Grant Agreement N°101092861

Making the Invisible Visible for Off-Highway Machinery by Conveying Extended Reality Technologies

DELIVERABLE 3.3 – PROTOTYPES FOR PRIVACY-RELATED QUESTIONS [FIRST VERSION]

This work is part of the THEIA^{XR} project that received funding from the European Union's Horizon Europe research and innovation program under grant agreement no. 101092861

Funded by the European Union

Document Identification

Project	THEIA^{XR}
Project Full Title	Making the Invisible Visible for Off-Highway Machinery by Conveying Extended Reality Technologies
Project Number	101092861
Starting Date	January 1st, 2023
Duration	3 years
Horizon Europe Programme	Horizon Europe Framework Program (HORIZON)
Topic	HORIZON-CL4-2022-HUMAN-01-14: “eXtended Reality Technologies”
Call for proposal	HORIZON-CL4-2022-HUMAN-01
Type of Action	RIA-Research & Innovation Action
Website	www.theia-xr.eu
Work Package	WP3
WP Leader	[HdM]
Responsible Partner(s)	[UL]
File Name	D 3.3 – Prototypes for privacy-related questions (first version)
Contractual delivery date	30.06.2024
Actual delivery date	01.07.2024
Version	1
Status	Final
Dissemination level	Public
Author(s)	Anastasia Sergeeva, UL Manuel Kulzer, HdM Tanja Brodbeck, HdM
Contact details of the coordinator	Martijn Rooker, martijn.rooker@tttech.com
Internal Reviewer	Thomas Kernbauer, TUG Martijn Rooker, TTC

Disclaimer

Funded by the European Union	Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European union or the European Commission. Neither the European Union nor the granting authority can be held responsible for them.

Executive summary

This deliverable continues and expands upon the work conducted under the co-design approach (D3.2 and D3.4) to establish a set of procedures that help identify and actively verify privacy concerns during the development of Extended Reality (XR) technologies for off-highway machinery. Developing these technologies using a privacy-by-design approach requires promoting a privacy mindset among all stakeholders and implementing comprehensive procedures to understand how end users perceive these features from privacy and ethical standpoints at each stage of development. To meet these requirements, we needed to develop procedures to evaluate the privacy and ethical concerns of all stakeholders, including end users of the machinery. In the THEIA^{XR} project, we proposed and tested several qualitative methods to address these concerns. We also outlined a selection of quantitative methods that can be used in later project stages to validate the project's privacy and ethical goals with a wider audience of end users in the professional field. However, since we chose an interdisciplinary co-design approach for our user and stakeholder studies, we prioritize qualitative, in-depth methodologies to achieve our goals. The presented deliverable is organized as follows: First, we explain the main theoretical concepts that motivated the development of elicitation and evaluation procedures. Then, we present a step-by-step procedure we applied to use the selected methodology with the end users. Being slightly ahead of the planning schedule, we already made a pretest of the discussed procedures to show their applicability in the domain of off-highway machinery. We also provide the preliminary results of applying the procedure, evaluate its applicability, and suggest ideas for adjustments. Finally, we propose additional methods we plan to use in the final validation stage of the development of XR enhancements in addition to the procedures that have been made. The results of our work will inform D3.6 Context-of-use Analysis and D3.7 Interaction Scenarios (final version). After further re-evaluation with stakeholders, these findings will be presented in D3.8 Prototypes for privacy-related questions (final version). Additionally, the work carried out under task T3.3, The Co-design of Ethics and Privacy Control Mechanisms, has informed D7.3, the Design Guidelines, and the Validation Reports for privacy (first version).

Table of Contents

Document Identification........ 2
Executive summary........ 4
1 Introduction........ 7
2 Methodology........ 9
2.1 Co-design methodologies for ethics and privacy........ 9
2.2 Schwartz's Theory of Basic Values........ 10
2.3 Expanded Technology Acceptance Model........ 11
3 Development of Elicitation and Evaluation Procedures for Privacy and Ethics-Related Questions........ 12
3.1 Elicitation of basic ethical values of operators using an adapted short version of Schwartz's Theory of Basic Values questionnaire in the working context........ 12
3.2 Workshop for understanding privacy and ethical values of the end user of technology........ 13
3.2.1 Results of the workshop for understanding privacy and ethical values of the end-user of technology for UC1 and UC3........ 16
3.3 Evaluation of the industrial baseline for ethics and privacy........ 17
3.3.1 Results of evaluation the baseline for privacy and ethics across the three use cases........ 18
3.4 Co-design workshop for reevaluating privacy goals and specifying stages of privacy requirements 22
3.4.1 Results of co-design workshop for reevaluating privacy goals and specifying stages of privacy requirements........ 24
3.5 Quantitative methods for assessment of privacy and ethical concerns........ 28
4 Conclusion........ 29
References........ 30

List of Figures

Figure 1: Three basic levels of value hierarchy, adapted from Van de Poel, (2013), with investigation directions........ 10

Figure 2: Introduction of the persona of Marco, snow groomer operator, during the workshop. We deliberately make the description vague to allow participants projecting their work-related values through Marco........ 14

Figure 3: Board for privacy-goals setting and roles allocation after the first workshop with the stakeholders........ 24

List of Tables

Table 1: Short questionnaire for understanding Schwartz values in working context.**Error! Bookmark not defined.**

Table 2: Feature evaluation. 14

Table 3: Semi-structured interview, for establish baseline for privacy and ethics on workplace (use cases domains) 17

Table 4: Overview of the industrial baseline evaluation 18

Table 5: Privacy Requirements goal setting and roles allocation questions 23

Table 6: Co-design the privacy and ethics preserving implementations with stakeholders 26

1 Introduction

In the modern world, we are witnessing the rapid development of XR technologies. These technologies have evolved from experimental prototypes to widely used solutions, expanding from mere gaming and exploratory applications to various working contexts such as healthcare (e.g. [45]), industry (e.g., [14, 15, 49]), and education (e.g. [7, 27]). This integration of XR into the working environment offers users additional opportunities to communicate, collaborate, and build new knowledge. It also helps to model certain situations in virtual surroundings to predict and design actions required to address similar situations in the real world (e.g., employee training for extreme situations [49]). Overall, XR technologies make work more fun, engaging, and productive.

However, academics and industry stakeholders have pointed out that there are several severe problems associated with the current adoption of XR technologies. The first group of issues is connected to the fact that XR technologies while working, can capture a wide range of data [9]. This data can include physiological characteristics of the operator, such as the direction of movements of virtual controllers through haptic feedback devices or proximity sensors or pupil delay through the eye-tracking system integrated into the Virtual Reality (VR) headset. Some works discussing the joint application of VR and Artificial Intelligence (AI) algorithms highlight the opportunity to capture and combine physiological parameters and user actions, enabling the system to make predictions about a person's mental state or the perceived difficulty of the task they encounter. This creates a new level of invasion of personal privacy, making the discussion about "mental privacy" in XR applications very relevant [2, 34]. It is also important to stress that the use of XR devices also penetrates the privacy of bystanders—people who are not operating the XR-enhanced technology but are within the range of the device's data collection [34, 38]. They are usually unaware of ongoing data collection and, therefore, cannot opt out; however, previous works have shown opportunities to de-anonymize bystanders by linking the captured data with external datasets, such as those provided by Facebook databases [25, 34]. However, privacy problems are not the only risks posed by XR technologies. As interactions become more realistic, it becomes harder for people to discern the exact boundaries between realities [40]. For instance, people might unintentionally confuse real and virtual objects and become overly dependent on these "extended" parts of reality to complete their tasks, which creates a risk of physical harm. Moreover, recent research has shown the possibility of exploiting these psychological mechanisms to deliberately manipulate users toward certain outcomes of interactions with XR for malicious purposes [8]. These two groups of risks are equally applicable to any application of XR devices. However, when implemented in a work environment, XR technologies pose additional risks to ethical and privacy-sensitive work surroundings. For example, as systems collect a lot of information about how users perform job-related tasks, is it ethical to use this data to evaluate performance and make promotion-related decisions? Can a person opt out of technologies that can enhance performance but are too privacy-invasive from a personal point of view? How can XR technologies be integrated into certain professions' workflow without making users pay too much attention to XR elements and neglect real-world signs?

To address these concerns, developers of XR-enhancement technologies in the workplace should develop ways to understand the possible concerns users may have while envisioning and evaluating the technology. However, this also means that the development group should adopt a design-for-privacy-and-ethics mindset and be able to vigilantly assess any technology they plan to introduce from this perspective. This necessitates having a broad range of procedures for evaluating privacy concerns within the development team and among stakeholders.

