MOTIVATEXR

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

D3.1 SSH Framework

14/10/2024

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D3.1 SSH Framework

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Abstract	This deliverable presents the societal, ethical, legal issues to consider for both the activities and the results of the project and after its termination. It is the result of the initial work within Task 3.1 and aim to obtain a picture of the challenges that must be anticipated and addressed in the formulation of the end-user requirements and the further work within WP3. In this report, focus is on providing an overview list of SEL issues raised by the use XR and AI in the industry context and mapping stakeholders who may be affected by these issues
Keywords	Social, Ethical, Legal.

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EXECUTIVE SUMMARY

This report (Deliverable 3.1) establishes the fundament for a framework to address the social, ethical, and legal (SEL) challenges emerging from the use of Artificial Intelligence (AI) and extended reality (XR) technologies within the Motivate XR project. It serves to ensure that the project's activities and outcomes are aligned with moral and societal values, fundamental rights, and international norms. The report provides essential guidance to technical and end-user partners on how to mitigate social, ethical and legal (SEL) risks as they develop and deploy tools within the Motivate XR use case contexts.

The primary objective of this deliverable is to define and maintain an SSH framework, ensuring that both project activities and outcomes adhere to SEL principles, particularly those concerning AI and XR technologies. Two major outcomes are emphasized in this report: (1) a comprehensive list of SEL issues raised by the use of AI and XR in the industry, and (2) a map of stakeholders who may be affected by these issues.

The report's methodology includes three key components:

1) Stakeholder Mapping: A detailed identification of stakeholders, including direct users and organizations affected by the deployment of Motivate XR technologies, compiled from use case and tool presentations and refined using partner inputs.
2) Identification of general social, ethical and legal Concerns: Utilizing an AI-driven big-data tool (SurikaS[1], developed by YAGHMA B.V.[2]), academic literature was analysed to identify and describe relevant SEL issue areas.
3) Project-Specific social, ethical and legal Challenges: SEL challenges unique to the Motivate XR project was identified through consortium collaboration in a workshop focusing on the ethical, legal, and social risks posed by the project's technologies and prioritized through survey responses from consortium members.

The key findings indicate that there are multiple risks associated with the use of XR and AI technologies, including but not limited to the potential for harm due to remote instruction, insufficient legal frameworks, increased cyber risks, and privacy concerns. The full list of concerns relevant to the Motivate XR context can be found in Section 6. It is highly encouraged that both technical partners, who design and develop the tools, and use-case partners, who must ensure ethical conduct during pilot activities reflect on the findings in Section 6.

This document is intended for technical partners, end-user partners, and stakeholders from other EU projects with similar goals, providing them with actionable insights on which human values to safeguard and what SEL risks to prioritize mitigation measures for. The insights gathered here will be critical for informing future developments in the project, with the next deliverable (D3.2) scheduled for month 19 to provide further recommendations and mitigation strategies.

[1] www.SurikaS.com

[2] https://yaghma.nl/

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ABBREVIATIONS

AI	Artificial Intelligence
CSR	Corporate Social Responsibility
DDoS	Distributed Denial-of-Service
DIY	Do It Yourself
HMD	Head Mounted Display
IP	Intellectual property
PTSD	Post-Traumatic Stress Disorder
R&D	Research and Development
SEL	Social, ethical and legal
SSH	Social science and humanities
WP	Work Package
XR	Extended Reality

1 INTRODUCTION

Background

The cutting edge innovation work undertaken by researchers in Work Packages (WP) 4-7 takes place within the context of a comprehensive social, ethical and legal (SEL) framework (WP3), to promote the development of technical tools that respect moral and societal values, fundamental and human rights, and international legal norms.

In what follows, and as will be outlined, we focus our efforts on providing an updated set of social, ethical and legal (SEL) recommendations that end-users and contributing partners need to be aware of and take necessary action in order to support their compliance with the SEL framework.

Purpose and Scope

With pilot scenarios having begun, this deliverable sets out to achieve an objective, namely:

- define and keep updated the SSH framework ensuring that both the project's activities and outcomes are compliant and acceptable, and informing the project about societal, ethical and legal issues to consider, in particular those related to the use of AI and XR technologies.

To this end, two specific outcomes will be provided within the scope of this report as outlined and numbered in the Grant Agreement, namely:

1) A comprehensive list of SEL issues raised by the use XR and AI in the industry context.
3) A map of the stakeholders who may be affected by these issues.

This is the first report on the SSH framework, which in month 19 of this project will be supplemented with a second report (Deliverable 3.2) that will take these outcomes further and extend with:

2) The identification of existing approaches developed to address these challenges, including ethical principles and guidelines for responsible research and innovation in AI and XR, and DNSH obligations.
4) the recommendations for the project to consider for its own implementation as for the tools it will create.

As humans pare significantly involvement in the pilot activities by utilising new XR technologies and tools and being present in environments with significant data capturing capabilities and new physical features, it is of urgent and intrinsic importance to set about investigating how SEL principles can satisfactorily be upheld.

