European Commission, Horizon 2020

D6.1 Human Factors Study Plan

SHOTPROS

Deliverable	D6.1
Deliverable Lead	AIT
Related work package	WP6
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Versions

Vers.	Date	Author	Description
V0.1	06/02/2020	Sebastian Egger-Lampl (AIT)	First draft of study plan template
V0.2	12/03/2020	All research partner	Provision of inputs and details about studies
V0.3	18/03/2020	Sebastian Egger-Lampl (AIT)	Transfer to excel planning sheet and aggregation of study descriptions
V0.4	10/05/2020	All research partner	Update with respect to COVID (1st wave)
V0.5	06/06/2020	Helmut Schrom-Feiertag (AIT)	Incorporation of new studies, postponed studies and primarily results
V0.6	03/10/2020	Sebastian Egger-Lampl (AIT)	Update with respect to COVID (2nd wave) – addition of BerlinStress and NRWStress study
V0.7	05/10/2020	All research partner	Update / addition to study plan
V0.8	15/10/2020	Sebastian Egger-Lampl (AIT)	Incorporation of partner inputs, including cancellation of BerlinStress and NRWStress
V0.85	23/10/2020	All research partner	Provision of feedback on revisions and upcoming studies with respect to COVID
V0.9	25/10/2020	Valerie Schlagenhaufen (USE)	Incorporation / update of partner inputs, cross-check of study schedule and interrelation with other project activities
V0.95	20/11/2020	Sebastian Egger-Lampl (AIT)	Final draft for partner feedback (received from all research partner)
V1.0	29/11/2020	Sebastian Egger-Lampl (AIT)	Integration of feedback and finalization
V1.1	01/07/2021	Quynh Nguyen (AIT)	Re-opening of deliverable, consolidation of the previous study plan into an updated

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			study plan due to travel and study conduction restrictions resulting from COVID-19
V1.2	15/07/2021	All research partner	Integration of partner inputs
V1.3	20/07/2021	Quynh Nguyen (AIT)	Final Partner feedback
V1.4	27/07/2021	Birgit Harthum (USE), Markus Murtinger (USE) & all Partners and Advisors	Final Check and approval
V1.5	15/11/2021	Olivia Zechner (AIT)	Integration of requested information
V1.6	18/11/2021	Helmut Schrom-Feiertag (AIT)	Executive Summary and final review
V1.7	19/11/2021	Birgit Harthum (USE)	Final adaptions content
V1.8	19/11/2021	Gerhard Helletzgruber (USE)	Final version sent to PO for feedback
V1.9	13/12/2021	Helmut Schrom-Feiertag (AIT)	Incorporation expert review feedback, Final check
V2.0	20/12/2021	Gerhard Helletzgruber (USE)	Formatting and submission
V2.1	12/04/2022	Gerhard Helletzgruber (USE), Valerie Schlagenhaufen (USE)	Re-inserting adapted template for user requirements collection in Annex Formatting and submission

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List of Acronyms and Abbreviations

Acronym / Abbreviation	
AAR	After-action review
DMA-SR	Decision-making and acting under stress and in high-risk situations
HF	Human factors
HRV	Heart rate variability
KPI	Key performance indicator
LEA	Law Enforcement Agency
UCD	User centred design
VirTra	2D-based training technology
VR	Virtual Reality
WP	Work package

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Executive Summary

To achieve the SHOTPROS project objectives, 22 studies or experiments have been planned. To date (M28 of the project), 4400 police representatives (from more than 12 police organisations) and 1390 civilians (in the surveys conducted through EUCitizenStudy and EUCitizenPerception – D2.4) have participated in the studies conducted so far.

The aim of the document is to provide an overview of the planning of the individual studies and to indicate which further deliverables the results will contribute to. Specific user requirements and feedback identified for the new VR system were collected on an ongoing basis and are reported in D4.6 (M33) as technical requirements - this process is explained in chapter 5.

Especially the planning and execution of the studies was already an important example of co-creation within SHOTPROS and its 13 partners and advisors and network members. During the studies, all LEA partners from SHOTPROS were continuously involved, they were responsible for the on-site set-up and implementation and together with the coordination team took care of the recruitment of participants. The planning of these studies has followed the end user management approach (described in D1.4). The participating LEA partners as well as the external advisors and external network members enriched all human factor studies with their police expertise and thus contributed significantly to the success. Scientific and technology partners worked closely together to set up the studies and to create the suitable (VR) environment.

All studies were completed on time with their results having a direct impact on the deliverables that build on these study results (e.g. results from the Human Factor Week 2 (HFW2) study in Berlin for the features and design of the dashboard in D4.5 (M28) or the findings from the TrainCompar study in Amsterdam for D3.3 (M28) with a focus on the future training curriculum, etc.).

Through the early establishment of the VRandPolice Network (see D.8.10) and the contacts thus gained, it was possible to integrate other European LEAs into the studies in addition to the existing six SHOTPROS LEA partners. The two studies with the City Police of Zurich (Switzerland) with so far more than 650 police officers as well as the participation of police officers from Brussels, Antwerp, Zurich or Vienna at the Human Factor Weeks (HFWs) during the summer of 2021 should be highlighted. Through this integration of other non-SHOTPROS LEAs, out-of-the-box insights could be generated, and the studies also served as a very positively acknowledged networking event between the authority representatives. Furthermore, all attending participates positively mentioned the opportunity for networking

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and especially talking about VR experiences with different use cases, VR systems etc. besides the study and feedback content.

A great success, especially during the HFWs in summer 2021, was the participation of high-level management representatives of the authorities (e.g. the police president of Berlin, heads of police academies, representatives of the ministries of the interior in Selm, Germany, etc.).

Thus, these studies were also used for strategic and policy-relevant discussions on the core topics of SHOTPROS and to take concrete exploitation measures (such as invitations to strategy talks at European ministries, invitations to internal police symposia for demonstrating the SHOTPROS VR system) and offered suitable dissemination options for the project. These outputs are reported in detail in the dissemination and exploitation reports (D8.9 M41).

1 Introduction

The aim to create a future SHOTPROS VR (virtual reality) solution is fed by 3 major streams, which are technology development, human factors (HF) implications and end user feedback & requirements.

To elaborate and answer the human factors stream (WP2-4) related research and innovation questions, all necessary experiments and studies are listed in this D6.1 as an overview. Reporting on the results is spread around different WPs.

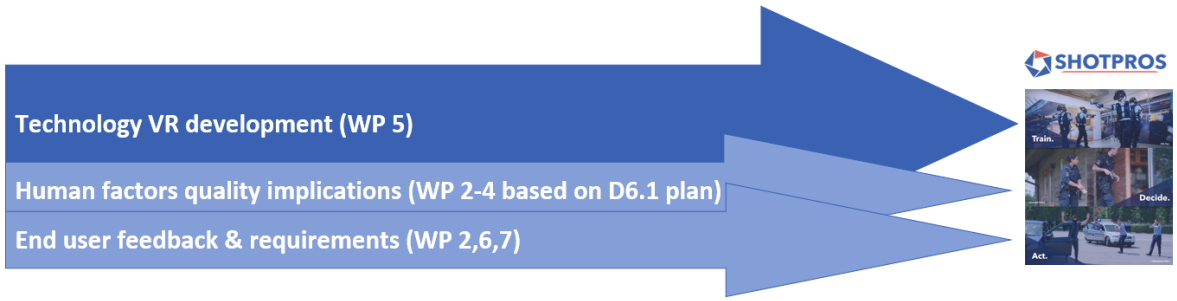

Figure 1: Overview on WPs and the different streams resulting into SHOTPROS VR solution

WP2 covers the requirements, WP3 the scientific model and WP4 the detailed stress and HF related innovations. The basic scientific model on human factors was firstly defined in D3.2.

To identify and elaborate the relevant HFs that influence the decision making and acting (DMA) of police officers under stress and in high-risk situations and to identify how to measure performance and stress and how to develop an appropriate VR solution (WP5) with respect to user-centred-design (UCD) and to involve end user, different studies were set up and

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defined. Information about the set-up, the objectives and the status on the studies are available as an overview and as detailed description.

Study data itself is reported in WP6 (e.g.: measurement instruments D6.2) and act as content for the training approaches in the field trials (WP7) for further validation and will be useful for the development of the policy-maker documents and for scientific dissemination (WP8). To achieve maximal ecological validity, the majority of these studies and experiments will be (or have been) conducted at the premises of the SHOTPROS LEA (Law Enforcement Agency) partners.

The study plan presented in this deliverable is a living document and therefore subject to changes based on agile project development necessities and COVID-related adaptions.

1.1 Study Impressions – Berlin 2021

As an example, impressions from the HFW2 are shown here: StressCueValidation study and EndUser FeedbackWeek 2, conducted in June 2021 in Berlin with more than 75 participants from 12 European authorities and the visit and observation of the studies of the Berlin Police Management Board (Police President and Vice President of Berlin and Head of Police Academy):

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1.2 Integration of WP6 in SHOTPROS

With respect to user involvement in the form of human factor (HF) studies, WP6 serves as a bracket for the identification of user requirements (WP2), the study-based work towards future training concepts and the decision making and acting (DMA) model (WP3), and the assessment and modelling of training experience (WP4). All studies necessary to achieve the goals from WP2-4 are summed up in an overall study plan in the present D6.1. This approach also offers the great opportunity to share study plans and results among the SHOTPROS partners to enhance collaboration.

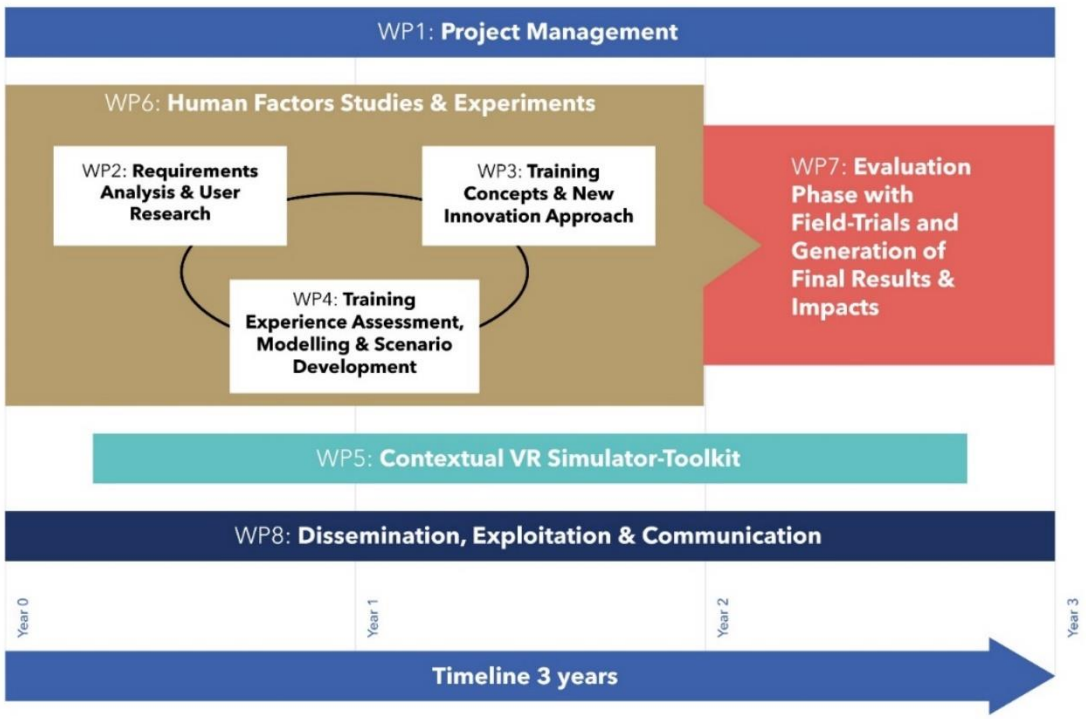

Figure 2: WP structure

Furthermore, user-centred-design studies are carried out in the context of WP6 that deliver inputs, evaluation results and insights for the agile development of the VR system (WP5). Finally, feedback weeks with end users as part of the agile development process for the SHOTPROS VR solution are executed within the WP6 human factor studies (EndUser FeedbackWeeks1-6).

WP6 itself consequently supports WP2-4 in terms of study data management and data analysis of the impact of (simulated) influencing human factors on user behaviour, decision-making and acting, and user experience**.** All these WPs also feed their UCD-relevant study results into WP5 for the development process of the VR training system and related scenarios

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as well as into WP7 for the measurement set-up configuration, respective training scenarios and updates of the HF model, the training framework and curriculum, the guidelines for VR training and the training scenarios in accordance with the field trial results to validate the solution. WP8 also benefits from WP6 studies, as for example the policy maker toolkit or dissemination and communication work is based on our scientific results in the police context combined with LEA involved hands-on feedback.

