practice situation offer variety?
5.2 Is the skill practiced randomly? (Instead of blocked/serial)
5.3 Is there differentiation between participants?
5.4 Is there differentiation within participants?
5.5 Is 'error-free learning'* used?

6. Is there a possibility for self-management of the learning process?
6.1 Can participants vary the number of practice attempts?
6.2 Can participants vary difficulty in practice attempts?
6.3 Can participants choose which tools they use?
6.4 Can participants choose when they receive feedback?
6.5 Can participants choose where to receive feedback?
6.6 Can participants choose how they will receive feedback?
6.7 Is the trainee encouraged to think about possibilities for improvement?
6.8 Is "implicit feedback"* provided?

7. Is there constructive, motivating feedback?
7.1 Is feedback given after successful attempts?
7.2 Is feedback based on careful observation and analysis of implementation?
7.3 Does the feedback ensure understanding of the purpose of implementation?
7.4 Does the feedback provide an understanding of the current level of implementation
7.5 Does the feedback provide an understanding of the possibilities for improvement of implementation?
7.6 Is there time for reflection by the participant?
7.7 Are good results named?
7.8 Are improvements named?
7.9 Is effort named?
7.10 Does the feedback invite externally focused attention*?

Table 10. Observation guide. Items containing an "" are further explained in the Glossary (see Table 11).*

5.1.1 Training Observation Guide Glossary

Item/Term	Description/Explanation
Autonomy	Autonomy describes the freedom for people to "act following their own beliefs and values while exercising control over some aspect of the environment" (Chiviacowsky, 2014; Lewthwaite et al. 2015).
External attention/externally focused attention	External focus of attention refers to the direction of attention to the effects of the movements in the environment rather than the movement itself (Wulf & Prinz, 2001; Becker & Fairbrother, 2019).
Explicit instruction	Explicit learning is defined as "an intentional acquisition that results in verbalizable knowledge" (O'Brien-Malone & Maybery, 1998). Thus, explicit instruction refers to the specific verbalization of the task at hand (Raab, 2003)
Self-efficacy	Self-efficacy represents people's beliefs in their capabilities to perform an action successfully (Bandura, 1997).
Constraint-led approach	The constraints-led approach (a principle of non-linear pedagogy) describes a method of teaching in which certain constrains specific to the learner, the environment, or the task are manipulated to achieve goal-directed movement and facilitate learning (Davids et al., 2008). Within this approach, the learner is tasked with finding solutions to the constraints placed upon him or her (Brymer & Davids, 2014).
Model learning	Model learning refers to a teaching strategy that utilises demonstration of behaviour as instruction for skills or movements. The learner has an observational role in which he or she closely watches the model to acquire the modelled behaviour (Gould & Roberts, 1981; Hebert, 2018).
Error-free learning	Error-free or errorless learning describes the to the intentional regulation of the task difficulty to enable the learner to experience the learning environment without failure. In an error-free learning approach, the trainer

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	creates an increasingly challenging environment for a learner to have a positive experience and adjust the level of difficulty to the capacities and developmental phase of the learner (Capio et al., 2016).
Implicit feedback	Implicit learning describes the process of acquiring knowledge without being aware of it and oftentimes even without being aware of having learned something (Wulf & Schmidt, 1997). In this sense, implicit feedback refers to feedback regarding the "underlying sensory experience of a movement" (Hodges & Franks, 2002).

Table 11. Glossary for the training observation guide.

5.2 Overview of Experiment Results

Table 12 summarises the research questions, set-up, participants, measures, and results of the studies that have been conducted in WP3.

5.2.1 Planned Publications WP3

Based on the experiments presented in *Table 12*, the following publications are planned for the study results obtained within WP3:

- Police Training in Practice: Strengths and Challenges According to European Law Enforcement Agencies (using results from Site Visit interviews)
- Training under Stress: A Comparison of Real-Life and Technology-Enhanced Police Training Practices (using results from Twente study and Zurich study)
- Police Training During a Pandemic: Using VR as a Training Tool to Support Learning of Police Academy Students (using results from Rotterdam study)
- The Importance of Feedback in Police Training: Taking Advantage of VR Feedback Features (using results from Zurich study)

For more details on submission dates and possible journals, see the SHOTPROS publication plan (T8.5, "Scientific Dissemination").