Fundamentally, the guidance provided in this document is intended to help technical partners design AI, XR and systems that safeguard human values and mitigate social, ethical and legal issues within the context of the use cases. Furthermore, it will help end-user partners and other contributing partners take further evaluating to ensure that pilot activities are carried out aligned with ethical and regulatory standards, and further mainstream mitigation and monitoring efforts into their research design and implementation.

Intended Readership

The primary intended readership of this deliverable is technical partners. They have a key role in ensuring tools that safeguard SEL outcomes as they are responsible for designing and developing the tools that will be deployed in the use case sites as well as processing different types of research data. To that end, it is firmly recommended that technical partners read and respond to, in their work, the insights provided here, which applies to them insofar as they supply equipment which should be safe and accessible, and that they are data controllers or are responsible for provision of tools utilised by data controllers that should in any case support General Data Protection Regulation (GDPR) compliance. Use-case partners are the secondary intended audience. They are recommended to read and reflect on the insights of this report as they operate the pilots and have the ultimate responsibility for ensuring the ethical and social conduct of research activities on their premises and ensuring that no harm or disadvantage comes to their employees, particularly as a result of their involvement in Motivate XR research and pilot activities.

A tertiary intended audience of this deliverable is members of other EU projects with similar goals, circumstances. The work presented here may represent a useful point of reference and guidance for future industrial demonstrations and pilot activities of a similar nature.

1.1 DOCUMENT OUTLINE

This document is structured as follows. Section 2 Method presents the methodology of this deliverable, outlining how the components support each other, including mapping of affected stakeholders, identification of concern areas and general issues, and identification of social, ethical and legal challenges specific to the Motivate XR project activities and results. In the following chapters, the activities of each component are detailed and the results provided. Section 3 'Affected stakeholders' focus on mapping the stakeholders that potentially may be affected by the Motivate XR outputs within the context of the use cases. Section 4 'Concern areas' describes how social, ethical and legal issues were identified from academic literature at large scale through SurikaS (an AI-driven tool that was customized specifically for the XR context). Section 5 'Motivate XR specific challenges' presents the results of the SEL workshop held in the project with project partners for identifying social, ethical and legal challenges. The SEL workshop was followed by a survey for prioritization of social, ethical and legal challenges, which is described in the second part of the section. In Section 6 'List of social, ethical and legal issues relevant for the Motivate XR project' a comprehensive list of SEL issues targeted in the Motivate XR context can be found. Finally, in Section 7 'Conclusions' key considerations on the work performed and the upcoming steps are presented.

2 METHOD

This report (Deliverable 3.1) documents the foundation for identifying social, ethical and legal (SEL) issues that should be addressed by the Motivate XR project. Three main paths have been followed. Firstly, a map of stakeholders that potentially may be affected by SEL issues by the Motivate XR results has been designed. Secondly, the SEL issues that are commonly discussed within academic papers have been identified using a big-data approach. Thirdly, Motivate XR specific issues were identified by consortium members in a SEL workshop and later prioritized through a survey. This methodology ensures a full overview of potential issues with project-specific details and a broad coverage as well as what stakeholders to keep in mind when working towards positive impact of the Motivate XR results. In the following sections are short descriptions of the methodology of each path. In Section 3, 4 and 5 follow detailed descriptions of the performed work and the detailed results.

2.1 MAPPING OF AFFECTED STAKEHOLDERS

To create an initial map of affected stakeholders, existing work by other Motivate XR partners was leveraged. Use case overviews from T3.2 (in D3.3) were used to identify what users would be directly and indirectly involved within the use-case organizations. Tool presentations from the project Kick-off meeting and information from tool presentation workshops hosted by UPM over the summer 2024 were used to identify users of the Motivate XR tools. Additionally, indirect users and other stakeholders that potentially may be affected by the social, ethical and legal impacts of the use of Motivate XR results were identified. This was done from the viewpoint of the use cases and of the individual tools. This initial list of stakeholders identified was sent to the Motivate XR partners to be corrected and enriched.

Based on the lists from each use-case/tool, a generalized list of stakeholders that may become affected by the social, ethical and legal impacts of the use of Motivate XR results was compiled. It is important to keep these stakeholder groups in mind throughout the development of the Motivate XR results and their demonstration in the use-cases.

The stakeholder mapping process and results are detailed in Section 3.

2.2 IDENTIFICATION OF CONCERN AREAS AND GENERAL ISSUES

The use cases within the Motivate XR project cover a range of scenarios. To ensure all relevant social, ethical and legal issues are considered, an analysis of the type of issues discussed in academic literature within the broad field of XR was performed, regardless of sector and application specifics. To cover as many articles as possible, a big-data tool developed by YAGHMA B.V.[3] called SurikaS was customized to the XR sector context. It was chosen to use this tool as it can identify

[3] https://yaghma.nl/

values and topics reliably for large quantities of text. The tool identified social, ethical and legal issues expressed in the abstract of academic papers and clusters them. By thoroughly identifying SEL issues and later on addressing them, Motivate XR can ensure the responsible and ethical development of XR technologies, while safeguarding user well-being and data privacy.