In the THEIA^{XR} project, we adopted the privacy-by-design co-creative approach [51] from the very start. Firstly, we triangulated data from user interviews, workshops with developer stakeholders, and stakeholders' technology privacy-focused assessments to determine the starting points and privacy goals of the project (described in D2.3). In the presented work, we show the following steps to create and validate the procedures to continue the privacy-sensitive development of the technologies in the project. We approach it from the following positions:

- We created and tested the procedure of eliciting and discussing users' expectations from their work while using XR technologies. Bonded to the main co-design procedure described in D3.2 and D3.4, we used the main persona and storyline of the problem scenarios to highlight the aspects of the work that are important for the workers and linked it to the developing technologies that can help them achieve their goals or, in contrast, create additional difficulties.
- We conducted interviews with industry experts in each of the Use Cases (UC) to establish the baseline of privacy and ethics practices in the industry and see how developers' and end users concerns can be evaluated towards industrial standards.
- We created synchronous-asynchronous focus groups with the project's developers and stakeholders to reevaluate the Privacy Requirements elicited in the previous stage of development and mark our progress toward achieving privacy goals.

These three procedures can be used to conceptually investigate privacy and ethics in the developed technologies and can serve as control mechanisms to determine whether the project is following its privacy goals. In the following stages, we plan to use the proposed methods more extensively with a broader range of end users and stakeholders to ensure the continuity of the development of privacy and ethics processes.

2 Methodology

2.1 Co-design methodologies for ethics and privacy

The THEIA^{XR} project adopted a transdisciplinary co-design approach, which aimed not only to create technologies for users but also to develop them with users in active collaboration with all potential stakeholders. This approach is part of the family of participatory and co-design methodologies developed within the European tradition of social engagement and designing for social good. An important aspect of the methodology is its practical orientation and focus on communicating with end users in their own language. This involves carefully creating and discussing the use of the developed technology with end users through understandable use cases and scenarios. These scenarios can incorporate personas and situations that end users can relate to [39, 41]. A more detailed definition and explanation of the transdisciplinary co-design approach can be found in D3.2. In the frames of the presented deliverable, we would like particularity stress two main lenses we applied to investigate privacy and ethics issues in the project: Humanity-Centred design (HCD) and Value-Sensitive Design (VSD). HCD is a concept proposed by Norman [35] which encapsulates the extension of Human-Centred Design in the following dimensions: addressing the root problem instead of the actual problem, focusing on the ecosystem, taking a long-term systems perspective, continually testing and refining, and designing with the community as much as possible; while the framework can be criticized being too vague in terms of addressing the specific population and specific problem (how it can be possible to design beyond specific population and specific problem) [19] we believe that the adopting the perspective to the future (beyond the research project) and evaluating the broader societal outcomes of the designs for XR enhancement in industry can be useful because of novelty and potential huge impact of the results to the domain.

VSD is an approach related to participatory design and is deeply rooted in ethical theories. It emphasizes the design of technology that incorporates human values into the design process [18] The main goal of the approach is to integrate a broad range of human values into the design of technology early and throughout the design process. The approach advocates for considering a broad range of values, including fairness, justice, human welfare, and virtue [18] and is widely used for projects that include multiple stakeholders and potential societal outcomes [6, 12] The approach stresses that researchers should specify and structure the values important to the end users and other stakeholders in the project [28]. The approach acknowledges that the list of people affected by the designed technology is usually broader than just the end users. Therefore, it often focuses on identifying possible stakeholders and addressing potential value conflicts between them [47]. This is done to create methods to resolve conflicts or organize values by priority. It also suggests starting by identifying project-specific needs, which can help with the prioritizing process and determine the exact methodological instruments to apply [18].

The methodology involves a broad range of design techniques [50] and methods [17] that allow for conducting conceptual, empirical, and technical investigations applied iteratively and integrative. More specifically, conceptual investigations aim to identify and define the values implicated in each design context. This includes identifying direct and indirect stakeholders, their values, and potential value conflicts, as well as analysing relevant ethical guidelines and creating frameworks for prioritizing values. Empirical investigations involve a broad range of human-machine interaction methods, including interviews, surveys, observations, and discussions with stakeholders to assess the use of existing technology and determine the baseline. Technical investigations take the developed principles and apply them via prototyping or analysis of existing technology to understand how the technology should be designed or redesigned to better support the values [18]. The approach applies across different social domains, such as designing technology for manufacturing, education, agriculture, etc. It is also applicable to discuss the roles and values of social components of sociotechnical systems, e.g., operator's work. For example, discussing the difficulties of operator's work, Franssen [16] pointed to the fact that the role of operators in sociotechnical systems can be viewed as the tension between conformity to the rules (operators must follow specific instructions and rules) and autonomy (need to adapt to unforeseen circumstances). The work pointed to the need for a better understanding of the values and responsibilities of human operators to be able to design systems that respect operators' autonomy while clearly defining their responsibilities to ensure the general system's functionality and safety [16].

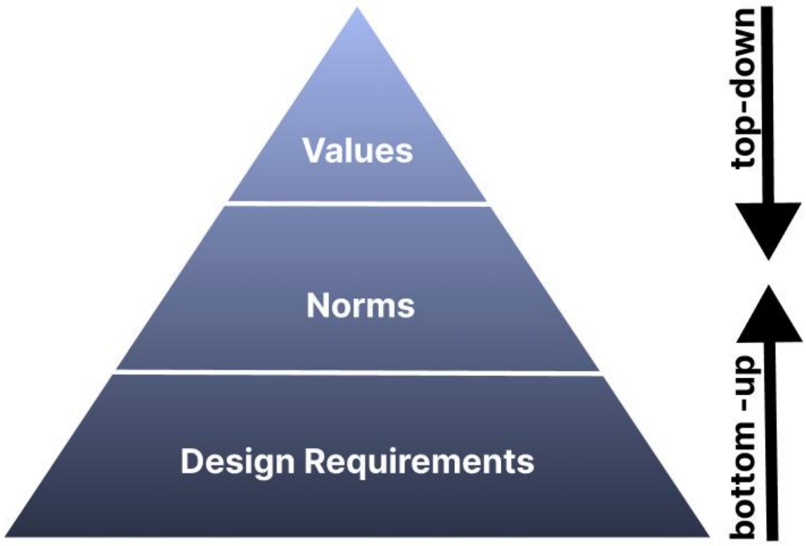

Figure 1: Three basic levels of value hierarchy, adapted from Van de Poel, (2013), with investigation directions

Talking about the translation of high-level values into design recommendations, Van de Poel showed that it can be presented as a hierarchical structure [46]. This structure includes levels of abstract values, different kinds of norms (which he viewed as objectives, goals, and constraints), and specific requirements derived from the norms (see Fig. 1). He also mentioned that for creating this value hierarchy from higher, more abstract, and more essential ideas to practical recommendations, it is possible to use both top-down and bottom-up approaches. In the latter case, we apply a "reverse-engineering" mindset to understand which values were in place to create certain design requirements and whether these bottom elements are the exact solutions needed to achieve the values we have in mind [18].

2.2 Schwartz's Theory of Basic Values

VSD does not argue for a particular way of setting the initial set of values for exploration [17]. The set of values can be high-level ethical values motivated by the topic of the design investigation, or they can be specifically elicited through preliminary procedures of discussing values with stakeholders. In our project, we decided to take the list of theory-grounded values proposed by Schwartz [43]. The original Schwartz approach identifies core human values as ten main concepts: benevolence, universalism, self-direction (autonomy), achievement, stimulation, hedonism, security, conformity, tradition, and power [43]. Explaining the nature of his values model, Schwartz proposes the following characteristics: values are closely tied with emotions, and people receive positive or negative emotional feedback when acting in line with or against their values. They are also the standards for evaluating actions, situations, and people (e.g., as good or bad) and motivators for people to take action. It is also important to mention that Schwartz considered values as transcendent and applied in different contexts [43], which led to the attempts to discuss the values in application to the different sides of everyday life, including working processes. For example, Cohen investigated the connection between values and organizational commitment and showed the connection between benevolence and commitment in employees; he also scored the perception of justice as an important factor of employee commitment [11]. There are several questionnaires dedicated to measuring the importance of each value and creating a hierarchy of values for individuals. The most popular forms are the Schwartz Value Survey (SVS) and the Portrait Values Questionnaire (PVQ40) [44]. There is also a short 10-item adaptation proposed by Lindeman and Verkasalo [32]. However, Albrecht et al. argue that to understand values in a work context, it is essential to tailor the questionnaire specifically to this setting. To address this, they proposed the Values at Work Scale, which includes 52 questions and addressed the revised list of Schwartz values [4].