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	Site Visits	Twente Study	Rotterdam Study	Zurich Study	TrainCompar
Research Questions	1. What are the training objectives of current training curriculums of European law enforcement agencies? 2. What do current training practices of European law enforcement agencies look like in practice? 3. How do police trainers assess the current training practices?	1. How realistic is the tension/stress/anxiety that police officers experience during VR training scenarios compared to "live" training scenarios? 2. How intense is training/practice during VR training scenarios compared to "live" training scenarios? 3. What is the quality of the experience of police officers during VR training scenarios?	What is the effect of police student's level of experience and type of training instruction on: 1. The learning experience during the VR training? 2. Engagement with VR as a training tool? 3. The experience with and the reception of VR? 4. The experienced stress during VR training?	1. How does the experience of police officers during VR training scenarios compare to scenarios performed in the VirTra? 2. What is the effect of different feedback options in VR on the quality of the learning experience? 3. What is the effect of adding a pain stimulus (minor electrical shock) in VirTra training on the quality of learning experience and experienced stress? 4. How do police trainers assess the deployment of the VR system in their training routines?	1. How much actual training in a specific time is done during VR training compared to “live” training scenario? 2. How many repetitions and variations (of scenarios) are executed during VR training compared to “live” training scenario? 3. How much and what type of feedback is provided during VR training compared to “live” training scenario?
Set-Up	VUA researcher visited the LEA locations to observe training sessions and conduct interviews with police trainers and police	During the training days of the Dutch police, each police officer trained one session with the Re-liON VR system and three real-life training session. VUA researchers gathered data	VUA researchers distributed the DangerZone VR system to police students and trainers for training at home. Police students were asked to perform at least 9 training session of 20	During the training days of the Zurich city police, each police officer trained one session with the Refense VR system and one session in the shooting cinema VirTra 300. VUA/AIT researchers	VUA researchers conducted a study in which the didactical training features of VR training with the RE-liON system were compared to real-life scenario training. Groups of

	practitioners with educational tasks.	on the experience of each of the session to compare real-life to VR training.	minutes each. Half of the students received closed instructions, the other half open instructions.	gathered data on the experience of each of the session to compare trainings using technical support.	4 students trained in VR and real-life for 1:30 h each and rated their training experience while VUA researchers conducted behavioural observations.
Participants	All Shotpros LEAs; 24 participants for interviews	309 patrol officers (protection unit)	45 police students; 12 trainers	654 patrol officers	45 police students; 3 trainers
Measures	• Trainer Interviews • Overview Interviews • Training Observations of skill training, car procedure training, tactical training, and shooting training	• Physiological Measures (Heart rate, accelerometery) • Visual Analogue Scales (Stress, mental effort) • Sense of Presence in VR Questionnaire (ITC-SOPI) • Activity/Observation Logs	• Sense of Presence in VR Questionnaire (ITC-SOPI) • Visual Analogue Scales (Stress, mental effort) • Questionnaire for Learning Experience • Self-Efficacy Questionnaire • Questionnaire for Trainers (VR Training Tool Evaluation)	• Physiological Measures (Heart rate, accelerometery) • Sense of Presence in VR Questionnaire (ITC-SOPI) • Visual Analogue Scales (Stress, mental effort) • Quality of Learning Questionnaire • Technology Acceptance Questionnaire	• Physiological Measures (Heart rate) • Visual Analogue Scales (Stress, mental effort) • Quality of Learning Questionnaire • Questionnaire for Trainer Evaluation • Questionnaire for Trainer Evaluation • Behavioural Observation of Training Elements
Results	• Training frequency and duration as seen in *Table 3* • Training session evaluation based on didactical features (see *Table 10*) of skill training, car procedure training, tactical training, and	• Officers experienced moderate sense of presence in VR with high engagement and a moderate experience of negative effects (predominantly nausea and motion sickness) • Maximum heart rate during the training	• Learning experience and engagement with the VR training tool was highest for more experienced police students who received closed training instructions • Sense of presence was high with a single user VR system like DangerZone	• Pain stimulus increased the mental effort and subjective stress experienced during a VR • Adding a pain stimulus to the training in VR and VirTra did not influence the maximum or average heart rate during a training	**Results based on training observation:** • In 1:30 h of training, time spent on preparation was 'on average 15 minutes higher in VR training than in real-life training. • In 1:30h of training, frequency and time spent