The process and results are elaborated upon in Section 4.

2.3 IDENTIFICATION OF SOCIAL, ETHICAL AND LEGAL CHALLENGES SPECIFIC TO THE MOTIVATE XR PROJECT ACTIVITIES AND RESULTS

To enrich the generally applicable indicators for social, ethical and legal issues related to XR and AI, a consortium-wide SEL workshop was organized, where all partners were invited to participate. The SEL workshop was structured around two key elements: first, a comprehensive list of stakeholders potentially impacted by XR and AI technologies; second, a set of core values relevant to the social, ethical, and legal domains. These elements served as guiding principles, enabling participants to collaboratively identify challenges and concerns that are unique to the Motivate XR project. The discussions covered both XR-specific aspects and those related to AI, ensuring a holistic exploration of the issues.

Following the SEL workshop, the participants' inputs were compiled and formulated into a list of risks. These risks were then prioritized by consortium members in an online survey. As a result, a tailored list of social, ethical, and legal challenges specific to the project was developed. These challenges will be closely monitored and addressed throughout the project's lifecycle, ensuring that Motivate XR remains aligned with ethical guidelines and anticipates potential legal and societal implications.

The SEL workshop, prioritization survey and results are detailed in Section 5.

3 AFFECTED STAKEHOLDERS

A stakeholder map was developed to capture the stakeholder groups which may be affected by technologies developed within Motivate XR. Firstly, a preliminary map was created and thereafter, consortium partners enriched it with their in-depth knowledge to develop the final map.

Use case overviews prepared in Task 3.2 was used to create an initial list of users and other stakeholders within the Motivate XR use-cases. In Task 3.2, a survey was conducted to collect the necessary information from the use-case partners. This survey consisted of a word-file for collecting nuanced explanations and an online survey for collecting clear answers (Presented in Deliverable 3.3). In this way, nuanced information about users within the use cases of the XR experiences was collected. Additionally, the online survey was enriched with one question aimed at identifying stakeholders, namely "Which stakeholders are expected to be involved with the XR besides the main user (e.g. IT maintenance department, internal content supervisor)?". Four out of five use cases identified additional main users within the survey:

TABLE 1: ADDITIONAL MAIN USERS IDENTIFIED THROUGH USER REQUIREMENT SURVEY

Pilot	Use Case	Additional main users
1	Aerospace Industry	IT maintenance department
2	Home appliance Industry	IT, Technical support, call center
3	Aluminum Industry	Trainer – supervisor – remote expert
4	Electric Distribution Industry	Health & Safety Department
5	Robot-human hybrid manufacturing	N/A

The Motivate XR project is developing tools that ease the creation of XR experiences for training and field assistance to industrial operations. Therefore, the stakeholders were also mapped from the perspective of the tools that are brought into the Motivate XR project as background IP. This mapping was based on the presentations of the tools at the Kick-off meeting and of the detailed tools workshops arranged by UPM over the summer of 2024. The map was organized by the proximity of each stakeholder group to the tools and providing an overview of which stakeholders are expected to be relevant for which use cases and what tools.

The initial map was sent to consortium partners for their feedback. Three partners had corrections before the SEL workshop was conducted and two additional had after the SEL workshop was conducted (two use case partners (AV and HGE) and three technical partners (D3, YBQ, CETMA)). The full stakeholder map can be seen in Appendix A.

Below is the summary list of stakeholders within the user organizations that are foreseen to potentially be affected by the social, ethical and legal impacts of Motivate XR. The feedback from the consortium is indicated by the number of use cases and tools for which a consortium partner has given explicit feedback that the stakeholder is seen as relevant for the use case or tool. This number is indicated in the right column "Confirmed cases".

TABLE 2: POTENTIALLY AFFECTED STAKEHOLDERS WITHIN USER ORGANIZATIONS

	Potentially affected stakeholders	Confirmed instances
End-user (on location or VR glasses side)	Technician in the field	4
	Student at training location	3
	non-expert/general technician/operator	3
	General public	2
	Content creators	3
	Management & decision makers	7
	Trainer	1
End-user (backend/before)	Expert in office/remote support for trained personnel	3
	Trainer for remote training	1
	Trainer for classroom training	3
	Content creators	3
	Task support (e.g. note taking)	0

	Customer support team	1
	Management & decision makers	0
Other directly involved users	Health & Safety Department	3
	Other employees/students in the same physical space	2
	Procurement	3
	IT	3
Indirect within user organizations	IT department	3
	IT maintenance department	5
	Technical support	2
	Call centre	1
	Procurement	1
	Sales department	2
	Management & decision makers	0

In addition to the stakeholders within the organizations that will use the tools developed by Motivate XR, other users may be affected. These external stakeholders have been structured in the mapping on micro, mezzo and macro-level. Additionally they have been mapped as either stakeholders in the broader society or specifically within the value chain of the user organizations. Across all use cases and tools, the identified stakeholder groups outside the user organizations are:

TABLE 3: POTENTIALLY AFFECTED STAKEHOLDERS OUTSIDE USER ORGANIZATIONS

Indirect in Value chain of user organization	Affected individuals	Assistant workers that currently take notes in the field, Aircraft technician, Potential students that currently have to low literacy, Service technicians providing service on the field, Trainers from tool providers, Support team, Other workers accidentally recorded as part of XR
	Affected organizations	Energy consumers, Original Equipment Manufacturers (Engine manufacturers, Aircraft manufacturer, Robot supplier), Equipment suppliers, Part producers and suppliers, System suppliers, Aircraft companies, Maintenance companies, Certified maintenance organisations, Standardization bodies, Training centres
	Affected sectors	Energy sector, Logistic sector, Aerospace sector, Aero training sector, Maintenance sector, Manufacturing sector, Construction sector, Repair industry (inc. certified, uncertified and DIY), Second hand market
Indirect in broader society	Micro-level (citizens)	Citizens accidentally recorded as part of XR, Workers for whom the tasks were previously too complex, Consumers of second hand products
	Mezzo-level (organizations)	Liability organizations (insurance) related to remote support, Part providers
	Macro-level (policy makers, national level, global impact)	National construction regulations

4 CONCERN AREAS AT LARGE

To identify areas where it is already well-established within academia that XR can cause social, ethical and legal issues, an AI-driven big-data tool was used. The tool, named SurikaS[4] and developed by YAGHMA, was customized to the necessary context. SurikaS was used for this analysis as it can identify values and issues reliably for large quantities of text. First 228.384 academic papers (journal articles, conference proceedings, book chapters and other peer reviewed material) were identified using Scopus. In the further refinement of the search, it was ensured the articles of the papers discuss at least one of the following:

- extended reality technology,
- virtual reality technology,
- augmented reality technology,
- mixed reality technology,
- virtual environment technology or
- immersive technology.

This resulted in 180.449 papers, of which it was established that 6.744 contained discussions on social, ethical or legal issues. This set of articles formed the basis for the AI-driven analysis of the issue areas discussed in the paper. Using a language model tuned specifically for this purpose 112 topics were identified. Keywords for each topic can be seen in Appendix B. 52 of the topics were social, ethical and legal issues. These have further been described using generative AI to summarize the intersection between the topic and the abstracts associated with the topics. They were clustered into 18 areas based on what issues were often discussed in the same abstracts. This approach ensures meaningful groupings where the intersections between issues are also covered and described as opposed to groupings along fixed dimensions such as stakeholder types or technical solutions.

The analysed literature covers social, ethical and legal issues from multiple angles. Figure 1 shows the values associated with the discussions in the abstracts of the analysed academic papers. Safety is the largest concern. Security, understood as protection against intentional harm, is often linked to safety, which is understood as protection against harm. There is therefore an overlap between the two terms that may cause disproportions between the two values within Figure 1. However, as both are within the five most discussed values, it can be concluded that protection against harm and malicious attacks is highly relevant when considering XR. The deeper analysis revealed that regarding safety and security, the areas concerned span from data protection and cyber security, to physical harm over societal changes and mental wellbeing. Safety was found to be a significant value for all topics of high relevance to the Motivate XR project. Other highly significant values for the discussion of social, ethical and legal issues with XR are accountability, social balance and solidarity.