2.3 Expanded Technology Acceptance Model

While the Schwartz model is useful to analyse the user's high-level values, which inform their expectations and attitudes during the work, it is also important to have a more utilitarian set of parameters, which can help to quickly weigh particular technological implementations or features coming through the technological development. To reach this goal, we applied the Technology Acceptance Model (TAM) [13], which we interpret as the alignment of XR implementations' features with the user's utilitarian values. We also used some enhancement of the TAM model in the frames of the Value-Based Adoption Model (VAM) [26] to incorporate the values of safety and excitement, which are theoretically proven to be important in the concept of engineering development and specifically XR. The TAM is a widely used framework designed to predict users' attitudes toward using technology. It does so by evaluating two key factors: perceived usefulness (which we can consider as utility value in our context) and perceived ease of use (which corresponds to accessibility value) [33]. The VAM interprets the items of TAM in the frames of values and also complements the original set of concepts with the notions' drawbacks, which negatively affect the desire to adopt the technology. It is also important to note that the VAM extension of TAM incorporates the concept of enjoyment as a core value affecting the adoption of the new technology [26]. A survey conducted by Chuah showed that enjoyment plays a significant role in the structure of XR adoption across multiple XR applications [10]; Lee et. al even mentioned enjoyment as better prediction of VR adoption than usefulness and other utilitarian qualities [31]. Enjoyment is also mentioned in the discussion about the research agenda of industrial XR applications [23]. Finally, after discussing the drawbacks of XR technologies in the industrial setting, we decided to incorporate security/safety concerns into our explorative model. We did it for the following reasons: first, the values of security and safety play one of the core roles in the discussion of Engineering Values proposed by van de Poel [48]. It is also shown that notions of privacy and security risks in XR are shared between users and experts [1, 3, 20, 21, 37], creating a common ground for further co-designing activities.

3 Development of Elicitation and Evaluation Procedures for Privacy and Ethics-Related Questions

Building solidly on the presented methodologies, we developed the following procedures to address the privacy and ethical concerns in the project. Following the privacy-by-design framework, the evaluation will continue during the subsequent stages of development and implementation to ensure that new privacy and ethical risks do not appear in the later stages of the project. Additionally, we present the preliminary results of these procedures, demonstrating how the findings are already influencing the ethics and privacy-preserving mechanisms implemented in the project.

The work described in this section are following the previous privacy-related investigation procedures discussed in D2.3. They are also deeply connected with the work described in D3.2, as all the scenario-based elements used in our procedures are tied to the main storylines of the scenarios and features, co-elaborated during the ideation phase of the transdisciplinary scenario-based co-design approach.

3.1 Elicitation of basic ethical values of operators using an adapted short version of Schwartz's Theory of Basic Values questionnaire in the working context

As mentioned in the "Methodology" section, to understand the core drivers of individuals in a profession, it is necessary to put values in the context of working life. Albrecht et al. [4] successfully integrated the Schwartz values in the context of work. However, their approach, which consists of 52 items, may be overly long for presenting concepts to operators. In our work, we created a short, 10-item version of the questionnaire based on the conceptual work and formulations of Albrecht et al. [4]. Our goal was to encapsulate the concepts in a concise manner, similar to the short version of the original Schwartz instrument created by Lindeman and Verkasalo [32]. The result is a brief questionnaire where the main values of Schwartz's theory are presented, and respondents are asked to rate each value's importance in their work (presented in Tab.1). Since the goal of this stage was not to validate the questionnaire, it was used merely as an instrument to help users better understand the Schwartz model for subsequent values-related discussions. However, we plan to conduct a full-scale validation procedure in the following stage of the project.

Table 1: Short questionnaire for understanding Schwartz values in working context.

How important is it to you that your job...:						
	1 (extremely unimportant)	2	3	4	5	6	7(extremely important)
offers clear opportunities for **success and recognition** (e.g., you can achieve career advancement, promotions, etc.)							
offers **substantial personal pleasure** and opportunities for **enjoyment** (e.g., you can experience pleasurable activities or have fun during work).							
involves a **dynamic and challenging environment** that keeps you engaged (e.g., your work includes a variety of tasks and challenges).							
allows for **autonomy** and **creativity** in your tasks and projects (e.g., you can make your own decisions and set priorities at work).							

contributes to broader societal goals like environmental sustainability or social justice (e.g., your work helps make the world a better place).							
operates in a **supportive and caring team environment** where you **can trust and help your colleagues** (e.g., your job allows you to support and collaborate with the people you meet at work).							
respects and incorporates **cultural or corporate traditions** (e.g., in this job, you can work according to your values or within a company that shares your approach to work)							
emphasizes **following rules** and **respecting authority** (e.g., you work in a group where everyone supports the organization's policies and rules).							
provides **stability** and **security** in a well-organized environment (e.g., you perform your work in a safe and secure space; the company prioritizes security).							
provides you with a position of **influence and authority** (e.g., you can decide who does what, command other people and resources).							

3.2 Workshop for understanding privacy and ethical values of the end user of technology

Based on Van de Poel's [46] hierarchical approach to go from Values to Design Requirements and in the opposite direction (using Requirements to understand Values better), we proposed a Value-Centred co-design workshop for the operators.

The workshop has the following structure: First, we explained to the operators what VCD is and why it can be useful to keep values in mind while designing features and implementations in the industrial context. We also explained that the workshop would have two parts. In the first part, we discussed the values beyond their work and which of them best align with the operator's profession (specified for each use case). In the second stage, we specifically discussed the ideas that emerged from the ideation phase of transdisciplinary co-design, focusing on usefulness, safety, enjoyment, and ease of use. Second, we showed the operators the list of original Schwartz values and pointed out that values can be used in different contexts, including the context of work. To familiarize the operators with the values, we asked them to fill out the questionnaire described in the previous section. We emphasized that we were not collecting this data and that operators would keep it for their own purposes. Third, we initiated a discussion about the core values embedded in the operator's profession. We explored which personal values can help achieve success in this job and which are secondary. We specifically stressed that the set of Schwartz values discussed can be used as a starting point and that operators can create their own concepts to better describe the values they have in mind. To facilitate ideation, we introduced a persona (Fig. 2 represent the way we present it to the operators), used in previous problem scenarios described in D3.1 and D3.2. This persona should possess a value set that helps them make a long and successful career in the discussed domain. First, each participant made their list of value hierarchy separately; then we asked operators to share their insights with colleagues and researchers to see how close their opinions were. By the end of the procedure, we expected to have a list of values important to the operators in their everyday work.

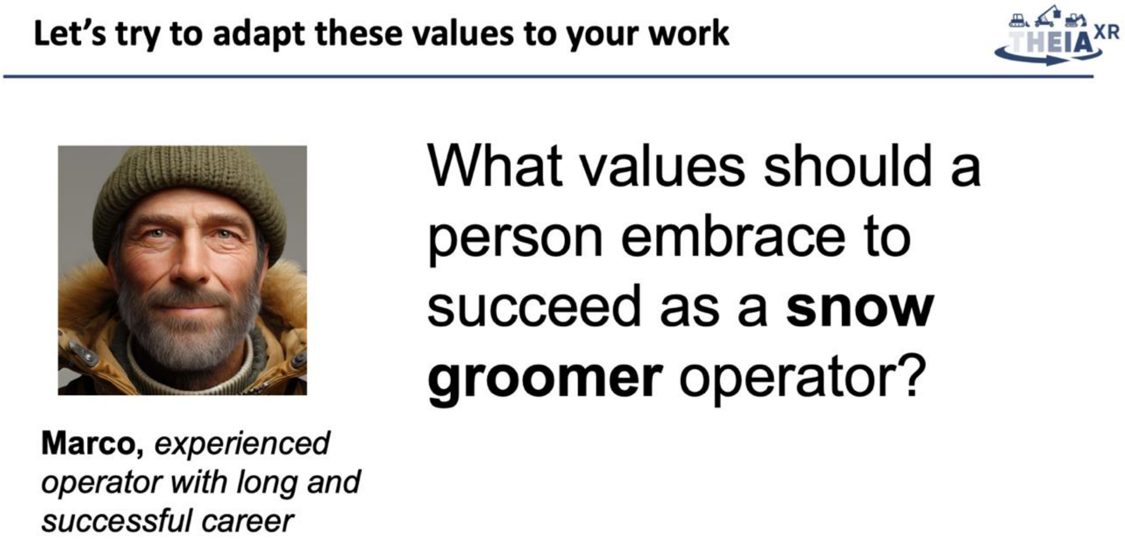

Figure 2: Introduction of the persona of Marco, snow groomer operator, during the workshop. We deliberately make the description vague to allow participants projecting their work-related values through Marco[1].