Human Centred Research (HCR) as a Project Framework

The defined structure of the WPs follows a human-centred research (HCR) approach. HCR is an iterative process focusing on the end users and their needs in each phase of the project process. HCR calls for involving users throughout the process via a variety of research and design techniques to create highly usable and accessible products and services for them and to fulfil the defined objectives.

HCR considers the Whole User Experience

In HCR, researchers base their projects upon an explicit understanding of the users, tasks and environments. The process aims to capture and address the whole user experience. Therefore, the research team must include professionals from across multiple disciplines (e.g., human factors researcher, ethnographers, psychologists, movement-scientists, software and hardware engineers, training experts, etc.), as well as domain experts, stakeholders and the users themselves.

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2 Study overview and status

Table 1 gives an overview of already conducted studies as well as on planned studies and their contribution towards other work packages. A more detailed description for each of the studies and their impact on project objectives can be found in the subsequent sections.

Colour Coding:	Study & evaluation completed	Study completed, evaluation/reporting ongoing	Study ongoing / planned	Study cancelled or postponed

2.1 List of Human Factor studies

Nr.	Abbr.	Study Topic	(Planned) dates	Involved main partners	No. of participants	assigned to WPs	Additional report & further use of results[1]
1	**User_Req**	(First) user requirements analysis	08.2019 - 10.2019	KUL, USE, all LEAs	60	WP2	**Report in** D2.1, D2.2, D6.3, D6.4 **Further use in** WP3-8
2	**TrainPrac**	Analytics and validation of current training practices of European LEAs	12.2019 - 03.2020	VUA, all LEAs	24	WP3 WP5	**Report in** D6.3, D6.4, D3.1, D3.3 **Further use in** WP5-7
3	**Case Study**	Police Officer's psychophysiological stress reactivity on duty	09.2019-10.2019	UHEI, VUA, BP	1	WP4	**Report in** D6.3, D6.4, D4.3 **Further use in** WP4-6

[1] In addition to the further use of results in other WPs as stated, all project outcomes and study results will be taken into consideration for the development of the policy-maker toolkit and for scientific dissemination (WP8). Hence, all partners will continuously monitor the outcomes with respect to their policy relevance and publication opportunities.

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4	**Paintball study**	Performance under physical and psychological stress	11.2019 - 12.2019	UHEI, AIT	16	WP6	**Report in** D6.3, D6.4 **Further use in** WP6-7
5	**EnschVR**	Comparison between reality-based scenario training and VR scenario training	01.2020 - 02.2020	VUA, NPN, RL, LAFP NRW	309	WP3	**Report in** D3.3, D6.3, D6.4 **Further use in** WP5-7
6	**DEC-TREE**	Development of operational VR scenario (1st phase) for DMA-SR training	01.2020 - 05.2020	KUL, USE, all LEAs	-	WP2	**Report in** D2.3, D6.3, D6.4 **Further use in** D4.2 and WP5-7
7	**RottVR**	The impact of type of instruction and level of experience on learning and VR training experience	05.2020 - 06.2020	VUA, AIT, NPN	57	WP3	**Report in** D3.3, D6.3, D6.4 **Further use in** WP5-7
8	**Field exercise**	Assessment of physiological stress responses during field exercise at Campus Vesta	16.05.- 17.05.20	UHEI, VUA, AIT, VESTA	-	WP4	Re-planned: See HFW1 ,2 and 3
9	**SHOT-COVID**	Police officers' work demands, stressors and coping strategies during COVID19 crisis	27.03.- 05.06.20	UHEI, AIT, VUA, KUL, BP, NPN, SIAK Austria and others	2.567	WP3 WP4	**Report in** D6.3 and D6.4 **Further use in** WP3-4, 7
10	**ZüriVR**	The effect of different feedback options and the addition of a pain stimulus on the (learning) experience of Swiss police officers in VR training	06.2020 - 08.2020	VUA, AIT, StaPo Zürich, BP	654	WP3 WP4	**Report in** D3.3, D4.4, D6.3, D6.4 **Further use in** WP5-7
11	**BerlinStress**	Initial Stressors Assessment	28.09.20 - 02.10.20	AIT, UHEI, BP	-	WP4 WP6	Re-planned: See HFW2

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12	**NRWStress**	Assessment of stressors in training scenarios	Q4/2020	AIT, UHEI, LAFP NRW	-	WP4 WP6	Re-planned: See HFW2
13	**RAT_study1 & RAT_study2**	Risk Assessment Tool	11.2020 - 02.2021	KUL, ADCC IBZ, all LEAs	550	WP4 WP6	**Report in** D6.3, D6.4 and D1.7 **Further use in** WP3-7
14	**EUCitizenStudy**	EU Citizens Study on perceived behaviour of police officers	01.2021 – 02.2021	KUL, all partners for distribution	640	WP2 WP8	**Report in** D2.4, D6.3, D6.4 **Further use in** WP7-8
15	**EuCitizen Perception**	Addition to the EUCitizenStudy survey with a focus on citizens' perceived experience of stress by police officers, the importance of police training and the potential added value of VR for police training	02.2021 – 03.2021	KUL, VUA, AIT, UHEI, USE	750	WP2	**Report in** D2.4, D6.3, D6.4 **Further use** in WP 7-8
16	**EndUser FeedbackWeek 1**	Online - 5 appointments with all LEA organisations and advisors: Feedback on online VR walkthrough and previous live experiences of partners; Focus on: Workflow for trainers, feedback on stressors, general look & feel regarding scenarios and user interface design	March 2021 (10.3., 12.3., 26.3., 30.3.)	online setting, AIT, USE, RL, all LEAs and advisors	37	WP5 WP6	**Report in** D6.3, D6.4, D5.2 **Further use in** WP5-8

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17	**EndUser FeedbackWeek 2**	Berlin (Germany)– executed together with HFW2: Partners, invited network members and advisors evaluated and tested different VR scenarios and gave feedback on user experience, training options and performance measurements according to current development status	05.-09.07 2021	AIT, USE, RL, BP, all LEAs, advisors and network partners	47	WP5 WP6	**Report in** D6.3, D6.4, D5.2 **Further use in** WP5-8
18	**EndUser FeedbackWeek 3**	Selm, NRW (Germany) -executed together with HFW3: Partners and invited network members will test updated VR scenarios and give feedback on user experience, training options and performance measurements	09.-13.08. 2021	AIT, USE, RL, LAFP NRW, all LEAs and network partners	open	WP5 WP6	**Report in** D6.3, D6.4, D5.2 **Further use in** WP5-8
19	**EndUser FeedbackWeek 4**	Scenario 2 Details: Workshop combined with the November consortium meeting – focus on evaluating the scenario 2 and the planned new features from the actual release	Nov 2021	AIT, USE, RL, all LEAs	open	WP5 WP7	**Report in** D5.3, D7.6 **Further use in** WP5, 7, 8
20	**EndUser FeedbackWeek 5**	Gender Workshop: Identification Workshop on gender specific requirements in VR police trainings	Tbd – Q1 2022	AIT, USE, RL, all LEAs	open	WP5 WP7	**Report in** D7.6 **Further use in** WP7-8
21	**EndUser FeedbackWeek 6**	Executed together with one of the first field trials from WP7; partners, invited network members and advisors evaluate	Tbd - Q2 2022	AIT, USE, RL, all LEAs, advisors	open	WP5 WP7	**Report in** D7.6 **Further use in** WP7-8

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		the final VR scenario and feedback sessions for the training curriculum.					
22	**HFW1: TrainCompar**	Direct comparison of realistic training and VR training	07.-11.06 2021	VUA, AIT, RL, NPN (location NPN)	48	WP3, WP4, WP6	**Report in** D3.3, D6.3, D6.4 **Further use in** WP3-4 and WP6-7
23	**HFW2: StressCues**	Validation of effects of VR stress cues on police officers' and trainees' stress levels	05.-09.07 2021	UHEI, AIT, USE, BP (location BP)	22	WP4, WP6	**Report in** D4.6, D5.2, D6.3, D6.4 **Further use in** WP4-7
24	**HFW3: RealTime Stress**	Real-time measurement of stress and performance in VR training	09.-13.08 2021	UHEI, AIT, USE, LAFP NRW (location NRW)	44	WP6	Report in D6.3, D6.4 Further use in WP 4, 5, 7
25	**ZüriVR2**	Collection of physiological data during VR training with different biodata hardware and competitive comparison (with the actual Refense VR System)	Sept 2021	AIT, UHEI, external LEA (location: Zurich)	open	WP6	Report in D6.3, D6.4 Further use in WP 5, 7, 8

Table 1: Study overview and status

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2.2 Original work plan and deviations

The original workplan had foreseen to execute the studies *FieldExercise* in Q2/2020, *BerlinStress* and *RAT_study1&2* in Q3/2020, and *NRWStress* in Q4/2020. Due to the circumstances around COVID-19 and resulting travel restrictions, those studies had to be either cancelled (*BerlinStress, NRWStress, FieldExercise*) or postponed (*RAT_study 1&2*).

In addition, due to logistical reasons caused by COVID-19 restrictions (e.g. limitations of participation of LEAs, travel restrictions of RL), it was decided to merge the original HFW1-3 and TrainCompar into three new HFW Studies (now: HFW1 – TrainCompar, HFW2 – StressCues and HFW3 – RealTimeStress).

To adapt the study contents, the study plan was revised in the following ways:

- Research questions from the original HFW3 study (on stress responses in real world training in comparison to VR training) were integrated into HFW1: TrainCompar.
- Research questions from BerlinStress and NRWStress were merged into the new HFW2: StressCues.
- The assessment of physiological stress responses originally planned for the field exercise at Campus Vesta was integrated in HFW1-3 and ZüriVR2, where physiological stress responses will be measured and collected.

Due to the adaptions of the internal project management process regarding the need of more agile and more end user-oriented implementation (see D1.1), we set up so-called EndUser FeedbackWeeks. Partly held together with HFW studies (to be resource-friendly) or executed separately (due to the implementation status or release plan) these feedback cycles offer the opportunity for LEAs to try out the system and to give direct feedback from their point of view (trainer and trainee view). This feedback is again incorporated as requirements into the product backlog and is taken into account in the next release to be implemented in the VR software. All results directly feed into WP5 (the VR solution integration). Six End User Feedback Weeks have been added to the schedule.

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3 Individual study Descriptions

The following information and overviews describe the individual studies (from table 1) and explain the objectives as well as the connections to other deliverables.

3.1 User_Req

User_req	User requirements analysis
Date(s)	08-10, 2019
Main WP's	WP2
Status	completed
Involved Partners	KUL, USECON, All LEAs
Involved LEAs	All LEAs
Location(s)	At all six LEAs premises
Brief description of content	Extensive collection of data from 60 end users (police officers and police trainers) across all six SHOTPROS LEA partners with regards to their requirements, needs and constraints concerning DMA-SR training (in VR), and collection of information on HF influencing their DMA-SR. Data was collected via 6 end user workshops (one organised by each SHOTPROS LEA partner) and expert interviews.
Relation to SHOTPROS objectives / technical system development / training development	The findings from this study feed into almost all other WPs and support all SHOTPROS objectives • WP3: Supported the creation of the HF DMA-SR model (D3.2) and will also help shape the DMA-SR training framework and curriculum (D3.3) • WP4: Assisted in the selection of stress and immersion creating cues (D4.1), insights from the requirements will help shape the presentation of real-time measurement of

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	training progress (D4.5). Build the base for the technical requirements in D4.6 and provided the basis for the selection of stressors included in the studies related to the Risk Assessment Toolkit (D4.7) • WP5: Technical requirements identified in these workshops build the base for the scenarios and the VR solution and are represented in the product backlog (for D5.1, D5.2 and D5.3) • WP6: It provides a selection of HF identified by end users that can be further empirically tested on their ability to induce stress in D6.2 and D6.3. Additionally, it sets the base for all EndUser FeedbackWeeks. • WP7: Finalising the basic outcomes will be influenced by the end user requirements defined in theses workshops • WP8: Dissemination will be based on these and further end user requirements gathered during the project. Findings from this study also shaped the DEC-TREE study
Key Impacts on other SHOTPROS activities	This study contributes to all SHOTPROS objectives and feeds into the WPs 3- 8. Main outcomes of the study are: • List of factors/stressors identified by LEA practitioners as influencing their DMA-SR (feeds obj. 1, impact on WP3, 4, 5 and 6) • Overview of possible training scenarios in VR (feeds obj. 2 and 3, impact on WP4, 5 and 6) • List of VR requirements (feeds into obj. 2, 3 and 4, impact on WP5) • Stakeholder map (feeds into obj. 5, impact on WP8)