[4] www.SurikaS.com

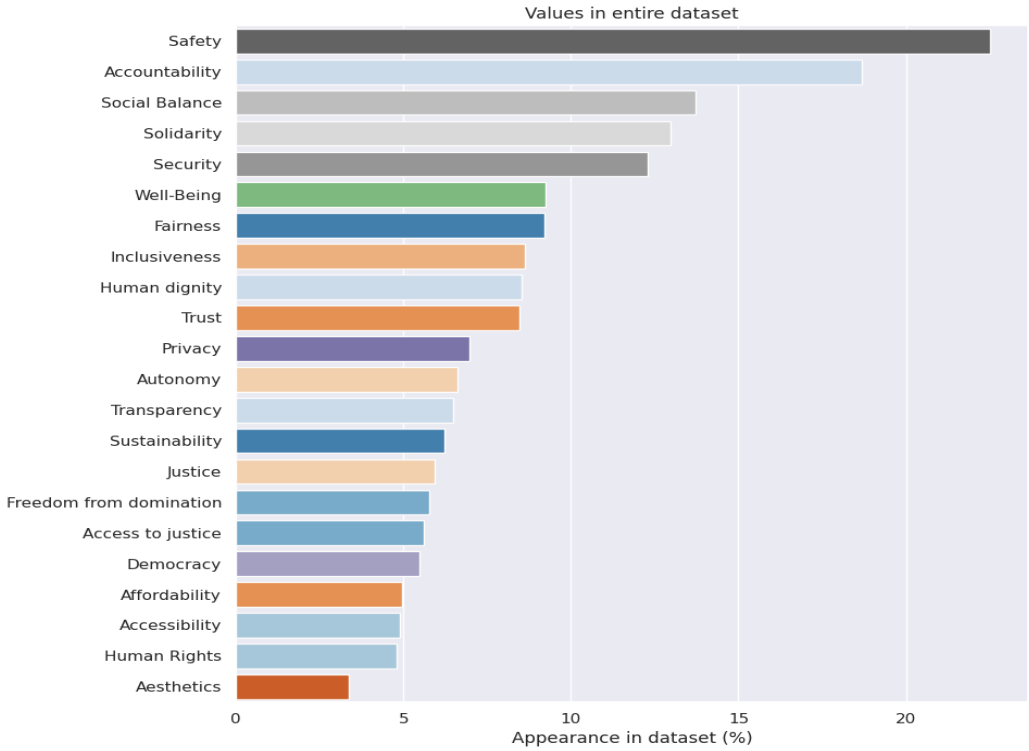


FIGURE 1: VALUES FOUND IN ACADEMIC LITERATURE ON EXTENDED REALITY USING SURIKAS

This underlines the scale and significance of the changes XR is expected to bring to society. Well-being, fairness, inclusivity, human dignity and trust are also frequently present in the analysed literature, indicating a human-centered focus, as expected, as that aligns with the core of most social, ethical and legal issues. Privacy, autonomy and transparency are discussed to a lesser degree. This is surprising given the technologies ability to alter perception of reality.

Here follows the full list of issues identified by SurikaS. Four of the clusters consists of only one topic each. Each of these topics covers sufficiently many papers (minimum 105) to ensure the issue area is not a result of outliers. Areas and issues highlighted in **bold** are found to be of importance for the project based on the current definition of the Motivate XR technologies and use cases. These issues are included in the results in Section 6. After the list follows an in-depth discussion of each cluster of issues individually. Summaries of each topic can be found in Appendix C. To create these descriptions, the abstracts of the associated papers as well as the topics have been processed by generative AI. Next to the summaries, the values that the language model identified as being discussed most frequently in the abstracts associated with each topic are also listed.

Cluster 1: Equitable Access and Regulatory Standardization in Emerging Extended Reality Technologies

1. **The Accessibility of Emerging Technologies** (Topic 41)
2. **Legal Standardization and Liability in Extended Reality Applications** (Topic 98)

Cluster 2: Ethical and Privacy Challenges in Extended Reality

3. **Privacy and Security Challenges in the Ethical Adoption of Extended Reality Technologies** (Topic 32)

4. **User Privacy and Data Security Risks in Extended Reality Applications.** (Topic 20)
5. Ethical Implications of AI-Powered Applications in Medical Extended Reality (Topic 11)
6. Privacy and Security Challenges in the Emergent Metaverse Ecosystem (Topic 1)

Cluster 3: Transformation of Social Networks and Community Dynamics

7. **The Transformation of Social Networks and Communication in the Age of Extended Reality** (Topic 29)
8. Community Building and Social Participation in Virtual Environments (Topic 12)
9. Psychological Impacts and Behavioral Addictions in Virtual and Online Environments (Topic 30)
10. Disinformation and Political Manipulation in XR and Social Media Platforms (Topic 56)
11. **Legal and Intellectual Property Challenges in Virtual Economies and XR Environments** (Topic 43)

Cluster 4: The Influence of Extended Reality on Social Narratives, Identity, and Political Discourses

12. The Impact of XR on Social Narratives and Political Discourses in Contemporary Society (Topic 72)
13. The Blurring of Identity and Reality in Cyberspace (Topic 6)

Cluster 5: The Impact of Virtualization on Team Dynamics

14. The Impact of the COVID-19 Pandemic on Virtual Interactions and Social Adaptation (Topic 3)
15. **The Challenges of Leadership and Team Dynamics in Virtual Environments** (Topic 77)

Cluster 6: The Impact of Extended Reality and Digital Media on Child Development and Parental Concerns

16. Parental Concerns and Child Development Risks in the Age of Digital and Social Media Influence (Topic 55)
17. Impact of Extended Reality on Children's Visual and Cognitive Development (Topic 106)

Cluster 7: Cultural, Ethical, and Communication Challenges in the Age of Digital Twins and Extended Reality (authenticity, accuracy and rights)

18. Cultural and Ethical Implications of Digital Twins in Heritage, Farming, and Product Design (Topic 21)
19. The Digitization and Preservation of Cultural Heritage in the Age of Extended Reality (Topic 8)
20. **The Impact of Digital Communication on Society and the Post-Truth Era** (Topic 66)

Cluster 8: Mental Health and Psychological Risks in Immersive Extended Reality Environments

21. Social Exclusion and Mental Health Risks in Virtual Environments (Topic 90)
22. The Emotional and Psychological Impact of Immersive Virtual Experiences (Topic 91)

Cluster 9: Extended Reality in Pain Management

23. The Use of Virtual Reality for Pain Management and Its Effectiveness in Chronic and Acute Conditions (Topic 88)
24. The Evolution of Telehealth and Patient Care in the Age of Extended Reality (Topic 67)
25. The Integration of Extended Reality in Medical Operations and Telemedicine (Topic 96)
26. The Role of Virtual Reality Exposure Therapy (VRET) in Treating Anxiety and Mental Health Disorders (Topic 40)