In the second part of the workshop, we presented the operators with a list of implementation ideas validated in previous stages of co-design and asked them to rate each idea based on four parameters: ease of use, usefulness, safety (including security and privacy risks), and enjoyment. As we were interested in discovering possible conflicts between values, we specifically pointed out to the operators that the same implementation could be beneficial in one parameter but detrimental in another (e.g., making the work easier but more boring). As we outlined in D2.2, we combined the evaluation with the Sentence completion method [29], asking for the reason behind the assessment. After filling out the questionnaire, we prompted participants to discuss the conflicts and trade-offs of the features among themselves and with researchers. An example of questionnaire is presented in Table. 2. We asked the participants to rate each feature by a set of parameters and provide the justification for their evaluation by completing the sentence.

Table 2: Feature evaluation.

Ambient lights (light strips) around the windscreen, which indicate vehicle status during start up and possibly height of the blade above soil (TBD);

I believe this feature can make my work **more efficient** (PLEASE, CIRCLE THE OPTION SUITS YOU THE MOST),

1 (I fully disagree)	2	3	4	5	6	7 (I fully agree)

because...(PLEASE WRITE DOWNTHE EXPLANATION).

I believe this feature can make my work **less efficient**

1 (I fully disagree)	2	3	4	5	6	7 (I fully agree)

because...

I believe, this feature can make my work **more enjoyable** (interesting, fun)

1 (I fully disagree)	2	3	4	5	6	7 (I fully agree)

because...

[1] The picture of Marco has been created with the support of AI.

I believe this feature can make my **work less enjoyable** (e.g., more boring)

1 (I fully disagree)	2	3	4	5	6	7 (I fully agree)

because...

I believe, if the feature will be implemented, it will be **easy to use It**

1 (I fully disagree)	2	3	4	5	6	7 (I fully agree)

because...

I believe, if the feature will be implemented, it wIll be **hard to use it**

1 (I fully disagree)	2	3	4	5	6	7 (I fully agree)

because...

I think, if the feature will be implemented, it will make my **work safer**, because (any possible notification of safety, e.g. I'll have less incidents)

1 (I fully disagree)	2	3	4	5	6	7 (I fully agree)

because...

I think, if the feature will be implemented, it will make my work **more dangerous** , because... (any possible risks, from dangerous machine behaviour, or to create some data which I am afraid to share with other people)

1 (I fully disagree)	2	3	4	5	6	7 (I fully agree)

because...

We pretested the proposed workshop structure internally with 3 participants at the University of Luxembourg to identify the main pitfalls of the method. We then conducted two workshops within the investigations of UC1 (6 participants, including 3 operators and 3 other stakeholders) and UC3 (a shorter version with 2 operators) to evaluate the applicability of the procedure for assessing the ethical values of the operators. The results showed that the workshop procedures are generally understandable for the operators and capable of facilitating further discussions for elicitation. The developed instrument is planned to be used iteratively in the following stages of the project with larger groups of operators. We also plan to use the feature-based model assessment not just for ideas but for earlier prototypes as well. This will help identify issues that go beyond usability (even if the feature is working efficiently) and address potential conflicts with the core values of the operators. In the next section we present the results of the first round of procedure in the UC1 and UC3; as the UC2 have some delay in the scheduling of the features extraction and validation process (see D3.2 for further clarification), we were not be able to make the pilot test of the procedure on this group of operators as well, however, as the primary goal of this stage of the project was to test the methodology with real end-users, the results looks sufficient to confirm the methodological soundness of the instrument.

3.2.1 Results of the workshop for understanding privacy and ethical values of the end-user of technology for UC1 and UC3

The structure of the results from the ideation around the cardinal values of the operators reveals a high level of agreement among the people involved in operating the snow grooming technique (three operators and one employee heavily involved in the development and operation process) and excavators (two operators). For all participants, the most important values for being successful and engaged operators are those connected to **autonomy and creativity in their work**. When asked why this value is so important in the operational side, the operators stressed that the work requires a **high level of autonomy and decision-making**. If a person does not want or feel comfortable with this mindset, it will probably not work for them. The second highest-rated value related to success in the professional life of an operator was **substantial pleasure and enjoyment**. They stated that for some people, the work and surroundings can be extremely monotonous, and if a person cannot find any joy in the process, these people quit quite soon. While talking about sources of enjoyment, the operators pointed to the internally rewarding features, aesthetics of the surroundings, and challenges in the process which create a sense of joy. Operators also emphasized the importance of a **supportive team** as a value for a successful operator (the value has high positions in the snow groomers operators' case and the highest – in excavator operators' case). Since the work is performed in harsh conditions, the person should have a team-oriented mindset to join the shared work or help in critical situations (which can also include the cases of cross-machines operations like on construction site). People who do not value this sense of connection are not successful in the process. Finally, operators mentioned the importance of **safety and security** in the process. The showroomers operators discussed it primarily in the context of a "secure mindset," as a person who wants to succeed as an operator should be attentive to security signals and prioritize security in operations. They also remarked on the omnipresent role of security in the whole process of operating. However, considering that the value of following rules and respecting authorities was rated much lower than creativity and autonomy in both use cases, we can conclude that security through following a strict path of operation will be less welcomed than one based on common practices and common sense. In contrast, the values of influence and authority, and success and recognition were rated much lower on the list (in exception of one excavator operator) because the job offers limited career opportunities and competition. The operators primarily think about their work as autonomous with some collaboration needed to execute specific tasks. However, the organization of the work provides little competition and cannot be used as a driver for performance.

On the level of **specific features**, we discover the following points:

In general, participants feel favourable toward the proposed features and think they can improve their working life by many parameters. The parameters seem to correlate with each other (if a person liked a feature, they often rated it high not just in usefulness, but also in enjoyment, ease of use, and security). The results are highly reassuring, as the first procedure showed that the parameters of feature investigations (enjoyment, usefulness, security, and ease of use) are close to the core values of the profession, meaning implementing them in feature design works to assure respect for operators' values. The most ambiguous component of evaluation was connected to enjoyment, as many users rated it in the middle of the scale for many features, pointing to the fact that the feature will not significantly change the status quo for the job. This can be connected to the fact that, at the current stage of development, we are mostly discussing utilitarian values (functionality) and have not yet moved to the hedonic dimension of design, so the assessment marks may rise later on. Additionally, operators pointed to two extremely important problems connected to security and the ease/difficulty of working based on the discussed features. The first crucial component, which lowered the assessment of multiple features, was the potential for visual overload from the new information coming from XR. In an overloaded situation, it will be harder to make operational decisions both in the normal workflow (therefore making the normal workflow harder) and, specifically, under critical conditions, where an operator under stress and in an overloaded condition can make serious mistakes while operating the vehicle. In the excavators use case it makes the ambient lights function, showing the distance to the object the problematic from one of excavators operator point of view as it could provide additional visual noise while still being useful. This was also tightly connected to the problem of professional education ethics: as stated by one of the snow groomers operators, if a person learns how to drive the snow groomer in the presence of those features, they won't learn the right practices and which information they should prioritize. Consequently, another safety concern pointed out by one of the snow groomers operators and confirmed by the others was connected to the fact that reliance on the features can also lead to the operator being unable to recognize if the system starts to make mistakes and do things wrongly. In the operational scenario, that can also lead to grave mistakes and injuries for the operators; therefore, some of the operators voted for the opportunity to make the solutions at least switchable and provide different levels of support to the beginner and experienced operator with more safety-related and reliance-related precautions in the first scenario.

Based on this round of evaluation, we add the following points and developed the following questions for the next stage prototypes, which should be answered positively before moving forward:

- **Does this technology respect operator autonomy? Can it be switched on and off? If not, is it properly explained to the operator? Is it verified with the operator that the technology can be used in "always on" mode?**
- **Does the technology support different levels of information presentations for different levels of operator expertise? Does it provide additional opportunities for professional learning and development?**
- **Have we created proper corrective mechanisms to avoid overreliance on the technology?**
- **Have we created a mechanism to support the user in prioritizing real-world parameters over virtual ones?**
- **Have we assured that the technology does not promote competition between operators (e.g., some forms of gamification will not be possible) as it can provoke more dangerous behaviour and is not in line with professional values?**
- **Does the technology support any forms of work-on collaboration (e.g., make joint operations easier)?**
- **Does the feature bring some additional hedonic value to the process (raising the enjoyment factor of operation)?**

3.3 Evaluation of the industrial baseline for ethics and privacy

To be able to properly pose the ethical and privacy concerns of the end users into the broader landscape of the domain’s practices and to determine if any of our proposed solutions penetrate the baseline of what is appropriate in the industry, we developed the structure for the semi-structured interview, which can be used in the frames of empirical evaluation of the domain in VCD [18]. Based on previous works dedicated to the privacy and ethics problems associated with XR, we created the following list of questions (Table 3).