Table 2: Study Description - User_req

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3.2 TrainPrac

TrainPrac	Analytics and Validation of Current Training Practices of European LEAs
Date(s)	12.2019 - 03.2020
Main WP's	WP3, WP5
Status	Completed
Involved Partners	VUA, all LEAs
Involved LEAs	All LEAs
Location(s)	At all six LEAs premises
Brief description of content	Initial desk research included a compilation of current training practices of European LEAs, analytics of good training practices and a training catalogue of practices in various training areas. The subsequent site visits with in total 24 participating interviewees validate the information obtained during the desk research and include observational data of training practices and interviews with police instructor.
Relation to SHOTPROS objectives / technical system development / training development	The aim of the Training Practices Study was twofold and contributes to the SHOTPROS objectives in the following ways: 1) The desk research was conducted to receive an overview of current training and assessment practices of European LEAs and thus, built the foundation to identify areas in which VR training might enhance current training methods. The results of the desk research can be found in D3.1. 2) The site visits at the location of the LEAs validated the results of the desk research and provided an overview of training components that were employed across all LEAs. Additionally,

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	interviews with instructors and other LEA personnel with conceptual tasks for training development provided insights into the possibilities of VR training in combination with existing training curricula. The results of the site visits are included in D3.3. Combined results will be further discussed in a scientific publication (see publication plan).
Key Impacts on other SHOTPROS activities	This study contributes to obj. 1, 3, and 4 and feeds into the WPs 5, 6 and 7. Main preliminary results are: • Cross-cultural training objectives and components of SHOTPROS LEAs • Inventory of training- and assessment methods commonly employed in training for decision-making • Overview of European training curricula on the basis of paper-reality and training observation

Table 3: Study Description - TrainPrac

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3.3 Case Study

Case Study	Police Officer's Psychophysiological Stress Reactivity on Duty
Date(s)	09.2019-10.2019
Main WP's	WP4
Status	Completed
Involved Partners	UHEI, VUA, BP
Involved LEAs	BP
Location(s)	Berlin, GER
Brief description of content	Case study on one police officer's psychophysiological stress reactivity on duty: For three weeks, a police officer provided data on his current stress levels, mood and four saliva samples a day.
Relation to SHOTPROS objectives / technical system development / training development	The case study validates components of the HF-DMA-Conceptual Model (D3.2; contributing to objective 1), thereby informing about psychobiological stress reactivity that can be expected from police officers in real-life high-stress situations (D4.3). The study addressed unexpected findings of hyperresponsivity to supposing stress-inducing training scenarios (e.g., Giessing et al., 2019; Strahler & Ziegert, 2015). Since the stress-inducing effects of cues will be tested in later HF studies, it is important to know police officers' typical real-life stress reactivity. The study results can be used as a comparison of typical stress reactivity in real-life police service to stress reactivity in scenario-based police training. The results are reported in D4.3 and in a scientific publication. (see DOI: 10.1016/j.psyneuen.2020.104865).

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Key Impacts on other SHOTPROS activities	This study contributes to objective 1, 2 and 3. • Validation of factors from the DMA model as being highly relevant for psychobiological stress reactivity that can be expected from police officers in real-life high-stress situations. • Knowledge about officers' psychobiological stress reactivity on duty allows valid interpretation of psychobiological stress responses measured in HF studies (in WP6) and for the real-time measurement of training progress in the dashboard (D4.5 and D5.4).

Table 4: Study Description - Case Study

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3.4 Paintball Study

Paintball study	Performance under Physical and Psychological Stress
Date(s)	11.2019 - 12.2019
Main WP's	WP6
Status	Completed
Involved Partners	UHEI, AIT
Involved LEAs	-
Location(s)	Heidelberg, GER
Brief description of content	16 paintball players underwent standardized game situations under low or high psychological stress (being shot at). Half of the participants performed a wingate test before (high physical stress). Data on performance, anxiety and heart rate variability was gathered. Additionally, the feasibility of eye tracking was tested.
Relation to SHOTPROS objectives / technical system development / training development	The paintball study validates human factors of the DMA-Conceptual Model (D3.2; contributing to objective 1), which were identified in the requirement analysis (i.e., threat to physical integrity and physical strain; D2.2). Additionally, the study explored the feasibility of eye tracking as a measure for visual attention in dynamic shooting situations.
Key Impacts on other SHOTPROS activities	The validation of influencing factors with respect to the DMA conceptual model contributes to objective 1.

Table 5: Study Description - Paintball study

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3.5 EnschVR

EnschVR	Comparison between reality-based scenario training and VR scenario training
Date(s)	01.2020 - 02.2020
Main WP's	WP3
Status	Completed
Involved Partners	VUA, RL, NPN, LAFP NRW
Involved LEAs	NPN, LAFP NRW
Location(s)	Enschede, NL
Brief description of content	During the 5-week long training days of the protection detail of the Dutch Police, VUA gathered data on self-perception of mental effort and anxiety, and physiological measures of 309 police officers to compare the experience of training in VR versus performing training scenarios in reality. Data on VR experience (sense of presence) were gathered as well.
Relation to SHOTPROS objectives / technical system development / training development	The aim of the Enschede study was to shed light onto the quality of the experience of police officers during VR training scenarios with the actual SHOTPROS VR system. These results provided our technical partner with first-hand experiences of police officers training with the VR system and to identify to improve the VR system for DMA training and police requirements. In addition, the VR training experience was compared to reality-based training scenarios to investigate how intense and how realistic the stress and anxiety that police officers experience in VR and real life were.

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	The findings of the study will be incorporated in D3.3 (European Police Training Framework and Curriculum) as input for the training concepts and thus provide an indication of the intensity level of DMA training under stress. The results will be further discussed in a scientific publication (see publication plan).
Key Impacts on other SHOTPROS activities	This study contributes to objectives 1, 3 and 4 and feeds into the other WPs, 5, 6 and 7. Main preliminary results are: • Police officers experienced fairly high levels of engagement and spatial presence when training with the VR system • Higher levels of sense of presence in VR increased the level of perceived stress and mental effort • Insights into physiological responses that VR training can elicit compared to reality-based training

Table 6: Study Description - EnschVR

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3.6 DEC-TREE

DEC-TREE	Development of operational VR scenario (1st phase) for DMA-SR training
Date(s)	01.2020-05.2020
Main WP's	WP2
Status	Completed
Involved Partners	KUL, USECON, all LEAs
Involved LEAs	All LEAs
Location(s)	-
Brief description of content	Decision trees were completed by SHOTPROS LEA partners to select a scenario topic for the first SHOTPROS scenario (domestic violence). The focus was on describing the context of the scenario and the identification of several 'events' that required decision points (and DMA) in the scenario.
Relation to SHOTPROS objectives / technical system development / training development	In this study, the goal was to gather descriptions about a specific scenario (selected together with the LEA partners) concerning the situation (context, actors, and environment) and the evolution in the scenario, with specific attention to the various decision-points where LEA officers will have to perform DMA-SR. The operational scenario developed in this study provides the basis for the further development of the training scenario(s) in WP5, its use for the HF studies in WP6 and potentially in the field trials in WP7.
Key Impacts on other SHOTPROS activities	This study contributes to objectives 2 and 3 and feeds into the VR development (WP5), other HF studies (WP6) and regarding the general input also into the field trials (WP7).

Table 7: Study Description - DEC-TREE

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3.7 RottVR

RottVR	The impact of type of instruction and level of experience on learning and VR training experience
Date(s)	05.2020 - 06.2020
Main WP's	WP3
Status	Completed
Involved Partners	VUA, AIT, NPN
Involved LEAs	NPN
Location(s)	Rotterdam, NL
Brief description of content	To investigate the effectiveness of VR as an at-home-training tool (during the COVID-19 pandemic), VUA assessed the impact of closed vs. open training instructions on the learning experience and self-efficacy of 45 students of the Dutch police academy with different levels of experience. 12 police instructors' experiences with the DangerZone VR training system have been assessed via questionnaires and interviews.
Relation to SHOTPROS objectives / technical system development / training development	The aim of the Rotterdam study was to identify VR training concepts that are relevant inputs for the European Police Training Framework and Curriculum (D3.3 and object 3). As part of the experiment with the Dutch Police academy, we tested police students with and without prior practical experience and provided them with closed and open training instructions. To investigate whether the level of experience and type of training instruction had an impact on the learning experience and engagement with VR, we distributed the single-user VR training system DangerZone to the participants for 2.5 days.

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	The findings of the study will be incorporated in D3.3 (European Police Training Framework and Curriculum) as the input for the training concepts and as such provide an indication of the level of experience and type of training instruction that is needed for future VR training. Results will be also discussed in a scientific publication (see publication plan)
Key Impacts on other SHOTPROS activities	This study contributes to objectives 1, 3 and 4 and feeds into the WPs 5, 6 and 7. Main preliminary results are: • Level of prior professional experience of police students contributes to the learning experience that students have with a VR training system • Providing closed training instructions (i.e. specific training guidelines) for students with prior professional experience increased the learning experience and engagement with VR as a training tool • Police instructors rated a single-user VR training system most useful for law and regulation training as well as tactical training

Table 8: Study Description - RottVR

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3.8 Field Exercise

Field exercise	Assessment of physiological stress responses during field exercise at Campus Vesta
Date(s)	15.-16.05.2020 cancelled
Main WP's	WP4
Status	**cancelled due to COVID19** Study objectives and content are integrated into the HFW1-3 and EndUser FeedbackWeeks 1-6.
Involved Partners	UHEI, VUA, AIT, VESTA
Involved LEAs	(potentially) all LEAs + external LEAs and other first responders
Location(s)	Campus VESTA
Brief description of content	During the annual field exercise at Campus Vesta, it was planned to collect data on psychological and physiological stress responses of the participating police officers.

Table 9: Study Description - Field exercise

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3.9 SHOT-COVID

SHOTCOVID	Police officers' work demands, stressors and coping strategies during COVID19 crisis
Date(s)	27.03.2020 – 05.06.2020
Main WP's	WP3, WP4
Status	Completed
Involved Partners	UHEI, AIT, VUA, KUL, USE, BP, NPN
Involved LEAs	BP, NPN network members: Austrian Police, Spain Police, Police Mannheim
Location(s)	Online
Brief description of content	Police officers' work demands, stressors and coping strategies during the COVID-19 pandemic were assessed in an online survey. The survey was conducted with 6 LEAs in five European countries at four measurement points between March and June 2020. Overall, 2.567 officers participated in the study.
Relation to SHOTPROS objectives / technical system development / training development	The SHOTCOVID study aimed to investigate two research areas that contribute to two SHOTPROS objectives. 1) As a real-life incident, the COVID-19 pandemic was considered as a promising opportunity to validate several human factors (HF) related to a stress response (Conceptual Model in D3.2). Specifically, the influence of sex, work experience, stress appraisal, emotion regulation strategies, and training on stress was tested by multi-level analyses (contributing to objective 1). • Personal factors: stress appraisal, emotion regulation strategies • Organisational factors: training, internal communication

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	• Contextual factors: risk of infection as threat to physical integrity • Societal factors: media communication, perception of police 2) The SHOTCOVID study further contributes to the development of a training curriculum (obj. 4) and of a European VR police network (obj. 5).
Key Impacts on other SHOTPROS activities	Knowledge of stressors in pandemic situation (WP4) Training necessities for volatile legal regulations novel approaches towards law and regulation training needed (WP3) Scientific Dissemination (see DOI: 10.1016/j.jcrimjus.2020.101756)

Table 10: Study Description - SHOT-COVID

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3.10 ZueriVR

ZueriVR	The effect of different feedback options and the addition of a pain stimulus on the (learning) experience of Swiss police officers in VR training
Date(s)	06.2020 - 08.2020
Main WP's	WP3, WP4
Status	Completed
Involved Partners	VUA, AIT, BP
Involved LEAs	BP, City Police Zürich
Location(s)	Zurich, Switzerland
Brief description of content	During the training days of the City Police Zürich, we gathered data on the effect of the various VR feedback options and the addition of a pain stimulus to VR on the learning experience of 654 police officers. HRV and movement data and data specific to the experience with a technological training modality (sense of presence, quality of experience, acceptance of technology) are compared across VR training and VirTra training.
Relation to SHOTPROS objectives / technical system development / training development	The aim of the Zurich study was to identify various didactical tools that can enhance VR training and thus provide relevant input for the European Police Training Framework and Curriculum (D3.3 and Obj. 3). To accomplish this aim, we have tested Swiss police officers with and without the addition of a pain stimulus during VR training. Further, we provided police officers with different feedback features during their AAR of the VR training to identify features that are most relevant for the quality of learning of police officers. The analysis revealed that police officers who trained with a pain stimulus had higher levels of perceived stress and mental effort

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	and rated their intention to use VR for future trainings higher. Based on qualitative findings of interviews with police instructors, the after-action review was rated as one of the most advantageous features of VR. The findings of the study will be incorporated in D3.3 as the input for the training concepts and feed directly into the product backlog and thus into WP5, the VR solution Results will be discussed in a scientific publication (see publication plan).
Key Impacts on other SHOTPROS activities	This study contributes to objectives 1, 3 and 5 and feeds into the other WPs, 5, 6 and 7. Main preliminary results are: • VR training was more immersive and elicited higher levels of sense of presence than a 2D-based training technology such as the VirTra. • Adding a pain stimulus to VR training increased the level of perceived stress and mental effort • Insights into the impact of VR after-action review feedback features for the quality of learning of police officers

Table 11: Study Description - ZüriVR

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3.11 BerlinStress

BerlinStress	Initial Stressors Assessment
Date(s)	28.09. - 02.10.2020 cancelled
Main WP's	WP6, WP4
Status	**Cancelled due to COVID19** - study content was integrated in HFW2
Involved Partners	AIT, UHEI, BP
Involved LEAs	BP
Location(s)	Berlin, GER
Brief description of content	Empirical study for assessing the stress inducing capabilities of the initial stressors described in D4.1. The study was planned to take place at the premises of BP and utilise BP personnel as test subjects.
Relation to SHOTPROS objectives / technical system development / training development	The aim of this study is to empirically proof the ability of the stressors as described in D4.1 to induce stress responses and create respective immersion for trainees in VR environments in order to identify well performing stressors for utilisation in follow-up studies such as NRWStress.
Key Impacts on other SHOTPROS activities	This study will contribute towards objectives 2, 3 and 4. Furthermore, it will feed mainly into the work packages 4 and 5 and through the scenarios defined for the field trial in T5.3 it will feed into WP7.