Cluster 10: Extended Reality in Healthcare and Rehabilitation (including for women and adolescents)

27. Technological Advances in Medical Imaging and Surgical Precision Through Extended Reality (Topic 27)
28. The Role of Extended Reality in Enhancing Intraoperative Navigation and Postoperative Outcomes (Topic 65)
29. The Integration of XR in Post-Stroke Rehabilitation for Motor Recovery (Topic 33)
30. The Use of XR in Maternal Health and Pregnancy Monitoring (Topic 97)

31. **The Impact of Distraction and Technology Use on Walking Safety in Adults** (Topic 95)
32. Gender Representation and Diversity in STEM and Virtual Environments (Topic 60)
33. The Impact of Cyberbullying, Sexual Content, and Online Aggression on Adolescents (Topic 110)

Cluster 11: Resource Management in Virtualized Cloud Environments

34. **Ethical Challenges of Data Security and Resource Management in Virtualized Cloud Environments** (Topic 48)

Cluster 12: Extended Reality in Urban planning and City Surveillance

35. **Data Privacy and Security Risks in the Internet of Things (IoT) and 5G/6G Networks** (Topic 42)
36. **The Integration of XR in Smart Cities and Its Impact on Civic Engagement and Urban Life** (Topic 57)
37. The Role of XR in Urban Planning and Digital City Design (Topic 63)

Cluster 13: The use of Augmented Reality in Robotics (Social and behavioral changes within industry and society)

38. **The Ethical and Public Consequences of Augmented and Mixed Reality Technologies** (Topic 47)
39. **Human-Robot Interaction and the Ethical Implications of Robotics in Industrial and Social Environments** (Topic 19)
40. **Privacy and Security Risks in Online Platforms and Information Sharing** (Topic 101)

Cluster 14: Trust and Human-Agent Interaction in Virtual Environments (Decision support systems)

41. **Trust and Human-Agent Interaction in Virtual Environments** (Topic 15)

Cluster 15: The Psychological and Social Impact of Avatars, Body Perception, and Relationships in Virtual Worlds

42. The Influence of Avatars on Identity, Social Behavior, and Representation in Virtual Environments (Topic 16)
43. Body Ownership, Perception, and Idealization in Virtual Environments (Topic 45)
44. Social Relationships, Grief, and Ethical Concerns in Virtual Worlds (Topic 85)

Cluster 16: Remote Collaboration and Expert Assistance in Healthcare and Mechatronics

45. **Remote Collaboration and Expert Assistance in Healthcare and Mechatronics** (Topic 71)

Cluster 17: The Use of Extended Reality Technology for Autonomous Vehicles and Driving Simulations on Road Safety and Behaviour

46. The Impact of Autonomous Vehicles and Driving Simulations on Road Safety and Behavior (Topic 10)

Cluster 18: User Safety and motion sickness in Virtual Environments

47. The Ethical Implications of Immersion and Empathy in Virtual Reality Experiences (Topic 0)
48. The Ethical Challenges of Immersive Journalism and News Storytelling (Topic 93)
49. **The Challenge of Motion Sickness and Sensory Feedback in Virtual Environments** (Topic 84)
50. The Intersection of Virtual and Physical Spaces in Architectural Design and Public Engagement (Topic 18)
51. **Participatory Design and User Interaction in XR: Evaluating Inclusivity and Research Practices** (Topic 79)
52. **Harassment and User Safety in Immersive Virtual Spaces** (Topic 73)

In the following, each cluster is elaborated upon:

Cluster 1: Equitable Access and Regulatory Standardization in Emerging Extended Reality Technologies

This cluster of issues is typical of emerging technologies. The first type of issue is that these technologies may not always be easily accessible to (potential) users. In the early phases of technological development, designers and engineers tend to focus on technological feasibility rather than usability. Specific to XR is the fact that its usage poses significant barriers for individuals with visual impairments, mobility challenges, and cognitive impairments. Overall, there is concern that XR technologies may widen the digital divide. A second type of issue is the current lack of legal standards to regulate rapidly advancing technologies such as XR. This is particularly problematic in high-risk sectors such as the military, healthcare, and manufacturing. Specific to XR are liability issues, especially when integrated into human-machine interfaces and autonomous systems. It is often unclear whether the developer, the user, or the manufacturer would be liable in the case of incidents.

Cluster 2: Ethical and Privacy Challenges in Extended Reality

The literature frequently discusses privacy and security concerns related to XR. XR technologies may capture significant amounts of personal data and may be used in sensitive places such as homes and workplaces. The more accurate advanced XR systems are at representing surroundings, the more intricate details of a user's environment they might reveal. Data gathered could be used for targeted advertising and behaviour manipulation. Privacy issues are especially problematic in the medical sector. XR technologies, often used in combination with AI-powered applications, can provide healthcare professionals with detailed insights into patient conditions. However, the data gathered is often vast and in real time. There are growing concerns in the medical sector about the potential misuse of highly sensitive patient data.