Table 3: Semi-structured interview, for establish baseline for privacy and ethics on workplace (use cases domains)

Does the vehicle collect (or can potentially collect, e.g., the feature exists in the new vehicles but was not present in the older models) **some types of information such as**: • GPS data, • data about the speed of movement and directions of the movement, • environmental conditions (like temperature, moisture), • (any) obstacle information through sensors or cameras (e.g. position of other objects nearby), borders of operation site. • operational efficiency metrics (e.g. fuel usage), • safety-related data (proximity alerts and collision warnings).

If any of that is collected, where and how this **information is typically stored**? **How long** is it **usually** stored? If there any additional rules for longer storage in case of incidents? How does **authorization for vehicle use** occur, step-by-step? **Where is the authorization data stored**? How is access to the **data typically managed**? Has the companies considered scenarios where operators request access to their data (if you ever heard about these types of requests)? If so, what types of data might they inquire about? Does the **vehicle monitor any vital signals from the operator** (e.g. fatigue levels/ alertness through eye tracking)? If yes, where does the information store? If the **operator leaves the company**, what **usually happens to the data associated with them** (e.g., performance data, if they are collected)? Have the companies usually implemented any **analytical approaches** to the data? Do the data used for promotion/salary decision? Do the data use for **other purposes**, e.g. **AI models training**? If there are any **standard consent forms** in the industry, explaining the operators GDPR related issues connected to their work, or each company implement their own forms? Are there any **fleet management** systems used in vehicles? If yes, **how do they work, what types of data are collected, and how is the data stored** (e.g., is the cloud hosting internal to the company or external)? **Can end-users (operators) choose whether to use fleet-management-related features**, or is their use mandatory in the contract? What is the current industrial opinion about **teleoperation/fully automated operations**? Is it already much in use? What is the **horizon of planning for intense automation in the field**? What are the **main barriers** (e.g., technical, social etc.) for that?

3.3.1 Results of evaluation the baseline for privacy and ethics across the three use cases

We tested the procedure with experts across all three use cases (3 experts in total, working in a company on the operations-related position for a long time or developing a digital solution for a domain). After the interviews we validated the key points with experts to assure the absence of mistakes.

A short overview of the answers to the main questions is presented in the Table 4.

Table 4: Overview of the industrial baseline evaluation

Question	UC1	UC2	UC3
Does the vehicle collect (or can potentially collect, e.g., the feature exists in the new vehicles but was not present in the older models) **some types of information such as**:			
GPS data	yes, it is mapping the position with GNSS (Global	yes	some of the vehicles can map position with GPS,

	Navigation Satellite System), like GPS, Glonass, Galileo or Baidu		but not the old vehicles
data about the speed of movement and directions of the movement	yes	yes	yes
environmental conditions (like temperature, moisture)	weather condition information coming from station, there is telematic system for temperature update which store no data	no	no
(any) obstacle and terrain information/terrain analysis through sensors or cameras (e.g. position of other objects nearby), borders of operation site	no for terrain analysis, some – for obstacle detection	no	partly, some excavators have cameras
operational efficiency metrics (e.g. fuel usage)	yes	yes, the processes connected to the machine performance	not any of them, but starts to become more popular, helping determine the real use of the vehicle (and prevent personal use situations
safety-related data (proximity alerts and collision warnings)	In development	the system is not collecting them, just inform operator; but collect collision information	no
If any of that is collected, where and how this **information is typically stored**? **How long** is it **usually** stored? If there any additional rules for longer storage in case of incidents?	It is stored in the cloud; operating companies makes agreement with the snow groomer developers; there is no specific rules for the information about incidents.	no special rules for incident handling, the collision avoidance call given, but not specifically stored; information is storing in the cloud for big companies, smaller companies save the information locally.	for now, most operational data are stored in the excavators themselves. It is possible to load this data onto the cloud, but using Wi-Fi can cause network connection issues
How does **authorization for vehicle use** occur, step-by-step? **Where is the authorization data stored**?	anonymised data stored on the vehicle developing company in	the operating company assigns the individual operator a number. The	in many companies there is no specific association between user and

	pseudonymised form (the pseudonymisation should be performed on the operating company side); the keys are stored on operating companies' level	machine development company only has the operator's number and does not know the identity of the operator.	vehicle (any operator can use any key to authorise, the area is not very digitalised), however more modern vehicles are identified through login procedures
How is access to the **data typically managed**? Have the companies considered scenarios where operators request access to their data (if you ever heard about these types of requests)? If so, what types of data might they inquire about?	no information about such requests, data are anonymous for vehicle developing company, theoretically operating company can request delete/provide data.	no information about such requests; companies providing data to terminals (KPIs about the customer operations, fuel level or tyre pressure)	no information about such requests
Does the **vehicle monitor any vital signals from the operator** (e.g. fatigue levels/ alertness through eye tracking)? If yes, where does the information store?	no	no	no
If the **operator leaves the company**, what **usually happens to the data associated with them** (e.g., performance data, if they are collected)?	vehicle data are stored; in case of mapping to operator, the standard setting is stored in anonymous version.	if any data stored, they are either anonymised (no connection to operator) or pseudonymise (company can relate them to the operator), but by default they are staying in the company.	if any data stored, they are either anonymised (no connection to operator) or pseudonymise; they are staying in the company.
Have the companies usually implemented any **analytical approaches** to the data? Do the data used for promotion/salary decision? Do the data use for **other purposes**, e.g. **AI models training**?	yes, but not any personal operator data	yes, the companies can use anonymized data for analysis and training AI; from the operator efficiency metrics side there is not yet requests from the companies about this type of service	use of AI is just starting in the industry, but it is probably the way forward for bigger companies, as it can help with optimization. However, it will not be possible to use

			this data for promotion decisions, as the trade unions will probably not approve it.
If there are any **standard consent forms** in the industry, explaining the operators GDPR related issues connected to their work, or each company implement their own forms?	no information, happened on the operating company side	for a moment there are initiatives in industry about using common protocols for data sharing, but it is rather on terminal side and it relates to machine data	decided on business level, e.g. there is not yet fully applied data sharing protocols, and all the discussion is related to machine data.
Are there any **fleet management** systems used in vehicles? If yes, **how do they work, what types of data are collected, and how is the data stored** (e.g., is the cloud hosting internal to the company or external)? **Can end-users (operators) choose whether to use fleet-management-related features**, or is their use mandatory in the contract?	at least some companies implement fleet management features, information stored in encrypted cloud, there is no opt-out options.	It can be useful to coordinate the machine and operator; by default, the collected information cannot be switched off	it is technically possible and there are several solutions on the market, which aim to coordinate the vehicles; in a moment the system is more to assign vehicle to task and not for coordinating operators. They can call each other if they need coordination
What is the current industrial opinion about **teleoperation/fully automated operations**? Is it already much in use? What is the **horizon of planning for intense automation in the field**? What are the **main barriers** (e.g., technical, social etc.) for that?	still the question for the future, the surrounding is too unpredictable.	there are teleoperations in the container handling industry for larger containers (automated terminals) operating machines, but not yet for reach stackers. The surrounding environment and the type of operations performed in the terminal are more difficult to automate compared to autonomous driving.	still the question for the future, the surrounding is rather unpredictable (compare to the road, where task for cars is easier to implement).

The results showed that the current ideas and implementations proposed in the project do not exceed the baseline in terms of personal data collection. In most cases, the data are taken from the machine in an anonymized/pseudonymized mode, with the task of keeping pseudonyms assigned to the operating company. It was also revealed that despite end users' concerns (discussed in D2.3), there are few initiatives from companies to use the performance data of operators in work-related decisions. However, technically, companies are capable (and more will be capable in the future) of taking the data and implementing sophisticated AI-based analyses of performance, which can also include the operator's performance. The data potentially generated by XR implementations can make the data collection richer and, in this case, create more risks in evaluation scenarios. The development should ensure a transparent way of communication and agreement between workers and the company in that scenario. However, it was also confirmed that operators are usually rather passive about their data and have little initiative to ask for access to or deletion of their data when leaving the company. The current baseline also shows that, intentionally or not, data storage is restricted to machine data. The vehicles are not currently collecting any specific operator vitals. As one of the goals of the project is to make work more enjoyable and meaningful for operators, one possible line of reaching this goal is to save some operational data and bring it to the operator. This, in turn, may require additional data collection about the operators' actions, which is currently above the baseline. Therefore, all decisions related to this additional data collection should be discussed within the development team with caution, as they can significantly alter the data collection status quo and provoke strong reactions from company stakeholders and end users.