Table 12: Study Description - BerlinStress

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3.12 NRWStress

NRWStress	Assessment of stressors in training scenarios
Date(s)	Q4/2020 cancelled
Main WP's	WP4, WP6
Status	**Cancelled due to COVID19** - study content was integrated in HFW3
Involved Partners	AIT, UHEI, LAFP NRW
Involved LEAs	LAFP NRW
Location(s)	Selm, GER
Brief description of content	Based on the results from BerlinStress, stressors will be integrated into ecologically valid training scenarios and tested for their stress inducing capabilities in these scenarios. The aim is to identify potential masking or cascading effects of stressors due to other activities in the scenario. The study is planned to take place at the premises of LAFP NRW and utilise NRW personnel as test subjects. Identically to the setup in BerlinStress induced stress will be assessed through subjective reports (TLX, analog-visual scales) and physiological measures (HRV, saliva samples for alpha-amylase and cortisol)
Relation to SHOTPROS objectives / technical system development / training development	The aim of this study is to identify the same stress inducing capabilities can be assessed if these stressors are integrated into more comprehensive police training scenarios.
Key Impacts on other SHOTPROS activities	This study will contribute towards objectives 2, 3 and 4. Furthermore, it will feed mainly into the work packages 4 and 5 and through the scenarios defined for the field trial in T5.3 it will feed into WP7.

Table 13: Study Description - NRWStress

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3.13 RAT_study1&2

RAT_study1&2	Development of the Risk Assessment Tool (RAT)
Date(s)	11.2020 - 03.2021
Main WP's	WP4, WP6
Status	Completed
Involved Partners	KUL, ADCC IBZ, all partners for distribution of the survey
Involved LEAs	all partner LEAs + external network LEAs
Location(s)	Online
Brief description of content	Two surveys among overall 550 police officers and trainers to explore stress levels associated with the (contextual and organisational) stress factors identified in WP2. Findings from the surveys will support the development of the Risk Assessment Tool (RAT – D4.7) and aid in the selection of factors to achieve training with low, medium or high complexity/stressfulness for the scenario selection in WP5. Based on results from the first study, a follow up study was distributed based on the first results to further assess stressors to be included in the Risk Assessment Tool (RAT - D4.7).
Relation to SHOTPROS objectives / technical system development / training development	The aim of the RAT studies is to identify categories (or levels) of stressors depending on how stressful they are perceived by LEA practitioners. The aim of this study is thus to add a certain hierarchy to the stressors identified in the User_Req. This categorisation can then be further empirically validated in the HF studies in WP6. The objective is to development a Risk Assessment Tool (RAT) that can be used by police trainers to design (VR) training scenarios of different stress or complexity levels, as is recommended by the DMA-SR model.

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	The RAT_study1 (hierarchisation and categorisation of individual stressors) will be the direct input for the RAT_study2 (combination and prioritisation) and consequently be the base of the RAT (D4.7) and used in the scenario selection of the SHOTPROS VR solution. The tool will be reported in D6.3, D6.4 and D1.7.
Key Impacts on other SHOTPROS activities	This study will contribute to SHOTPROS objective 1 (an evaluated and validated DMA-SR model) as it supports the categorisation of HF that influence DMA-SR, to objective 2 (VR environment) as it provides information on which HF to include in the environment, to objective 3 (training framework and curriculum) as it identifies stressors to be trained, to objective 4 (guidelines for VR training) as it provides information on elements to include in VR training and to objective 5 as it extends the contacts for the European VR police network.

Table 14: Study Description - RAT_study1&2

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3.14 EU Citizen Study

EU Citizen Study	
Date(s)	01.2021 – 02.2021
Main WP's	WP2
Status	Completed
Involved Partners	KUL, VUA, AIT, UHEI, USE
Involved LEAs	All LEAs
Location(s)	online
Brief description of content	This study sets out to assess differences in perceptions, experiences, trust, expected behaviour between citizens and police officers. 640 EU citizens were surveyed for this study.
Relation to SHOTPROS objectives / technical system development / training development	When training police officers in their DMA behaviour, it is beneficial to also consider the needs and expectations of EU citizens, to strengthen the perception of citizens that the EU is a region of freedom, justice, and security. Therefore, a large-scale online survey has been conducted with citizens of several countries represented in the SHOTPROS consortium (i.e., Austria, Belgium, the Netherlands, Germany and Romania). This survey will complement the relevant work of the Eurobarometer and will ask EU citizens about: • their perceptions of safety and security and how the police contribute to these perceptions • their satisfaction in and attributed legitimacy to the police • their assessment of the quality of their own experiences with the police and what might be influencing factors • their personal experiences with police use of force

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	• the impact of current societal trends (e.g., COVID-19, police misconduct in media) on their perceptions of police • their assessment of decision-making and acting choices of police officers in specific police-citizen encounters in terms of legitimacy, appropriateness, proportionality and danger posed to officer and citizen
Key Impacts on other SHOTPROS activities	The results of this study will contribute to objective 3 with respect to preferred and / or expected DMA behaviour of police officers and respective training approaches as well as towards objective 5 informing policy makers regarding guidelines for preferred and / or expected DMA behaviour.

Table 15: Study Description – EU citizen study

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3.15 EUCitizenPerception

EUCitizenPerception	Survey on perceptions of EU citizens concerning stress and training in police
Date(s)	02.2021 – 03.2021
Main WP's	WP2
Status	Completed
Involved Partners	KUL, VUA, AIT, UHEI, USE
Involved LEAs	-
Location(s)	online
Brief description of content	This study focuses on the opinions of EU citizens concerning the experience of stress by police officers, the importance of police training and the potential added value of VR for police training. 750 EU citizens were surveyed for this study.
Relation to SHOTPROS objectives / technical system development / training development	This survey complements the EU Citizen Survey. Whereas the EU Citizen Survey focuses more on the DMA, this survey zooms in on the stress related aspect of police work. A large-scale online survey has been distributed amongst EU citizens in Belgium, the Netherlands, Romania, Germany, and Austria. • To what degree police officers encounter stress in their daily work • What possible situations to be most stressful for police officers • Their opinions concerning the way police officers (should) deal with feelings of stress • Their opinions concerning the utility of police training in general and police training in VR specifically, for training good police officers
Key Impacts on other SHOTPROS activities	The results of this study will contribute to objective 3 with respect to preferred and/or expected DMA behaviour of police officers and respective training approaches as well as towards objective 5, informing policy makers regarding guidelines for preferred and/or expected DMA behaviour.

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Table 16: Study Description – EUCitizenPerception

3.16 End User FeedbackWeek1

EndUser FeedbackWeek1	End user experience & feedback on the VR solution (at this time current development status)
Date(s)	10., 12., 26. and 30. March in 2021
Main WP's	WP5, WP6
Status	Completed
Involved Partners	AIT, RL, USE, all LEAs
Involved LEAs	all LEAs
Location(s)	online
Brief description of content	37 participants from all LEA organisations within the SHOTPROS consortium receive a demonstration of the current VR system and provide feedback as well as requirements on the system in general.
Relation to SHOTPROS objectives / technical system development / training development	Originally planned as an in-person user-centred design related study, aiming to perform end user (police trainers and officers) testing for (newly developed) system functionalities in relation to initial requirements from WP2. Due to travel restrictions caused by COVID-19, the study was conducted in an online setting. In the context of UCD and agile development feedback this study is targeted towards collecting end user feedback that will be further used as user requirements for technical development in all tasks of WP5, hence contributing to objective 2. Additionally, the end user feedback will be integrated into the guidelines for VR training with respect to practical handling of such

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	training systems and related staff efforts thereby contributing to objective 4 and T7.4 as well as in T8.4.
Key Impacts on other SHOTPROS activities	This study will provide end user input for: • WP5 (all tasks): the development process on the scenario builder, the trainer control of the training scenarios as well as of multiple characters through a role player and trainer control and interaction of the AAR (impact on D4.5, D4.6. D5.2, D5.4) • WP8 and WP7 insights on necessary skills for future VR instructors in police training, estimation of staff efforts necessary for the operation of such a VR training system

Table 17: Study Description – EndUser FeedbackWeek1

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3.17 End User FeedbackWeek2

End User FeedbackWeek2	End user experience & feedback on the VR solution (at this time current development status)
Date(s)	05. – 09.07.2021
Main WP's	WP5, WP6
Status	Completed
Involved Partners	AIT, RL, USE, all LEAs
Involved LEAs	all LEAs & advisors and network members
Location(s)	Berlin, Germany - executed together with HFW2
Brief description of content	47 partners, invited network members and advisors (focus trainers, but also regular police officers) evaluated and tested different VR scenarios and gave feedback on user experience, training options and performance measurements according to current development status Special attention was on the trainer interface regarding scenario definition and development, scenario control and capabilities of the after-action review.
Relation to SHOTPROS objectives / technical system development / training development	The subjective experience of trainees and trainers will be collected through questionnaires and semi-structured interviews. In the context of UCD and agile development feedback this study is targeted towards collecting end user feedback that will be further used as user requirements for technical development in all tasks of WP5, hence contributing to objective 2. Additionally, the end user feedback will be integrated into the guidelines for VR training with respect to practical handling of such

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	training systems and related staff efforts thereby contributing to objective 4 and T7.4 as well as T8.4. In this study, attention is put towards scenario editing, control and trainer features for the after-action-review (AAR). For scenario editing the variation capabilities of existing scenarios as well as the creation of new scenarios (new building topologies, other characters) will be evaluated together with participating LEA trainers. Regarding trainer control, the workflow throughout a training session will be evaluated with respect to interaction complexity, mental effort as well as software skills required. In addition, the control ability of (multiple) scenario characters through a role-playing trainer will be assessed and feedback acquired. Furthermore, trainer options and trainer control of the AAR will be evaluated with the LEA partners
Key Impacts on other SHOTPROS activities	This study will provide end user input for: • WP5 (all tasks): the development process on the scenario builder, the trainer control of the training scenarios as well as of multiple characters through a role player and trainer control and interaction of the AAR (impact on D4.5, D4.6. D5.2, D5.4) • WP8 (T8.4), WP7 (T7.4) insights on necessary skills for future VR instructors in police training, estimation of staff efforts necessary for the operation of such a VR training system

Table 18: Study Description – EndUser FeedbackWeek2

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3.18 End User FeedbackWeek3

EndUser FeedbackWeek3	End user experience & feedback on the VR solution (at this time current development status)
Date(s)	09. – 13.08.2021
Main WP's	WP5, WP6
Status	Planned
Involved Partners	AIT, RL, USE, all LEAs
Involved LEAs	all LEAs
Location(s)	Selm, NRW, Germany - executed together with HFW3
Brief description of content	Partners and invited network members (focus trainers, but also regular police officers) evaluate and test different VR scenarios and gave feedback on user experience, training options and performance measurements according to current development status Special attention will be on the in-action and after-action monitoring and performance-based measurements.
Relation to SHOTPROS objectives / technical system development / training development	The subjective experience of trainees and trainers will be collected through questionnaires and semi-structured interviews In the context of UCD and agile development feedback this study is targeted towards collecting end user feedback that will be further used as user requirements for technical development in all tasks of WP5, hence contributing to objective 2. Additionally, the end user feedback will be integrated into the guidelines for VR training with respect to practical handling of such training systems and related staff efforts thereby contributing to objective 4 and T7.4 as well as in T8.4.