Security issues are particularly pronounced in immersive spaces, where hackers could manage to alter virtual environments and user experiences. Another specific security concern is the frequent use of decentralized computing in XR applications. While this approach helps to reduce latency, it also creates multiple points of vulnerability. Emphasis on platform interoperability means that data is often shared and therefore becomes more vulnerable. XR headsets are susceptible to cyberattacks, including distributed denial-of-service (DDoS) attacks and unauthorized access, which can compromise user data and disrupt services.

Cluster 3: Transformation of Social Networks and Community Dynamics

XR technologies and AR environments may transform how people communicate, allowing for more embodied and interactive experiences compared to traditional online platforms and real-world human contact. Virtual communities can form around shared interests, such as brands or specific topics. While these environments may be attractive to users, a concern is that they might progressively lead to a loss of social skills in real-world situations, particularly among the youth. Another concern is related to behavioural addiction and excessive time spent in online environments, which can disrupt daily routines, mental health, and social interactions. Virtual spaces might also reinforce avoidance behaviours. While they may provide a safe space for

individuals with anxiety issues, they could make real-world social interactions even more difficult over time. A final important issue mentioned is social segregation, as interactions between different virtual communities tend to remain limited.

Cluster 4: The Influence of Extended Reality on Social Narratives, Identity, and Political Discourses

The literature discusses the blurring of the frontier between real selves and virtual identities that XR technologies could cause. Cyberspace could be perceived as a new (false) utopia, and people might become trapped in their idealized augmented selves while losing touch with real life. The blurring of identity and reality can have profound psychological and social consequences, changing the way individuals perceive and engage with social and political issues. Virtual environments could provide platforms for both the dissemination of information and the manipulation of public opinion, thereby posing a threat to democratic processes.

Cluster 5: The Impact of Virtualization on Team Dynamics

This cluster focuses on the use of XR technologies in the context of remote working. Following the COVID-19 pandemic, many sectors, including education, healthcare, and administration, had to adapt to digital platforms. XR technologies can support virtual teamwork, for example, through the creation of immersive virtual workspaces. Concerns exist regarding the impact on group dynamics, team member motivation, and online behaviour. As the formation of virtual teams is not limited by physical location, they often consist of individuals from diverse cultural backgrounds, raising issues of communication, collaboration, and aligning different cultural expectations and working styles.

Cluster 6: The Impact of Extended Reality and Digital Media on Child Development and Parental Concerns

XR technology and digital environments may lead children to spend more time engaging with digital games and virtual worlds. Concerns have been raised about children's well-being, particularly regarding bullying, body image, and eating behaviours. Parents often fear the potential consequences of how XR technologies might shape children's learning, adaptation to real-world social situations, body image, and self-esteem.

Cluster 7: Cultural, Ethical, and Communication Challenges in the Age of Digital Twins and Extended Reality

A cluster of concerns focuses on the impact of digital twins and XR on heritage and design. Digital twins are often used in the context of cultural heritage, for example for creating virtual models of heritage sites, artifacts and cultural landscapes. However, this raises concerns about the authenticity, ownership, and access to cultural artifacts, as well as the marginalization of less prominent cultures or the misrepresentation of traditions to serve external commercial or political interests. Concerns have also been voiced about the use of digital twins in certain economic sectors. In farming, questions are raised about their impact on traditional farming methods and local knowledge and practices.

Cluster 8: Mental Health and Psychological Risks in Immersive Extended Reality Environments

The literature describes several issues related to the potential mental and psychological impact of XR technologies. The first issue is social exclusion in virtual environments, which is particularly problematic for children and youth. This group is heavily exposed to social media, and exclusion within these digital spaces can lead to isolation and mental health disorders such as depression and dizziness (see cluster 18). Virtual environments may trigger anxiety for some individuals, thereby excluding them from using these platforms. The literature indicates that women, in particular, are more exposed to anxiety issues. Other concerns include the deep emotional engagement these platforms can trigger and the fact that virtual environments mirror public spaces, making them challenging to participate in for people who are sensitive to being observed and feel vulnerable in front of others.

Cluster 9: Extended Reality in Pain Management

Virtual reality can be used for pain management, for example, as a form of distraction therapy. Concerns have been raised about equality of access to these technologies due to their costs, the skills required, and the infrastructure needed for their use. Additionally, there are worries related to perceptual manipulations in virtual reality environments, which could affect how patients perceive their bodies and surroundings.

Cluster 10: Extended Reality in Healthcare and Rehabilitation

XR can enhance medical procedures. However, there is a risk of over-relying on XR technologies, potentially undermining clinicians' skills and judgment. The interpretation of medical images can still be challenging despite advances in XR, leading to issues with accuracy, consistency, and errors in diagnosis or surgical planning. XR technology may also not always account for diverse anatomical or demographic characteristics of all patients, resulting in biased outcomes. This can cause disparities in the quality of care.