Based on this round of evaluation, we add the following points and developed the following questions for the next stage prototypes, which should be answered positively before moving forward:

- **If the feature implementation involves collecting personal data, what steps can we take to evaluate the risks and benefits of this implementation?**
- **Can the newly implemented XR feature affect established data collection and data handling processes? If yes, and if it exceeds industry standards (e.g., in data sensitivity or amount of data), what additional security/privacy measures do we plan to implement?**
- **If the feature requires storing personal data, have we evaluated alternative paths and designs that can work without data collection?**
- **If the developed feature collects data, could this data be beneficial for operators? How should this data be presented to them?**
- **If data from XR implementations will be stored, have we ensured that the data handling will adhere to a higher level of industrial baseline (e.g., encrypted cloud storage)?**

3.4 Co-design workshop for reevaluating privacy goals and specifying stages of privacy requirements

To assess the achievement of the project's privacy and ethics goals, we created a prototype of a synchronous/asynchronous workshop with the stakeholders. Following the paradigm of humanity-centred design, we organized the activities of the stakeholders not only around the questions of the ongoing stages of the project but also about the greater benefits of privacy- and ethics-guided development to society. The procedure included the following steps:

First, we re-iterated and evaluated the privacy requirements proposed in D2.3 in relation to the current specifications of the technologies we are implementing in the project. Our goal was to reflect on the most challenging ones from the perspectives of different stakeholders.

In the second phase, we asked participants to ideate around the following parameters related to the solutions. We specifically requested that participants be as detailed as possible and take a narrow perspective (e.g., answering from their perspective as providers of specific technology or holders of specific use cases). We used on-line format for the discussion and applied a Mural board for tasks allocation.

We asked to elaborate around the following questions (see the Table 5 for the exact questions, Fig. 4 illustrate the workshop process on the main online board):

- the first three questions were asked about the stages of adopting and applying our privacy requirements in the different stages of the project: in the middle of the project, at the end of the project, and after the end of the project. The last of them were specified beyond the project goals and were formulated for the industry in general ("How would you like to see this type of requirement being implemented by other companies and the industry in general?")
- the next two questions were organized to provide the envisioned route for implementing the requirement and to assign the responsibilities of the project's stakeholders regarding achieving and controlling privacy and other ethical goals in the project. This can help create a list of co-dependent actions from the stakeholder side and organize the network of implementations and control inside the project.
- finally, as we follow the principles of audibility in XR development, proposed by Norval et al. [36] (more information about the used paradigm can be found in D.7.3), we specify the measurable criterium, which will show if we achieved of failed the subtasks of privacy and ethic-related questions in the project.

Table 5: Privacy Requirements goal-setting and roles allocation questions

How we want it to be implemented **mid-term** (e.g., September 2024)	How we want it to be implemented in the **final stage** of the project	How we want it to be implemented **beyond the frames of the project** (e.g., in the industry in the future, what should be a standard for XR augmentation development for the industry)	Who is responsible for **implementing** it?	Who is **responsible** for **assessing** the implementation?	What are the criteria for **successful implementation**?	What are the criteria for **failure**?

The developed procedure should be performed during the different stages of the project to ensure consistent movement toward privacy-centred development. We tested the developed procedure with stakeholders (12 participants, including the technologies developers and the representatives of the companies), and the results showed that the procedure is useful for understanding the privacy-related questions that should be addressed within the project.

We also specified the best possible privacy-related outcomes of this and similar projects for society and what could be further implemented into the industrial guidelines for ethical XR development. However, we found, that the free procedure of the specification of the results of the project is still not clear enough for the participants, which provides too general answers to the question (e.g., "all the results should be in line with the project specification") so we are planning to move further specifying the co-design of the privacy and ethics support mechanisms on the levels of procedures and artifacts, which can help create more specified answers. We also plan to dedicate specific space to present the overarching values of the operators in each use case, pushing towards generating implementation ideas that keep these values as design constraints to specify the design space for privacy- and ethics-related mechanisms.

Figure 3: Board for privacy-goals setting and roles allocation after the first workshop with the stakeholders

3.4.1 Results of co-design workshop for reevaluating privacy goals and specifying stages of privacy requirements

During the privacy requirements elicitation, we performed in the frames of Task 2.3 (Identification of Privacy Requirements), we formulate seven privacy requirements (PR), which was relevant to the project on that stage:

- (PR1) The uses cases shall identify which personal data are they processing.
- (PR2) The use cases shall adopt a data minimization approach.
- (PR3) When a privacy threat is discovered, the team developing the use case shall convene to discuss a strategy for mitigating it.
- (PR4) The implementations proposed in the use cases shall have a system in place to modify and delete personal data.
- (PR5) Where the object detection model is in place, the applied algorithm shall be tested for fairness.

- (PR6) Where an object detection system is in place, the vehicle shall display a post or sticker informing about the use of this system.
- (PR7) Where XR-enhanced features are integrated into the system interface, there should be a clear method for users to opt in or opt out.

(More information about it can be found in D2.3).

In the presented workshop, we revisited the requirements to assess how they align with the technology and development progress in the project. We found that two of the requirements elicited in the previous stage of the work, namely PR4 and PR5 provided an extensive discussion about applicability at the current stage of the project. Specifically, stakeholders pointed out that the current list of technological implementations does not consider collecting and storing any personal information about the operator, only about the use of the machine (which is in line with the industrial baseline; see part 3.3.1 for reference). However, the discussion revealed that different stakeholders are not yet fully in agreement about whether the data collection of the XR parameters should be stored and when it should be given to the operator (in visual or textual forms) to enhance work fulfilment and enjoyment. As this point is a cornerstone of the project for privacy, it is necessary to make a decision and specify the data collection practice before implementing the tested XR solutions into the following prototype.

The second point of the requirements discussion was concentrated around the use of AI datasets and training set data collection in the project, specifically testing for the fairness of algorithms. As all the stakeholders acknowledged this as an important point to consider during development, they decided not to develop the algorithms (e.g., obstacle detection algorithms) from scratch but to use existing algorithms, fine-tuned with additional data, so the problem of the fairness of the original algorithm appears to be out of the scope of the current phase of project implementation. However, this consideration should be kept in mind at the level of results exploitation in the project.

The rest of the requirements remain in line with the current steps of project development, and therefore we proceed to the step-by-step analysis of how they should be implemented at different stages of the project.

Based on the second stage of the workshop, we collected and synthesized the joint vision of the actions and privacy-and-ethics-related mechanics we should implement for requirements at different stages of the project:

Table 6: Co-design the privacy and ethics preserving implementations with stakeholders

PR	How we want it to be implemented mid-term (e.g., September 2024)	How we want it to be implemented in the final stage of the project	How we want it to be implemented beyond the frames of the project (e.g., in the industry in the future, what should be a standard for XR augmentation development for the industry)	Who is responsible for implementing it?	Who is responsible for assessing the implementation?	What are the criteria for successful implementation?	What are the criteria for failure?
PR1	Final definition of data collection requests from technology developing partners; The data determined to collect should be validated through workshop with users (in co-design approach).	Validated list of the privacy and ethics concerns left in the project (based on requirement list); Each concern has actionable way to address (on technology and on interaction level).	Industry-validated guidelines with the best practices and lesson learned from the project for development for similar industry; The considerations should be included in the exploitation plan.	UC leads accumulating result from technology provider	UL partner, end-users; cross-reviewed by developing team	Clear documentation of the data processing which matches the requirements, (b) matches the implementation, satisfies stakeholders and end-users	Unclear requirements, unsatisfied end users (no acceptance of the solutions)
PR2	All technology partners confirm either no collecting personal data or provide the reasons for collecting	Clearly document the data processing pipelines to identify which data are processed, and whether or not they are retained long term	Provide a way to verify that the collection of the personal data is the minimal possible for the implementation to work	UC leads, supported with XR developers	UL partner, UC leads	Confirmation of privacy experts; Data processing matches the requirements.	Unclear what has been stored and why, lack of documentation describing data processing for each feature