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	In this study, attention is put towards scenario control and trainer features for the in action and after-action-review. Additionally, the performance-based measurement of police training in a VR context will be evaluated. Regarding trainer features, the workflow throughout a training session will be evaluated with respect to interaction complexity, mental effort as well as software skills required.
Key Impacts on other SHOTPROS activities	This study will provide end user input for: • WP5 (all tasks): the development process on the scenario builder, the trainer control of the training scenarios as well as of multiple characters through a role player and trainer control and interaction of the AAR (impact on D4.5, D4.6. D5.2, D5.4) • WP8 (T8.4), WP7 (T7.4) insights on necessary skills for future VR instructors in police training, estimation of staff efforts necessary for the operation of such a VR training system

Table 19: Study Description – EndUser FeedbackWeek3

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3.19 End User FeedbackWeek4

EndUser FeedbackWeek4	End user experience & feedback on the VR solution (at this time current development status) – focus scenario 2
Date(s)	Nov 2021
Main WP's	WP5, WP7
Status	planned
Involved Partners	AIT, RL, USE, all LEAs
Involved LEAs	all LEAs
Location(s)	Online or in person – attached to the Nov Consortium Meeting
Brief description of content	Workshop combined with the November consortium meeting – focus on evaluating the scenario 2 and the planned new features from the actual release
Relation to SHOTPROS objectives / technical system development / training development	The subjective experience of trainees and trainers will be collected through semi-structured interviews and a workshop setting. In the context of UCD and agile development feedback this study is targeted towards collecting future end user feedback that will be further used for technical development in all tasks of WP5, hence contributing to objective 2. Additionally, the end user feedback will be integrated into the guidelines for VR training with respect to practical handling of such training systems and related staff efforts thereby contributing to objective 4 and T7.4 as well as in T8.4. In this study, attention is put towards scenario2 finalisation as this scenario serves as a base for the field trials in WP7. Large-scale and outdoor options as well as terror, like behaviour of the characters are features that were required by LEAs in different pre-executed workshops. Now the scenario description, first graphical animations and especially the NPC behaviour need to be defined

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	together for the scenarios that will be used in the field trials. General software feature requirements will also be detected by this method and incorporated into the product backlog.
Key Impacts on other SHOTPROS activities	This study will provide end user input for: • WP5 (all tasks): the development process on the scenario builder, the trainer control of the training scenarios as well as of multiple characters through a role player and trainer control and interaction of the AAR (impact on D5.2, D5.4) • WP8 (T8.4), WP7 (T7.4) insights on necessary skills for future VR instructors in police training, estimation of staff efforts necessary for the operation of such a VR training system.

Table 20: Study Description – EndUser FeedbackWeek4

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3.20 End User FeedbackWeek5

EndUser FeedbackWeek5	End user experience & feedback on the VR solution (at this time current development status) – focus gender
Date(s)	Tbd – Q1 2022
Main WP's	WP5, WP7
Status	Planned
Involved Partners	AIT, RL, USE, all LEAs
Involved LEAs	all LEAs
Location(s)	In person, if possible
Brief description of content	Workshop on the identification of gender specific requirements in VR police trainings
Relation to SHOTPROS objectives / technical system development / training development	Female trainers, recruited from partners, network members and advisors evaluate and test the current VR solution, give subjective feedback, and identify gender specific requirements based on their personal experience in a workshop tries to identify. Possible topics: ergonomics, behaviour of characters in the VR, gear and resources (tactical belt etc.), adapted training objectives, etc. In the context of UCD and agile development feedback this study is targeted towards collecting end user feedback in the context of gender that will be further used for technical development in all tasks of WP5, hence contributing to objective 2. Additionally, the end user feedback will be integrated into the guidelines for VR training with respect to practical handling of such training systems and related staff efforts thereby contributing to objective 4 and T7.4 as well as in T8.4.

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Key Impacts on other SHOTPROS activities	This study will provide end user input for: • WP5 (all tasks): the development process on the scenario builder, the trainer control of the training scenarios as well as of multiple characters through a role player and trainer control and interaction of the AAR. • WP8 (T8.4), WP7 (T7.4) insights on necessary skills for future VR instructors in police training, estimation of staff efforts necessary for the operation of such a VR training system

Table 21: Study Description – EndUser FeedbackWeek5

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3.21 End User FeedbackWeek6

EndSuer FeedbackWeek6	End user experience & feedback on the VR solution (at this time current development status)
Date(s)	Tbd – Q2 2022
Main WP's	WP5, WP7
Status	Planned
Involved Partners	AIT, RL, USE, all LEAs
Involved LEAs	all LEAs
Location(s)	Online
Brief description of content	Executed together with one of the first field trials from WP7 at the beginning of 2022; partners, invited network members and advisors evaluate the final VR scenario and feedback sessions for the training curriculum.
Relation to SHOTPROS objectives / technical system development / training development	The subjective experience of trainees and trainers will be collected through questionnaires and semi-structured interviews In the context of UCD and agile development feedback this study is targeted towards collecting end user feedback that will be further used for finalising WP5, WP7 and WP8. Focus is, besides software experience also future sales definitions – how does a product like a VR police training need to be defined so that it can be implemented in a LEA organisation.
Key Impacts on other SHOTPROS activities	This study will provide end user input for: • WP5, WP7, WP8

Table 22: Study Description – EndUser FeedbackWeek6

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3.22 HFW1: TrainCompar

HFWeek1: TrainCompar	Direct comparison of realistic training and VR training
Date(s)	07. – 11.06.2021
Main WP's	WP3, WP4
Status	Study completed, evaluation/reporting ongoing
Involved Partners	VUA (Lead), AIT, RL
Involved LEAs	NPN
Location(s)	Amsterdam, NL
Brief description of content	The aim of *HFW1: TrainCompar* is to determine the didactical aspects of training with VR and to identify advantages and disadvantages of VR compared to realistic "live" training. This is done by comparing the training experience of trainees and instructors between the two conditions *("live" training and VR training)* in terms of *training elements*, i.e. didactical and logistical aspects (e.g. how much training can be conducted) as well as user experience (UX), specifically on VR-specific elements. **Set-up:** • Teams of 4 participate in 1.5h 'live' and 1.5h VR training • 48 participants in total (45 students, 3 trainers) **Measurements:** For physiological stress, we will measure HRV (i.e., RMSSD; HF absolute power) and breath rate via Zephyr biosensors and/or the Garmin Smart Watch. In terms of didactic variables, we will collect how much actual training is done in a specific time, how many repetitions are

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	executed, how many variations (of a scenario) are executed, and how much and what type of feedback is provided. To assess the user experience, observations will be conducted (e.g. what features of the AAR are mainly used, how do instructors prepare and set-up the training). Furthermore, the subjective experience of trainees and trainers will be collected through questionnaires and semi-structured interviews. **Questionnaires to be used:** • training experience (questionnaire - do they think they can improve performance with this training, etc.). • Visual analogue scales (stress thermometer 1-100, rating of mental effort 1-150) • ITC SOPI for VR experience • QoLe (Quality of Learning) • Cost and Effort (questionnaire asking to track preparation time (asking for cost, effort, etc. for setting up both trainings)
Relation to SHOTPROS objectives / technical system development / training development	The research question is based on questions of LEAs within the SHOTPROS project concerning the advantages of VR training compared to their regular training, particularly realistic live training.
Key Impacts on other SHOTPROS activities	This study will contribute towards all SHOTPROS objectives but obviously mainly the objective 3 (training framework & curriculum). Furthermore, it will feed into the WPs 3, 4, 6 and 7. It will contribute to the development of a European framework for training and assessment and thus the final version of D3.3, reveal additional requirements for WP4 and 5 and it will help shaping the final field trials (D7.1) and other final outcomes in WP7.

Table 23: Study Description – TrainCompar

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3.23HFW2: StressCueValidation

HFWeek2: StressCueValidation	Validation of VR Stress Cues for VR Police Training
Date(s)	05. – 09.07.2021
Main WP's	WP4, WP6
Status	Study completed, evaluation/reporting ongoing (Replacement of BerlinStress and NRWStress)
Involved Partners	AIT (Lead), UHEI, USE, RL, BP
Involved LEAs	BP
Location(s)	Berlin, GER
Brief description of content	Empirical study to assess the likelihood of the developed stress cues to induce stress in police officers and trainees with the VR research prototype from AIT. The study will comprise two parts: • stress cue validation (saliva sampling and biosensor data) • stress cue validation (biosensor data) The aim of the study is to empirically prove the likelihood of stress cues to induce stress responses and to identify stressors with a high probability of inducing stress. Furthermore, the objective is to identify potential interrelations between different stress cues and potential masking or additive and cascading effects of stress cues and confounding factors. **Number of participants:** 22 police officers and trainees **Measurements:** HRV (i.e., RMSSD; HF absolute power), breath rate, eye movement, cortisol concentration, alpha-amylase concentration and observations of experimenters

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	Procedure: Overall duration: 5 hours, comprising of 3 x 30 min tests for study 1a and 1 x 30 min for study 1b **Used software and tools:** iMotions, Kubios, Zephyr OmniSence, Matlab, R (refer to D6.2 for more details) **Used Questionnaires:** • Visual analogue scales: 1) Rating Scale of Mental Effort (RSME; Zijlstra, 1993); 2) State Anxiety: Anxiety Thermometer (Houtman & Bakker, 1989) • Short qualitative interviews on the effect of the stress cues on behaviour and experience (stress level) • Demographic data (e.g. age, gender, profession, prior experience with VR) and necessary health data • Perceived Stress Scale (PSS) (Cohen, S., Kamarck, T., and Mermelstein, R., 1983) • VR Induced Symptoms and Effects (VRISE) (Cobb et al., 1999) • State-Trait Anxiety Inventory (STAI), (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983)
Relation to SHOTPROS objectives / technical system development / training development	**Results from the study will be used for** • Defining requirements in D4.5 and D4.6 • Development in WP5 • Development of machine learning algorithms D6.3
Key Impacts on other SHOTPROS activities	This study will contribute towards objectives 2, 3, 4 and 5. Furthermore it will feed mainly into the WPs 4 and 5 and through the scenarios defined for the field trial in T5.3 it will feed into WP7.

Table 24: Study Description – StressCueValidation

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3.24 HFW3: RealTime Stress and Performance

HFWeek2	Real Time Stress and Performance
Date(s)	09. – 13.08.2021
Main WP's	WP6
Status	Planned (Replacement of BerlinStress and NRWStress)
Involved Partners	UHEI (Lead), AIT
Involved LEAs	Lead: LAFP NRW, all LEAs,
Location(s)	Selm, GER
Brief description of content	This study aims to test the usability of real-time assessment of stress and performance measures and to identify interrelations of psychophysiological stress responses and performance. This will be done by mapping a dose-response-relationship between stress and performance. Furthermore, we aim to identify (not directly observable) real-time performance measures that are linked to stress responses and patterns as „warning signal" for overstress. In addition, the recovery processes after the scenario (e.g. during the AAR) will be tracked as an indicator of resilience. To further the human-centred research approach in SHOTPROS, Quick co-creation workshops with experts (experienced police trainers) will be conducted based on real-time observations of the VR (training) experience. This will feed back into the current SHOTPROS VR system and procedure (training setup, AAR, etc.) and provide user-centred alternatives/changes in the process. **Requirements**

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	• 40 police officers: 4 per training session; 2 training sessions per day - 5 training days • 4 trainers for the study and for the co-creation workshop **Set-Up** • 4 trainees as a team in different amok scenarios with varying stress potential (low, medium, high) • For each trainee team: prospectively 1-2 trainers • For each scenario: 1 role player **Measures** • Subjective measures: Stress (VAS) after each scenario, difficulty of each scenario by trainees and trainers • Physiological measures: HR, HRV, etc.(with the Zephyr) • During the scenarios & During after-action review & In the recovery phase • Performance measures during VR training: visual field, position data, movement data. • Observation of user experience of the VR system (AIT) • Observation of trainers and analysis their needs (AIT)
Relation to SHOTPROS objectives / technical system development / training development	This study contributes to objectives 2, 3, 4 and 5 and feeds into WP 4, 5, 6 and 7. UCD and agile development feedback will be collected into WP5 as well as practical feedback on system operation that will be incorporated in WP7+8.
Key Impacts on other SHOTPROS activities	Results from the study will be used for • Evaluation of utilisation of physiological and performance measures as potential KPI for the integration in the trainer dashboard and the real-time training progress visualisation (D4.5 and 5.4) and the real-time training progress (D4.4) • Further requirements (D4.6)

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	The results from the additional co-creation workshop will feed into agile technical development (WP5). In addition, collected feedback on system handling and interaction for trainees and trainers will be fed back to VR development in WP5 and integrated into WP8 and thereby contributes to objective 2.