	shooting training as seen in *Table 4* **Results based on the interviews:** • VR training can supplement real-life practice well because it allows LEAs to schedule training independent of training location, props, and role-play actors • Real-life training can have limitations concerning the level of realism because training tools like FX training requires participants to dress in protective clothing • Police trainers thoroughly enjoy creating supportive and challenging training environments and would like to do that in VR as well	session was significantly higher in real-life training (on average 136.00 bpm) than in VR (on average 129.95 bpm) • Average heart rate during the training session was similar in real-life training (on average 86.796 bpm) and VR (on average 86.798 bpm) • The investment of mental effort was similar in real-life training and VR • The subjective experience of stress was significantly higher in real-life training than in VR	• Police trainers rated VR most useful for tactical training and law and regulation training • Police trainers rated VR least useful for fitness, combat, and shooting/weapon handling training • Less experienced police students spent less time training with the VR training tool compared to more experienced police students • Police students who received closed training instructions experienced higher spatial presence in VR • Police trainers found VR training (DangerZone as an at-home training tool particularly) to be a valuable addition to regular training	• The subjective experience of stress was significantly higher in VR than in VirTra (for 1 training group, no difference in 2 groups) • The investment of mental effort was significantly higher in VR than in VirTra (for 2 trainings groups, no difference in 1 group) • Maximum heart rate during the training session was significantly higher in VR (on average 131.47 bpm) than in VirTra (on average 117.11 bpm) • Average heart rate during the training session was significantly higher in VR (on average 86.67 bpm) than in VirTra (on average 106.49 bpm) • Using the After-Action Review feedback features “bird’s eye view and suspect perspective with line of sight of the weapon” and “bird’s eye view and suspect	on instruction was lower in VR than in real-life. • In 1.30 h of training, frequency and time spent on execution was higher in VR than in real-life. • In 1:30 h of training, frequency and time spent on feedback was lower in VR than in real-life. • Variation of scenarios was higher in VR than in real-life. • Order of training (i.e., VR training before or after real-life training) did not influence the duration and frequency of activities in VR training. • The trainer had a major influence on the preparation time in VR, more experience meant shorter preparation time • Gender did not influence the duration and frequency of training activities of trainees **Results based on questionnaires:**

				perspective" influenced the quality of learning the most **Results based on the interviews:** • Trainers and trainees indicated that the weapon handling, 3D sound output, and interaction with objects and NPCs was not sufficiently realistic • Trainers and trainees value the potential for VR in future training as immensely high • Trainers and trainees found VR training to have a strong effect on learning due to the AAR • Trainers and trainees enjoyed training in an environment that resembled a place they encounter on work (Parade Platz, public square in Zurich) • Trainers found VR training to be less labour intense	• Stress and mental effort scores of trainees were on average higher in real-life than in VR. • The higher the preparation time, the lower stress and mental effort scores of trainees • The higher the number of variations in scenarios, the higher trainees evaluated their quality of learning and perceived the quality of feedback in VR training • Trainees did not perceive differences in training activities (prep, instruction etc.) and number of variations and repetitions between VR and real-life. **Results based on interview with trainers:** • Trainers call the cooperation with the VR-operator an important aspect in teaching in VR. • Trainers suggested that VR training is superior for

				when compared to real-life training	tactical and perception and action training. Real-life is superior for communication and physical contact training. • Trainers indicate that variation in location is the feature what VR makes so valuable in addition to real-life. • Trainers stated that the use of the AAR was time-consuming and less suitable with a limited training duration, yet they recognised the great value for feedback. • Trainers suggested to use small learning objectives or subtasks to facilitate repetition and variation in VR training. • Trainers perceived the preparation time in VR as long and think this should be more time-efficient.

Table 12. WP3 study summary and description.

5.3 Explanation of Roles

Role	Description of role
Policy-maker	Policy-makers are responsible for making informed decisions regarding the relevance and technical, logistical, didactical, and human resource requirements of VR training and for translating their organisation's vision into the needs for VR training.
Training coordinator	Training coordinators are responsible for exploring how the VR training can be successfully and effectively implemented based on their expertise in police training and knowledge of (didactical) features of VR.
Trainer	Trainers are responsible for preparing the VR training session (including organisational preparation, etc.), its learning objective(s), and the selection of appropriate training scenarios (deciding on scenarios, objects. NPCs, scripting roles etc.). Trainers are responsible for guiding the learning experience of the trainees and creating a safe learning environment. Making use of the Real Time VR Trainer Dashboard to monitor and steer the training and conducting an efficient AAR with the trainees are tasks that are added to a trainer role within the VR context.
Trainee	Trainees are responsible for ensuring proper conduct during the VR training session (i.e., refraining from the risk of gamification) and adhering to the rules and instructions provided by the trainer. Trainees can take on various roles in VR: the officer, the suspect, bystanders, or a "ghost" observing the scenario.
VR operator	The VR operator is responsible for ensuring the proper functioning of the VR equipment, supervising the technical aspects of the training session, and providing technical support during the VR training. The operator translates the training needs described by the trainer into the VR training experience (e.g., providing specific VR environments that align with the training aim, steering the course of a scenario in accordance with the wishes of the trainer). For more information on the operator tasks and the logistical requirements for the set-up of a VR training session, see *Table 9.*

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Role-player	Role-players in VR are responsible for acting according to their assigned role within the VR training scenario. To provide realistic training experiences for trainees, role-players need to stay in the role-play character throughout the entire scenario and act upon the behaviours and reactions of the trainees. The role-player thereby follows the instructions of the trainer closely and should allow for changes to the role-play script even during a scenario (since VR training allows the trainer to provide input to the role-player without trainees noticing). In VR, role-players can be trainers, trainees, or (professional) actors. For more information on the role-player tasks and the logistical requirements for the set-up of a VR training session, see *Table 9.*

Table 13. Explanation of roles.

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