PR3	Any researcher/developer discovering a concern should be responsible for brining it to attention, discussion should be carried out by ethics / privacy lead and project lead + partners responsible for the development of the affected feature; topic should be brought to attention to the whole team and support with Ethics/privacy lead (UL) as soon as possible.	All privacy threats need to be identified. If certain privacy/ethics threats are not solved, they need to be clearly documented	No privacy threats are allowed to be present anymore before bringing it to market; Provide some guidance on how ethical and privacy concerns should be handled (based on the process and learnings in this project), should they arise in subsequent co-design projects or industry development.	The mitigation process is guided by UL, UC-leads and technical experts are part of the team.	Privacy lead, coordinator, UC lead, end-uses	List of identified and resolved concerns validated and approved by stakeholders and end-users	Concerns and issues which stay unresolved/ unsatisfactory resolved to the end of the project
PR4	Currently the development team follow the approach to not collecting the personal data (see more above). However, if the decision about (some) data storage will be justified after the following stage of co-design, we planning to implement the mechanism of control and monitoring which data are collected from operator, for which period of time and how they can be used from operator and company side.						
PR5	Currently developers are planning to use only preexisting algorithms (see more above), however in any case the algorithms will be tested according to use case specification to assure the absence of the performance problem.						
PR6	Project should have preliminary decision how and when present the warnings (some use cases already propose their ideas of placement and structure of warnings	Create the warning system using automation transparency principles	Develop clear guidelines for presenting the warnings in case of Off-Highway Machinery	Systems provider, Site operator	Safety inspector (the implementation would be mostly on operation side)	Clear and understandable warning (rested with end-users)	Unclear non-accessible information

PR7	Describe which features are can/can't be opt in/opt out. Several partners already confirmed the mechanism is implemented in their solutions	All solutions should be considered and decided which benefit from the possibility to opt in/out. By the end of the project, it should be identified which technologies can benefit from this.	Before bringing it to the market, the possibility to opt in/out should be available for all technologies that make sense to include this feature.	UC Leads, Technology developers	Technology developers, co-design and privacy leads	User feedback, confirmation of privacy experts	Unclear requirements, unsatisfied end users (operators reject the solutions)

The results of the workshop helped formulate the list of short, mid, and long-term goals in privacy and ethics for the technologies we are developing in the project. Our next step will be to hold the next workshop in the series in mid-September to determine if we are in line with the short-term privacy goals and how we are implementing the privacy-related ideas co-designed with the stakeholders. We will also add additional parameters for evaluating the XR solutions based on the privacy questions identified in sections 3.2.1 and 3.3.1, respectively.

3.5 Quantitative methods for assessment of privacy and ethical concerns

In the final stage of the evaluations of the proposed XR-enhanced solutions for off-highway machinery (in the end of the project), we also plan to use two quantitative methods to compare the developed solutions with the existing baseline in the industry. The first one is the subsection of the User Experience Questionnaire (UEQ), dedicated to privacy/trust [42], developed by Hinderks [24]. The original User Experience Questionnaire [30] based on the theoretical model of hedonic and utilitarian values of the product, proposed by Hassenzahl [22]; however, the instrument is constructed to be able to incorporate additional modules for the extensive investigation; the chosen trust scale was validated and extensively used in UEQ+ approach. The second proposed questionnaire, developed by Ayalon and Toch, is dedicated to evaluating users' perceptions about a system's privacy in the aspects of perceived information control, confidentiality, importance of information transparency, secondary usage, data deletion, perceived privacy risk, information sensitivity, protection strategies, identity sharing. The structure of the questions allows the tailor of the questionnaire to evaluate specific systems or applications [5]. While not all the scales can be applicable in the context of XR-for-work (the questionnaire was developed in the context of evaluation of third-party systems and tested on social media platforms as systems examples), it can help provide a quick evaluation of users' perception of privacy in the final implementation.

4 Conclusion

Developing technologies that are sensitive to user privacy and do not create additional risks to ethical and fulfilling work can be challenging. As shown in previous literature, the use of XR technologies poses considerable risks to users' privacy and security, creating room for the intentional or unintentional implementation of bad practices. Additionally, putting XR into the context of work presents additional challenges related to the risks that new technology can create for work ethics (e.g., disturbing practices of physical data collection or undermining users' agency). In the presented deliverable, we showcased a range of methods to help us address these challenges. Through the paradigm of co-design, we examined methodologies to address stakeholders’ and users’ values and privacy needs. The developed procedures were already tested with stakeholders and users, and the insights received have helped us further co-design and evaluate prototypes of the solutions. The full procedures will be updated with the results of D3.6, and the final version of the privacy and ethics procedure evaluation will be presented in D3.8.

The results of this deliverable will be used in the following ways:

- To empirically inform the guidelines we are developing for the domain of off-highway machinery (the first version of the guidelines is presented in D7.3).
- To bring the discovered ethical and privacy concerns to the stakeholders and end users in the following cycles of prototype development. To do this, we are planning monthly meetings with scientific (developing) and use case holders to critically discuss how the findings from the user studies and privacy considerations, formed in D2.3 and refined in D3.3, are met in the proposed designs of technologies.
- To make the road for the final validation with the users and stakeholders in the end of the project, which will be presented in D6.7 Privacy assessment results.

References

[1] Melvin Abraham, Pejman Saeghe, Mark Mcgill, and Mohamed Khamis. 2022. Implications of XR on Privacy, Security and Behaviour: Insights from Experts. In Nordic Human-Computer Interaction Conference. 1–12.

[2] Rebecca Acheampong, Titus Constantin Balan, Dorin-Mircea Popovici, and Alexandre Rekeraho. 2023. Embracing XR System Without Compromising on Security and Privacy. In International Conference on Extended Reality. Springer, 104–120.

[3] Devon Adams, Alseny Bah, Catherine Barwulor, Nureli Musaby, Kadeem Pitkin, and Elissa M Redmiles. 2018. Ethics emerging: the story of privacy and security perceptions in virtual reality. In SOUPS@ USENIX Security Symposium. 427–442.

[4] Simon Albrecht, Andrew Marty, and Nicholas J Brandon-Jones. 2020. Measuring values at work: Extending existing frameworks to the context of work. Journal of Career Assessment 28, 4 (2020), 531–550.

[5] Oshrat Ayalon and Eran Toch. 2019. Evaluating {Users'} Perceptions about a {System's} Privacy: Differentiating Social and Institutional Aspects.In Fifteenth Symposium on Usable Privacy and Security (SOUPS 2019). 41–59.

[6] Balbir Barn, Ravinder Barn, and Franco Raimondi. 2015. On the role of value sensitive concerns in software engineering practice. In 2015 IEEE/ACM 37th IEEE International Conference on Software Engineering, Vol. 2. IEEE, 497–500.

[7] Sandra Barteit, Lucia Lanfermann, Till Bärnighausen, Florian Neuhann, Claudia Beiersmann, et al. 2021. Augmented, mixed, and virtual reality-based head-mounted devices for medical education: systematic review. JMIR serious games 9, 3 (2021)

[8] Peter Casey, Ibrahim Baggili, and Ananya Yarramreddy. 2019. Immersive virtual reality attacks and the human joystick. IEEE Transactions on Dependable and Secure Computing 18, 2 (2019), 550–562.

[9] Francesco Chiossi and Sven Mayer. 2023. How Can Mixed Reality Benefit From Physiologically-Adaptive Systems? Challenges and Opportunities for Human Factors Applications. arXiv preprint arXiv:2303.17978 (2023).

[10] Stephanie Hui-Wen Chuah. 2018. Why and who will adopt extended reality technology? Literature review, synthesis, and future research agenda.Literature Review, Synthesis, and Future Research Agenda (December 13, 2018) (2018).

[11] Aaron Cohen. 2009. A value based perspective on commitment in the workplace: An examination of Schwartz's basic human values theory among bank employees in Israel. International Journal of Intercultural Relations 33, 4 (2009), 332–345.

[12] Mary L Cummings. 2006. Integrating ethics in design through the value-sensitive design approach. Science and engineering ethics 12 (2006), 701–715

[13] Fred D Davis. 1987. User acceptance of information systems: the technology acceptance model (TAM). (1987).

[14] Luís Fernando de Souza Cardoso, Flávia Cristina Martins Queiroz Mariano, and Ezequiel Roberto Zorzal. 2020. A survey of industrial augmented reality. Computers & Industrial Engineering 139 (2020), 106159.