Table 25: Study Description – RealTime Stress and Performance

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3.25 ZueriVR2

ZueriVR2	Collection of physiological data and comparison analysis (from competitive VR system)
Date(s)	September 2021
Main WP's	WP6
Status	Planned
Involved Partners	AIT (Lead), UHEI, USE
Involved LEAs	External LEA Partner (Advisor: City Police Zurich/Swiss Police)
Location(s)	Zurich, Switzerland
Brief description of content	**Objectives** • Collection of physiological data during a real VR training with another VR system with appr. 150 police officers • Comparison of different hardware tools for collecting physiological data (Zephyr belt vs. Garmin smart watch) • Required features for real-time information visualisation and interactions during training and in the AAR, feedback on concept screens and mockups from a new perspective (as the involved LEAs are not part of the core team) • Analysis of another VR system (from the Refense AG) already on the market and comparison with the SHOTPROS VR solution. **Anticipated Results** • Usability and reliability in the use of Zephyr or Garmin in a real training application • The demands on the trainer during training monitoring

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	• Requirements on how to better support live monitoring and AAR • Competitor analysis (Refense system versus SHOTPROS) **Measures** • Physiological measures (such as HR, HRV, breathe frequency) • Observation data of the trainee behaviours • User experience and quality of experience questionnaires • Workshops and focus groups with the trainers
Relation to SHOTPROS objectives / technical system development / training development	The study contributes to objectives 2, 3 and 5. Results from the study will be used for • Evaluation of the stress hardware in a real training setting • Development of machine learning algorithms (D6.3) based on the collected raw data from the trainees • Trainer insights and inputs for the performance measurement of a training and the after actions review (D4.5 and D4.6)
Key Impacts on other SHOTPROS activities	• Additional raw data (biosensor data) for D6.3 • Comparative values of Zephyr and Garmin for measurement accuracies and usability in training use • Deduction of design guidelines for the user interface and features from trainers

Table 26: Study Description – ZüriVR2

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4 Contribution of HF studies towards SHOTPROS objectives

This chapter summarizes how the studies contribute to the five SHOTPROS objectives.

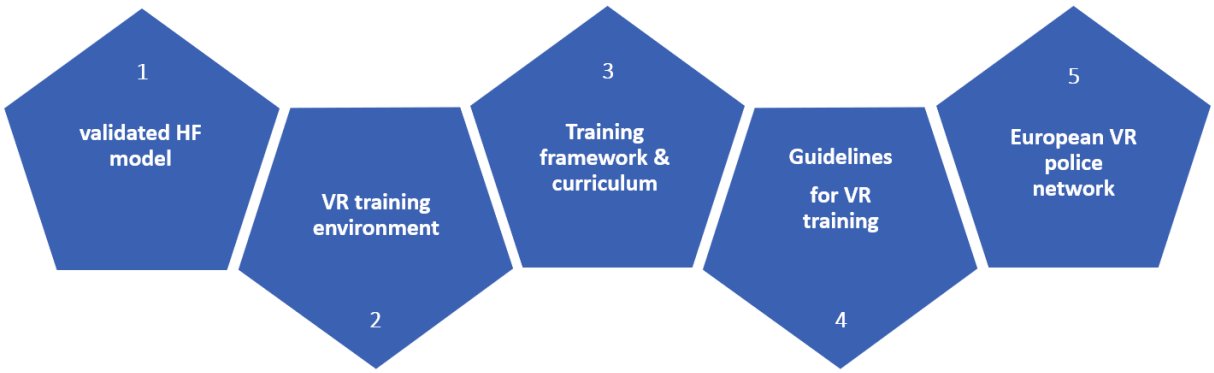

Figure 3: SHOTPROS objectives – overview

4.1 Overview on HF studies and the related objectives

	1 Validated HF model	2 VR training environment	3 Training framework & curriculum	4 Guidelines for VR training	5 European VR police network
User_Req	x	x	x	x	x
TrainPrac	x		x	x	
Case Study	x	x	x		
Paintball study	x				
EnschVR	x		x	x	
DEC-TREE		x	x		
RottVR	x		x	x	
SHOT-COVID	x			x	x
ZüriVR	x		x		x
RAT_study1&2	x	x	x	x	x
EUCitizenStudy			x		x

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EuCitizen Perception			**x**		**x**
EndUser FeedbackWeek 1		**x**	**x**	**x**	**x**
EndUser FeedbackWeek 2		**x**	**x**	**x**	**x**
EndUser FeedbackWeek 3		**x**	**x**	**x**	**x**
EndUser FeedbackWeek 4		**x**	**x**	**x**	**x**
EndUser FeedbackWeek 5		**x**	**x**	**x**	**x**
EndUser FeedbackWeek 6		**x**	**x**	**x**	**x**
HFW1: TrainCompar	**x**	**x**	**x**	**x**	**x**
HFW2: StressCues		**x**	**x**	**x**	**x**
HFW3: RealTime Stress		**x**	**x**	**x**	**x**
ZüriVR2		**x**		**x**	**x**

Table 27: Overview on HF studies and the related objectives

4.2 Objective 1: DMA-SR Model

Objective 1: Evaluated and validated Human Factors Model for Decision-Making and Acting under Stress and in High-Risk situations (DMA-SR Model)

Objective 1, to evaluate and to validate a Human Factors Model for DMA in high-risk situations, is fed by studies primarily conducted during the first half of the project as the model needed to be set up as the scientific base of SHOTPROS and consequently influenced the implementation of the future SHOTPROS VR solution and many other studies.

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User_req provides a list of factors and stressors that LEA practitioners (i.e., police officers, trainers, trainees, policy makers, etc.) identify as relevant for DMA training. TRainPrac delivers insights on current trainings at the LEAs to gain an overview on what is relevant and what is currently trained within police trainings. *CaseStudy* and *PaintballStudy* have validated factors from the DMA model as being highly relevant for psychobiological stress reactivity that can be expected from police officers in real-life high-stress situations. Results from *EnschVR* provide insights into relationships between stress and anxiety inducing factors that are utilized for the HF model. *RottVR* and ZueriVR results provide insights on the impact of police duty experience and type of training instruction on training engagement. *SHOTCOVID* delivered insights into human and contextual factors that contribute to increased stress levels in pandemic duty conditions. *ZüriVR* analysed the impact of the use of pain stimuli (system factor inducing stress and anxiety) on perceived stress and mental effort. Results from the *RAT_study1&2* further categorise the factors and stressors (and combination of factors/stressors) depending on the (subjective) level of stress/complexity attributed to them by LEA practitioners. Finally, *TrainCompar* contributes to objective 1 by gathering real training data (real life & VR training) for the validation of the DMA-SR model.

4.3 Objective 2: VR Training Environment

Objective 2: Virtual Reality (VR) Environment that allows to manipulate Human Factors in the Context of DMA-SR and observe related Behaviour

This objective is fed by many studies as the development of an VR environment is an objective that is based on an agile process (defined in D1.1). As a base User_req offers a set of functional and non-functional user-based requirements formulated by the LEAs concerning the VR training environment, from which a selection was made (in close collaboration with several partners and the LEAs) to be further developed. It also provided a list of possible factors/stressors that can be incorporated into the VR environment. *DEC_TREE* specified a first operational scenario for further development and scenario vignettes specifically aimed at training DMA-SR. The *RAT_studies1+2* will support the development of a Risk Assessment Tool that allows for the identification of a set or combination of factors/stressors to reach a specific level of complexity/stress in the VR environment. All these findings provide a key input for the functional requirements from an end user perspective for the first versions of the SHOTPROS VR system and formed the base that was used in other studies. But as the technological stream of SHOTPROS is based on an agile development process, the further development is an ongoing process and therefore is regularly influenced by study results and the feedback cycles with end users (all defined in D1.1).

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Following the SHOTPROS release plan (see D1.1) the *EndUser FeedbackWeeks* and the HFW1-3 serve as a central element for collecting iterative feedback from the end users and integrating it directly into the agile development process. In addition to gather new requirements for further development, the perceived quality and practical benefits of the VR system were also surveyed. This serves for the quality assurance of the developed VR-related features.

During *HFW2+3* and the *End User Feedback Weeks1-3,* the current development status was evaluated not only with the SHOTPROS LEAs but also with SHOTPROS advisors and network LEA partners in order to access another level of feedback (not only from the consortium view). External LEA partners who already have experience with VR systems available on the market (e.g. from Refense AG or the VRTS system) were also deliberately invited. In a first analysis, the collected feedback shows a very positive trend towards the SHOTPROS VR innovations, especially the possibility to train in a large area (up to 70x100 metres), the development of the tactical belt as a tangible device in the VR, and the possibilities of stress measurement in VR. In summary, it can be mentioned that the SHOTPROS VR solution is on the right track regarding LEA expectations and all findings and new approaches during upcoming studies and EndUser FeedbackWeeks will be applied in the planned field trials (WP7) and will pace into the further evaluation cycles. The actual evaluation results are reported in D6.3 but also serve as requirements in D4.6 and D4.5 and provide the agile core team with relevant insights for further development steps and planned releases.

4.4 Objective 3: Training Framework and Curriculum for DMA-SR

Objective 3: (European Police) Training Framework and Curriculum for DMA-SR

Objective 3, the actual framework and curriculum is supported by *User_req* by providing insight into factors and stressors that are considered relevant in training DMA-SR according to LEA practitioners.

TrainPrac provided insights on the current training situation among LEAS and enabled the base to think about VR training integration. *CaseStudy* delivered a detailed view on individual stress data. EnschVR contributes to objective 3 with results on the comparison between real world and VR based training and emerging stress levels. *DEC-TREE* additionally offers the first steps into describing possible scenario vignettes that support DMA-SR training.

RottVR supports with results on influence factors for engagement as well as results on optimized training instruction for VR training. Insights into the impact of VR after-action review feedback (AAR) features for the quality of learning of police officers acquired in ZüriVR contribute to objective 3 with respect to optimal design of the AR.

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The *RAT_study1&2* support the development of a Risk Assessment Tool (RAT) that can be incorporated in the Training Framework & Curriculum as a useful tool to design training curricula that fit the needs of the specific group of trainees and fit the goals of the specific training.

The *EUCitizenStudy* and *EUCitizenPerception* study report results on expected and/or desired DMA behaviour of European police officers and thereby provides target behaviour for DMA training tackled by objective 3.

The *HFW1-3* studies deliver insights from LEA trainings with the SHOTPROS VR system to be used for the implementation if a training curriculum. *StressCueValidation* will provide results on well working stress cues that should be incorporated in future VR trainings, thereby contributing to objective 3. *TrainCompar* provides useful insights on key didactical aspects of the framework like instruction, feedback, repetition and variation. *RealTime Stress and Performance* provides trainers the opportunity to co-create the training experience (e.g. in terms of didactic perspective), thus impacting the training curriculum developed in SHOTPROS. *EndUser FeedbackWeeks* serve as User insights on objective 3.

4.5 Objective 4: Guidelines for VR Training

Objective 4: Guidelines for VR Training (as a complement to theoretical and real-case practical training)

Including the voice of LEA's, who are the end users of VR training in the police context, is imperative to design useful and useable VR training. All studies therefore included LEA participation to achieve objective 4

User_req provides crucial insight into the user-based requirements, needs and constraints of LEA practitioners. *TainPrac* showed us the current training situation. EnschVR collected data on mental effort and anxiety as well as physiological measures to compare training in VR versus performing training scenarios in reality. This builts the base for upcoming studies and the guidelines (objective 4).

The results of the *SHOT-COVID* study together with the results from *RottVR* that showed that VR training on law and regulations is also well suited for VR training. The *RAT_study1&2* support the development of a Risk Assessment Tool that can act as an "entry tool" to VR training tailored to a certain objective or a certain trainee group.

HFW1-3 and the *EndUser FeedbackWeeks* collect end user experience with respect to stress measurement and visualisation, performance measurement during and after the training, the

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role of the trainer, the needs regarding visualisation and control of the training as well as setup, operational costs and staff efforts and thereby contributing valuable input for the VR guidelines under objective 4.

4.6 Objective 5: European VR Police Network

Objective 5: European Network for Knowledge Transfer on VR Training

Objective 5 aims to establish a European Network for knowledge transfer on VR Training in the police domain. Given the fact that all project outcomes (including the study results) are taken into consideration for the development of the VR solution itself but also the policy-maker documents and studies involving LEAs are raising the awareness about the project, all studies presented in this deliverable directly or indirectly feed into objective 5.