[15] Åsa Fast-Berglund, Liang Gong, and Dan Li. 2018. Testing and validating Extended Reality (xR) technologies in manufacturing. Procedia Manufacturing 25 (2018), 31–38.

[16] Maarten Franssen. 2015. Design for values and operator roles in sociotechnical systems. (2015).

[17] Batya Friedman, David G Hendry, Alan Borning, et al . 2017. A survey of value sensitive design methods. Foundations and Trends® in Human–Computer Interaction 11, 2 (2017), 63–125.

[18] Batya Friedman, Peter H Kahn, Alan Borning, and Alina Huldtgren. 2013. Value sensitive design and information systems. Early engagement and new technologies: Opening up the laboratory (2013), 55–95.

[19] Tim Gorichanaz. 2024. Toward Humanity-Centered Design without Hubris. arXiv e-prints (2024), arXiv–2402.

[20] Hilda Hadan, Derrick M Wang, Lennart E Nacke, and Leah Zhang-Kennedy. 2024. Privacy in immersive extended reality: Exploring user perceptions, concerns, and coping strategies. In Proceedings of the CHI Conference on Human Factors in Computing Systems. 1–24.

[21] Andreas Halbig, Sooraj K Babu, Shirin Gatter, Marc Erich Latoschik, Kirsten Brukamp, and Sebastian von Mammen. 2022. Opportunities and challenges of virtual reality in healthcare–a domain experts inquiry. Frontiers in Virtual Reality 3 (2022), 14.
[22] Marc Hassenzahl. 2001. The effect of perceived hedonic quality on product appealingness. International Journal of Human-Computer Interaction 1[2 4 (2001), 481–499.
[23] Anaëlle Hily, Laurent Dupont, Giovanny Arbelaez-Garces, Mauricio Camargo, and Jérôme Dinet. 2023. Evaluation and Validation Process of Extended Reality Applications Developed in an Industrial Context: A Systematic Review. SN Computer Science 4, 5 (2023), 637.
[24] Andreas Hinderks, Jörg Thomaschewski, Martin Schrepp, and Menno Ternieden. 2016. Modifikation des User Experience Questionnaire (UEQ) zur Verbesserung der Reliabilität und Validität. Unveröffentlichte Masterarbeit, University of Applied Sciences Emden/Leer (2016).
[25] Yan Huang, Yi Joy Li, and Zhipeng Cai. 2023. Security and privacy in metaverse: A comprehensive survey. Big Data Mining and Analytics 6, 2 (2023), 234–247.
[26] Hee-Woong Kim, Hock Chuan Chan, and Sumeet Gupta. 2007. Value-based adoption of mobile internet: an empirical investigation. Decision support systems 43, 1 (2007), 111–126.
[27] Murielle G Kluge, Steven Maltby, Angela Keynes, Eugene Nalivaiko, Darrell JR Evans, and Frederick R Walker. 2022. Current state and general perceptions of the use of extended reality (XR) technology at the University of Newcastle: Interviews and surveys from staff and students. Sage Open 12, 2 (2022), 21582440221093348.
[28] Peter Kroes and Ibo van de Poel. 2015. Design for values and the definition, specification, and operationalization of values. Handbook of ethics, values, and technological design: sources, theory, values and application domains (2015), 151–178.
[29] Sari Kujala, Tanja Walsh, Piia Nurkka, and Marian Crisan. 2014. Sentence completion for understanding users and evaluating user experience.Interacting with Computers 26, 3 (2014), 238–255.
[30] Bettina Laugwitz, Theo Held, and Martin Schrepp. 2008. Construction and evaluation of a user experience questionnaire. In HCI and Usability for Education and Work: 4th Symposium of the Workgroup Human-Computer Interaction and Usability Engineering of the Austrian Computer Society, USAB 2008, Graz, Austria, November 20-21, 2008. Proceedings 4. Springer, 63–76.
[31] Junghyo Lee, Junghun Kim, and Jae Young Choi. 2019. The adoption of virtual reality devices: The technology acceptance model integrating enjoyment, social interaction, and strength of the social ties. Telematics and Informatics 39 (2019), 37–48.
[32] Marjaana Lindeman and Markku Verkasalo. 2005. Measuring values with the short Schwartz's value survey. Journal of personality assessment 85, 2 (2005), 170–178.
[33] Nikola Marangunić and Andrina Granić. 2015. Technology acceptance model: a literature review from 1986 to 2013. Universal access in theinformation society 14 (2015), 81–95.
[34] McGill and Mark. 2021. White Paper-The IEEE Global Initiative on Ethics of Extended Reality (XR) Report–Extended Reality (XR) and the Erosion of Anonymity and Privacy. Extended Reality (XR) and the Erosion of Anonymity and Privacy-White Paper (2021), 1–24.
[35] Donald A Norman. 2023. Design for a better world: Meaningful, sustainable, humanity centered. MIT Press.
[36] Chris Norval, Richard Cloete, and Jatinder Singh. 2023. Navigating the Audit Landscape: A Framework for Developing Transparent and Auditable XR. In Proceedings of the 2023 ACM Conference on Fairness, Accountability, and Transparency. 1418–1431.
[37] Joseph O'Hagan, Pejman Saeghe, Jan Gugenheimer, Daniel Medeiros, Karola Marky, Mohamed Khamis, and Mark McGill. 2023. Privacy-Enhancing Technology and Everyday Augmented Reality: Understanding Bystanders' Varying Needs for Awareness and Consent. Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies 6, 4 (2023), 1–35.
[38] Suchismita Pahi and Calli Schroeder. 2023. Extended Privacy for Extended Reality: XR Technology Has 99 Problems and Privacy Is Several of Them.Notre Dame J. on Emerging Tech. 4 (2023), 1.
[39] Mary Beth Rosson and John M Carroll. 2002. Usability engineering: scenario-based development of human-computer interaction. Morgan Kaufmann.

[40] Marius Rubo, Nadine Messerli, and Simone Munsch. 2021. The human source memory system struggles to distinguish virtual reality and reality. Computers in Human Behavior Reports 4 (2021), 100111.
[41] Elizabeth B-N Sanders and Pieter Jan Stappers. 2008. Co-creation and the new landscapes of design. Co-design 4, 1 (2008), 5–18.
[42] Martin Schrepp and Jörg Thomaschewski. 2019. Handbook for the modular extension of the User Experience Questionnaire. In Mensch & Computer. 1–19.
[43] Shalom H Schwartz. 2012. An overview of the Schwartz theory of basic values. Online readings in Psychology and Culture 2, 1 (2012), 11.
[44] Shalom H Schwartz. 2021. A repository of Schwartz value scales with instructions and an introduction. Online Readings in Psychology and Culture 2, 2 (2021), 9.
[45] Tawseef Ayoub Shaikh, Tabasum Rasool Dar, and Shabir Sofi. 2022. A data-centric artificial intelligent and extended reality technology in smart healthcare systems. Social Network Analysis and Mining 12, 1 (2022), 122.
[46] Ibo Van de Poel. 2013. Translating values into design requirements. Philosophy and engineering: Reflections on practice, principles and process (2013), 253–266.
[47] Ibo Van de Poel. 2015. Conflicting values in design for values. Handbook of ethics, values, and technological design: Sources, theory, values and application domains (2015), 89–116.
[48] Ibo van de Poel. 2015. Design for values in engineering. Handbook of ethics, values, and technological design: Sources, theory, values and application domains (2015), 667–690.
[49] Minna Vasarainen, Sami Paavola, and Liubov Vetoshkina. 2021. A systematic literature review on extended reality: Virtual, augmented and mixed reality in working life. International Journal of Virtual Reality 21, 2 (2021), 1–28.
[50] Pieter E Vermaas, Paul Hekkert, Noëmi Manders-Huits, and Nynke Tromp. 2015. Design methods in design for values. Handbook of Ethics, Values and Technological Design (2015), 179–202.
[51] Sauro Vicini, Francesco Alberti, Nicolás Notario, Alberto Crespo, Juan Ramón Troncoso Pastoriza, and Alberto Sanna. 2016. Co-creating security- and-privacy-by-design systems. In 2016 11th International Conference on Availability, Reliability and Security (ARES). IEEE, 768–775.

ABBREVIATIONS / ACRONYMS

AI	Artificial Intelligence
HCD	Humanity-Centred Design
PVQ40	Portrait Values Questionnaire
SVS	Schwartz Value Survey
TAM	Technology Acceptance Model
UC	Use Case
VAM	Value-Based Adoption Model
VR	Virtual Reality
VSD	Value-Sensitive Design
XR	Extended Reality