All insights gained during the studies are important insights for LEAs and enhanced their experience regarding VR and its options to be integrated into police trainings as an additional tool to meet needs that cannot be met in real life in the same capacity (for example: large scale, public scenarios on real places that cannot be locked down for trainings or facing situations with children, elderly people, animals etc. that cannot be introduced in real life trainings.). Therefore, all studies are a relevant input for objective 5.

But the following studies have provided the most contribution and are therefore mentioned here: In particular, the two *HFW1-3 and the herby combined EndUser FeedbackWeeks1-3* have already made a significant contribution to network building. These events were the first opportunity during the COVID-19 pandemic situation and attached travel restrictions to enable a larger group of people to meet in parallel, make experiences with the VR and to promote personal exchange. In the course of these studies, all participating representatives of SHOTPROS' LEAs, advisors and network partners were invited. In addition to the actual implementation of the studies, there was opportunity for exchange, discussion, and networking – which was very well received.

Furthermore, the VRandPolice network was proactively marketed (e.g. via the VRandPolice website, flyers, banners and a short presentation about the network's advantages). Thus, different target groups could be reached during the studies: in addition to the operational police officers and trainers, representatives of the top management as well as media representatives were invited and introduced to the world of SHOTPROS through the studies. Furthermore, other first responders from the medical field, the CBRNe topic or from the field of fire rescue could also be reached. The intensive exchange resulted in new exploitation and communication opportunities for SHOTPROS and will be planned in particular for the upcoming field trials (WP7)

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and for further business activities (WP8). In summary, the HFW and EndUser FeedbackWeek studies and the activities attached showed a very high need for a European exchange in the VR/XR field and consequently laid a solid foundation for further network activities.

5 Guidelines to exploit added value from studies and end user feedback weeks

This chapter describes how continuous feedback for the agile process was collected and how this feedback was used to extract valuable information for evaluation, improvements, new requirements and to create innovation. The process of agile development was first described in D1.1 (project manual), is represented as an overview in the D6.1 at hand (HF study plan) and will be described in detail in D4.6 (requirements document).

5.1 Feedback collection during studies

The aim of the studies and end user feedback weeks (EUFWs) from a development perspective was, to steer the development of a VR training system with the highest possible value. End user feedback and the results of the human factor studies build the main part of the agile development process as shown in the figure below and enabled the team to constantly design, validate, test and improve features and the overall training framework.

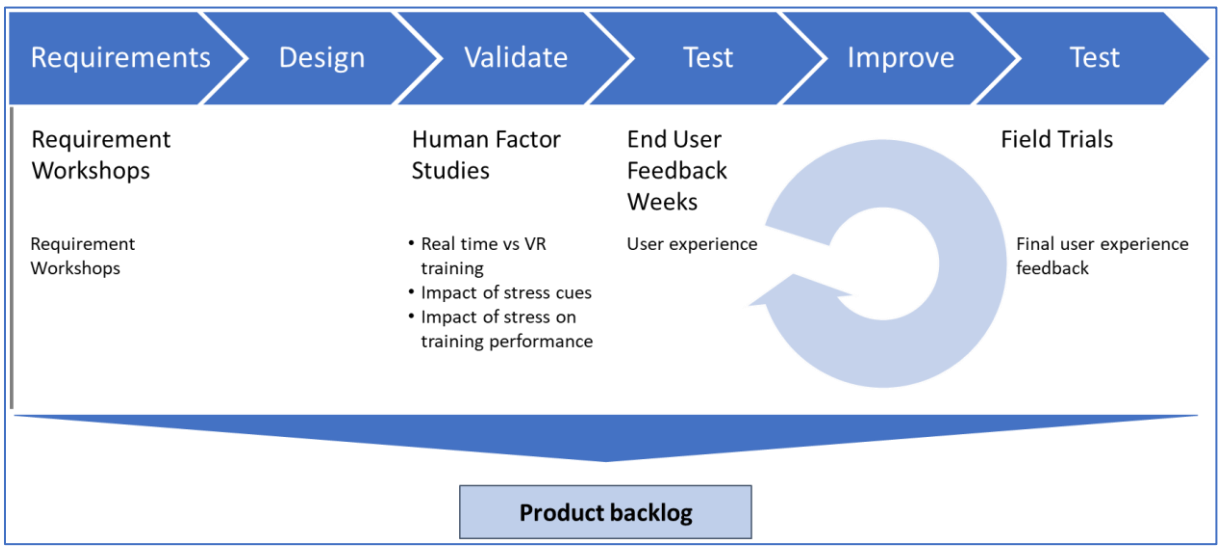

Figure 4: Feedback Collection Process

As shown in Figure 5, the feedback from human factor studies and from the end user feedback

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weeks was obtained through questionnaires, interviews and observations and subsequently captured in a standardised product backlog description template and later transferred in the product backlog list (see D4.6). With this template the feedback is grouped and translated into exploitable requirements. The following graphic describes the overall process used to transform feedback and ideas into valuable features managed and released in an agile manner.

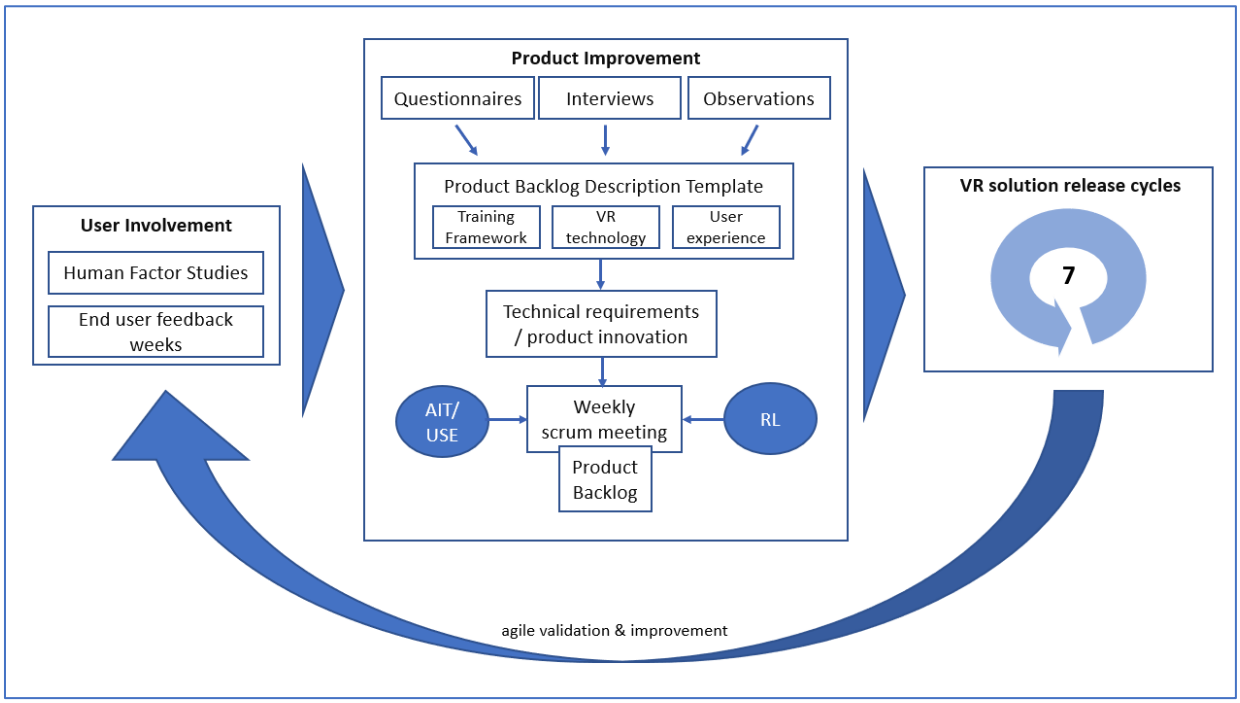

Figure 5: Product Transformation Process

The feedback collected throughout the project comes from very different sources (see D4.6) but is grouped into the following three clusters regarding its type to achieve the SHOTPROS objectives:

- Training framework including human factor studies (e.g. stress, After-Action Review)
- VR technology & innovation development (e.g. tactical belt)
- User experience (e.g. graphical interface)

For each of the clusters a variety of research studies and end user feedback weeks or other end user interaction events have been conducted.

5.1.1 Training framework and HF studies

Three HF weeks including 114 study participants provided valuable insights on the opportunities of VR training with LEAs and the impact of virtual stress cues on training and performance.

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- **HFW 1** (Amsterdam – see 3.22 HFW1: TrainCompar) compared the training experience in a "real world" setting to virtual reality in order to determine didactical aspects of the training and identify advantages of VR compared to "real world" training. Details of the study and its results can be found in D3.3 - European Framework for Training and Assessment (using VR) of DMA-SR Behaviour of Professionals.
- The main focus of **HFW 2** (Berlin – see 3.23 HFW2: StressCueValidation) was to provide empirical evidence of the trainees' stress responses to audio-visual triggers (stress cues) and evaluate their impact strengths in the context of a VR police training. The detailed results and ranking can be found in D4.5 - Real-Time Training Progress Assessment Tool.
- **HFW 3** (Selm – see 3.24 HFW3: RealTime Stress and Performance) analysed the impact of stress on performance in the context of a VR police training by evaluating trainee performance in scenarios with different stress levels. Results of the deliverable will be reported in D7.6 – Final guidelines for VR Training.

5.1.2 VR technology development feedback

Technological innovations and requirements were a result of translating end user requirements gathered in initial co-creation workshops (see D2.2) with LEAs as well as continuous end user feedback collected throughout the project in the agile process (see D4.6). Details about resulting innovation and technical development will be reported in D5.1 - VR System Design Document for development of SHOTPROS VR Environment for conducting the Human Factor Studies (WP6) and the Field Trials (WP7).

5.1.3 User experience feedback

In order to create a feedback loop for the current releases according to the agile development process (described in D1.1), several end user feedback weeks have been conducted. End users tried out the system in its current development status (after a release) and answered a standardised questionnaire focusing on user experience feedback and/or were selected for detailed interviews (see D6.3[2]). From these answers, product backlog descriptions were extracted (see example in next chapter) and transferred into the product backlog (MS Excel list), where it is prioritised, estimated for development time and resources, and depending on its

[2] The forms and questionnaires used to gather feedback and evaluate user and training experience can be found in D6.3 Human Factor Study Transcripts and Log Files.

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prioritisation added to a release cycle. Details on the agile development process and backlog items is given in D4.6 and D5.1.

5.2 Product backlog and prioritization process

For harmonisation and better traceability, feedback gathered through the different methods and events (research studies, questionnaires, observation, focus groups, discussions, workshops etc.) is recorded with a standardised template form (see Annex 1). The experts extract the requirement out of any source (e.g. user description or the research result) and enhance it with feature needs and a requirement description to make it exploitable for the technical partner. Then it is enhanced with details like one of the 15 available categorises (see Annex 2), the type of feedback, where it comes from, and how it was collected as well as a qualification of the feedback giver, if available, and its impact and an importance categorisation by the LEAs. This process supports the agile team to gather items in a comparable way and then continuously transfer them into the product backlog (MS Excel list see D4.6).

In the following, the procedure to harmonise requirements coming from different sources for transferring them into the product backlog is described with one example (selected options in the template marked bold).

Table 28: Exemplary completed form for feedback on requirements.

Item name	Real-time Stress Indicator
Date	12 March 2021
Topic	Assignment to a topic: ○ Hardware ○ Product ○ Graphic/visualisation/animation ○ Scenario scripts ○ Scenario editor ○ Introduction / set up / beginning ○ NPC ○ **Physiological stress measurement** ○ Stressors ○ Tactical belt ○ During execution – participants interaction ○ Tactile feedback ○ Performance ○ Trainer Dashboard

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	○ AAR
Type of feedback	○ **New idea** ○ Improvement ○ Bug fix ○ Technical requirement
Description	Trainers need to know and see the measured and calculated stress level of each trainee during the whole training. This helps the trainer to decide if they should raise or lower the stress inducing factors in the Trainer Dashboard and can observe the general stress load of their trainees. Therefore, a live indication of the estimated stress level of each trainee is indicated in real-time via a coloured shape with an icon. The icon is displayed above the virtual trainees and indicates one of four different status: (a) green indication with the thumbs up icon means normal conditions, (b) yellow with increase icon for increased stress, (c) orange and the triangle for high stress and (d) red and the alarm icon a very high and already dangerous level. The calculation and the categories for the measurement will be described in an upcoming backlog entry after all research results are available and evaluated. Until this time, we use a dummy categorisation to be able to re-check the visualisation.
Source of feedback	○ HF Week ○ **EndUser FeedbackWeek** ○ Other _____
Kind of collection	○ Quantitative results from questionnaire ○ **Statement mentioned during training, workshops, interview or questionnaire** ○ Observation protocoll

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Information on the respondent **(if available)**	Qualification: ○ Trainee ○ **Trainer** ○ Police officer ○ VR Operator ○ Stakeholder Skills: ○ Newbie ○ **Already experience with VR** ○ Heavy VR user ○ Skilled in VR technology/programming
Impact on	○ Trainee ○ **Trainer** ○ VR Operator ○ Curriculum
Importance for LEAs	○ 1 low ○ 2 ○ 3 ○ **4** ○ 5 high

This example is user feedback from the first end user feedback weeks in March 2021. At this time, the general need for stress measurements was already obvious (project goals and first requirements workshop reported in D2.2), but in this EUFW it was discussed in detail how users think it would make most sense to visualise the stress measurement for the trainer during the training. Furthermore, it is to mention that at this time (March) the HFWs (June) have not been conducted and therefore it was not evaluated yet how the stress level will be calculated in the backend.

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As this EUFW was an online session, a few screen designs on ideas how the visualisation could be solved were shown to the LEAs. Then their feedback was received and discussed in the LEA group. After the session a product backlog description was set up by the agile team as following:

Typically, the gathered forms were then made available in list-form (pre-backlog entries) to the LEAs for prioritisation. They had to rate each item and additionally had to mark their Top 10 from the list.

With this information from each LEA and the information of how often a need was mentioned, we internally calculated a prioritisation from 1 to 1000 to make the full backlog sortable (see details in D4.6). The product backlog also contains information on the status (beyond scope, open, in-progress or done) and a check on duplicates (which also influences the calculation of the priority as items mentioned often by different sources have a higher importance and need to be considered). An estimation of time and resources required to complete the task is added by the technical partner. Depending on prioritisation and availability of resources, items are assigned to a sprint cycle for implementation in one of the upcoming releases.

The next release is then tested again with the LEAs in further studies and feedback weeks to gather feedback which again is recorded in the templates to be transferred into the backlog to start the cycle again.

The filled out forms represent living documents until they are finally planned for a release. If a duplicate arises during the project, the new requirement is checked with the original and if needed (and not already implemented) enhanced with details form the new source. This can be tracked with the collector/duplicate column in the product backlog that shows all related duplicates to be able to filter (also see D4.6 for duplicate process). In our example, at the beginning of the requirements workshops (D2.2), the need to see the psychological data was mentioned very general and then with each event became clearer and clearer until it was finally implemented.

Product backlog entry	source	duplicate?	collectors/duplicates
Trainer can see physiological data during training	D2.2	yes	DOUBLE 39
create a (VR) training environment that enables the manipulation of human factors	D3.1	yes	DOUBLE 39
using the Stress Cue Control Panel to adjust stress cues to increase or decrease the stress load of a trainee	D3.3	yes	DOUBLE 39

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a live indication of the estimated stress level of each trainee is indicated in real-time via a coloured shape with an icon. The icon is displayed above the virtual trainees and indicates one of four different statuses (a) green indication with the thumbs up icon means normal conditions, (b) yellow with increase icon for increased stress, (c) orange and the triangle for high stress and (d) red and the alarm icon a very high and already dangerous level.	D4.5		COLLECTOR 39
overall display of all trainees in a list in the Stress Level Assessment panel on the right side to always have the complete overview on the stress assessment	D4.5	yes	DOUBLE 39
visualise calculated HRV as stress level	D4.5	yes	DOUBLE 39
Visualise the stress of a trainee for the trainer in the spectator view - colour and icon coded fields visible when trainer is monitoring	EFW - online	yes	DOUBLE 39

Table 29: Excerpt of the product backlog including duplicates for a certain entry

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5.3 Timeline of the Agile Development Process

The following table shows the list of evaluation sessions consisting of HF studies and LEA Feedback weeks together with their objectives and dates.

Table 30: List of evaluation sessions in the agile development process.

Session	Objectives	Date
HFWeek 1: TrainCompar	**T**he training experience in a "real world" setting to virtual reality **was compared** in order to determine didactical aspects of the training and identify advantages of VR compared to "real world" training. Details of the study and its results can be found in D3.3 - European Framework for Training and Assessment (using VR) of DMA-SR Behaviour of Professionals.	07.-11.06 2021
HFWeek 2: StressCues Validation	The main focus was to provide empirical evidence of the trainees' stress responses to audio-visual triggers (stress cues) and evaluate their impact strengths in the context of a VR police training. The detailed results and ranking can be found in D4.5 - Real-Time Training Progress Assessment Tool.	05. – 09.07.2021
HFW 3: RealTime Stress	The impact of stress on performance in the context of a VR police training by evaluating trainee performance in scenarios with different stress levels was analysed. Results of the deliverable will be reported in D7.6 – Final guidelines for VR Training.	09.-13.08 2021
EndUser FeedbackWeek 1	Online - 5 appointments with all LEA organisations and advisors: Feedback on online VR walkthrough and previous live experiences of partners; Focus on: Workflow for trainers, feedback on stressors, general look & feel regarding scenarios and user interface design	March 2021 (10.3., 12.3., 26.3., 30.3.)
EndUser FeedbackWeek 2	Berlin (Germany)– executed together with HFW2. Partners, invited network members and advisors evaluated and tested different VR scenarios and gave	05.-09.07 2021

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	feedback on user experience, training options and performance measurements according to current development status	
EndUser FeedbackWeek 3	Selm, NRW (Germany) -executed together with HFW3: Partners and invited network members will test updated VR scenarios and give feedback on user experience, training options and performance measurements	09.-13.08. 2021
EndUser FeedbackWeek 4	Scenario 2 Details: Workshop combined with the November consortium meeting – focus on evaluating the scenario 2 and the planned new features from the actual release	Nov 2021
EndUser FeedbackWeek 5	Gender Workshop: Identification Workshop on gender specific requirements in VR police trainings	Tbd – Q1 2022
EndUser FeedbackWeek 6	Executed together with one of the first field trials from WP7; partners, invited network members and advisors evaluate the final VR scenario and feedback sessions for the training curriculum.	Tbd - Q2 2022

Based on the required studies, end user feedback and available development resources the following agile development release plan has been established.

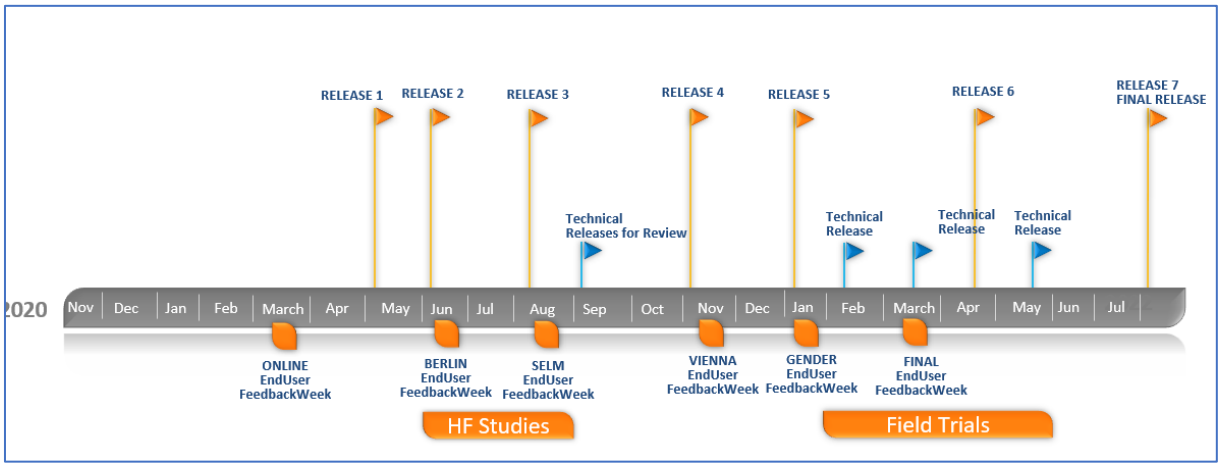

Figure 6: Timeline of the agile development process and the releases.

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6 Conclusion and next steps

This deliverable provides an overview of all conducted and planned HF studies in SHOTPROS. As it is a living document and was subject to changes due to re-planning of the studies (caused by travel restrictions) it also shows the path SHOTPROS took within the first 2/3 of the project.

It also serves as information in which deliverables, objectives or development steps the study results are included and documents the agile user-centred design and development process. Based on the results of the conducted HF studies from this deliverable, the following next steps are planned:

- **Integrate identified insights into the agile development process**
  - Quick comparison and adaptation of user and technical requirements
  - Continuous adaptation of the backlog by the agile core team
  - Implement quick learnings from the studies immediately

- **Evaluation and deep analysis of data from completed studies**
  - Identification of implications for further project activities with a special focus to the planned field trials (in WP7)
  - Aggregation with research outcomes from other activities
  - Utilisation of gained knowledge to achieve the project objectives

- **Execution of ongoing and planned studies**
  - Refinement of planned studies in close collaboration with the LEAs
  - Collect and (if necessary) develop measurement instruments and tools (D6.2)
  - Agile adaptation and re-scheduling of studies and experiments in terms of location, number of participants, safety measures etc. (e.g. due to COVID)

- **Reports and publications**
  - Outcomes will be reported in the respective deliverables and used for peer-reviewed publications to make the knowledge available to the scientific community

- **VR Network and policy-maker document**
  - All results are systematically evaluated by the consortium with respect to their policy relevance. SHOTPROS will derive strategies and decision-making support

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documents from the outcomes that are deemed relevant for policy- and decision maker in several areas.

- Use the HF studies as a proactive element to promote networking and European exchange in the field of VR/XR.

As of the current status (end of July 2021), we would like to emphasise that all studies have been carried out according to the plan and that the last open studies are currently in the final planning or implementation phase.

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7 Annex 1 – Template for collection of end user requirements

Table 31: Template for feedback on requirements.

Item name	
Date	
Topic	Assignment to a topic: ○ Hardware ○ Product ○ Graphic/visualisation/animation ○ Scenario scripts ○ Scenario editor ○ Introduction / set up / beginning ○ NPC ○ Physiological stress measurement ○ Stressors ○ Tactical belt ○ During execution – participants interaction ○ Tactile feedback ○ Performance ○ Trainer Dashboard ○ AAR
Type of feedback	○ New idea ○ Improvement ○ Bug fix ○ Technical requirement
Description	

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Source of feedback	○ HF Week ○ EndUser FeedbackWeek ○ Other _____
Kind of collection	○ Quantitative results from questionnaire ○ Statement mentioned during training, workshops, interview or questionnaire ○ Observation protocoll
Information on the respondent **(if available)**	Qualification: ○ Trainee ○ Trainer ○ Police officer ○ VR Operator ○ Stakeholder Skills: ○ Newbie ○ Already experience with VR ○ Heavy VR user ○ Skilled in VR technology/programming
Impact on	○ Trainee ○ Trainer ○ VR Operator ○ Curriculum
Importance for LEAs	○ 1 low ○ 2 ○ 3 ○ 4 ○ 5 high

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8 Annex 2 – Product Backlog categories

General Requirements

1. **Hardware**: covers the hardware relevant requirements and includes the VR system with HMD, tracking system, extension with sensors or haptic devices as well as features such as portability, weight, ease of setup, viewing area, etc.
2. **Product**: This category includes general product requirements such as number of trainees, distributed training with multiple systems, setup time, support or budget.
3. **Graphic/visualisation/animation**: This concerns the visual realisation of the virtual environment and objects as well as the realistic simulation and animation of avatars.

Training Preparation

4. **Scenario scripts**: Content aspects of the training scenarios as well as the sequence and variation of the story.
5. **Scenario editor**: Functionality and ease of use of the editor for the simple creation of training scenarios.
6. **Training ExecutionIntroduction & set up**: Everything that improves the introduction of new trainers to VR training and speeds up the set-up process.
7. **NPC**: Requirements related to Non-Player Character (computer-controlled avatar) appearance, behaviour, and realistic reactions
8. **Physiological stress measurement**: Requirements about sensors, applying sensors, data acquisition, analysis, stress score computation and dashboard for visualisation.
9. **Stressors**: Description of situations, activities and events that can trigger stress. These stressors have to be materialised into the VR scenarios.
10. **Tactical belt**: Equipment used in training which has to be realised as tangible device in VR with similar functionality as in real.life.
11. **During Execution** – participants interaction: these requirements describe how the trainees can interact during the training including grabbing/dropping objects, using the rotary button, visualisations in the VR screen etc.
12. **Tactile feedback**: Additional features and devices to provide haptic feedback to the trainees during training (e.g. pain stimulus)
13. **Performance**: Requirements to track and assess training performance during training and in AAR.
14. **Trainer Dashboard**: Requirements about the trainer dashboard including functionality, interaction and information to be shown (e.g. stress cue control, stress assessment)

After the training

15. **After-action review (AAR)**: This category includes requirements to review the training session based on the recorded data as well as what to record and how to compute training performance automatically.

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