An issue discussed in the literature is the underrepresentation of women in the design of XR technologies, which could lead to implicit gender bias. This bias could result in exclusionary practices and care that is less aligned with women's needs. While XR technology may assist with rehabilitation, significant safety issues remain. Older adults are particularly vulnerable to falls and accidents, and the use of this technology may exacerbate those risks.

Cluster 11: Resource Management in Virtualized Cloud Environments

A significant concern in virtualized cloud environments is the vast amount of energy it requires, which raises environmental concerns. Balancing performance and sustainability is often a challenge.

Cluster 12: Extended Reality in Urban planning and City Surveillance

This cluster discusses issues regarding the application of XR in urban planning. XR technology can offer immersive tools for urban planning and enhance city surveillance. However, concerns related to their usage in smart cities have been identified. Augmented reality glasses or immersive city data

interfaces could be used for mass surveillance. The use of XR technologies, along with 5G networks and IoT technology, increases vulnerability to cyberattacks. Additionally, concerns are raised about user consent, data ownership, and transparency regarding how data is collected, stored, and used. Another issue discussed is that the use of XR for city planning can lead to biases in design if tools and algorithms do not account for diverse urban populations.

Cluster 13: The use of Augmented Reality in Robotics

XR technology can be used in robotics for remote operation, training, and maintenance. However, this use of XR may exacerbate existing concerns related to robotics, including safety risks, job displacement, economic inequality, and the social impact of human-robot interaction. Additionally, XR technology can obscure the inner workings of robotic systems, leading to a lack of transparency.

Cluster 14: Trust and Human-Agent Interaction in Virtual Environments

This cluster discusses virtual agents and related trust issues. As these agents become integral to evacuation simulations, social interactions, and spatial reasoning tasks, ensuring trust between humans and agents is critical. However, users may have concerns about the lack of transparency regarding the agents' decision-making processes. Another concern is that increased reliance on virtual agents for social interaction can lead to social isolation.

Cluster 15: The Psychological and Social Impact of Avatars, Body Perception, and Relationships in Virtual Worlds

This cluster concentrates on avatars, which allow users to alter their identity and appearance. Concerns are raised about the psychological effects of virtual reality experiences, where users may feel as though a virtual body or avatar is their own, even if it differs significantly from their real body. Over time, users may feel pressured to conform to unrealistic standards posed by virtual bodies, contributing to body dissatisfaction and low self-esteem. Users may also experience grief over the loss of virtual friends; it is still uncertain how these virtual relationships may affect emotional health and grief in real-world situations. In virtual environments, individuals can manipulate their identity or deceive others. Users may feel betrayed when they discover that someone's virtual persona was not real.

Cluster 16: Remote Collaboration and Expert Assistance in Healthcare and Mechatronics

Concerns raised in this cluster include challenges related to the accuracy of representations in remote medical procedures. These inaccuracies can pose threats to patient safety. Liability issues are difficult to resolve if something goes wrong during remote interventions. Additionally, these systems raise concerns about patient autonomy and informed consent.

Cluster 17: The Use of Extended Reality Technology for Autonomous Vehicles and Driving Simulations on Road Safety and Behaviour

This cluster focuses on issues related to the use of XR technologies for the training of autonomous vehicles and human drivers. One challenge is that the simulations used are sometimes not realistic

enough, creating a false sense of security. XR simulations might encourage riskier behaviours if they do not fully replicate the dangers of real-life driving.

Cluster 18: User Safety and motion sickness in Virtual Environments

User safety is a significant issue in virtual environments, especially when XR devices are used outdoors, increasing the risk of accidents. Individuals engaged in immersive XR experiences may become less aware of their physical surroundings. Significant liability issues arise in the event of accidents. Another concern is motion sickness. VR environments often create a disconnect between what users see and how their bodies perceive movement (sensory feedback). This mismatch can lead to physical discomfort.

5 MOTIVATE XR SPECIFIC CHALLENGES

To capture Motivate XR specific social, ethical and legal issues, the knowledge within the consortium was mobilized. A SEL workshop was held to identify potential issues following a framework build upon the outcomes of the stakeholder mapping and a preliminary value analysis of the academic literature. The description of the SEL workshop and obtained results follow in Section 5.1. After the SEL workshop, the identified issues were prioritized based on feedback from the consortium. The results hereof can be seen in Section 5.2.

5.1 WORKSHOP FOR IDENTIFYING SOCIAL, ETHICAL AND LEGAL CHALLENGES

To identify social, ethical and legal issues specific to the Motivate XR project the full consortium was invited to participate in a SEL workshop. All types of consortium partners participated, including use case partners.

Date and time: 4/9 2024 9:30 – 11:45 (planned 9:30 – 12:00 to ensure sufficient time for post-workshop discussions)

Format: Online using Microsoft Teams and Miro

Participants: 19 members of the consortium from the following 14 organizations: D3, CETMA, SOP, BIR, AV, UPM, TEC, AAA, 2F, MAG, F6S, HEDNO, HGE, AC.

In preparation of the SEL workshop, the consortium had been engaged in the stakeholder mapping (documented in Section 3) which had also been discussed briefly in WP3 meeting on 28/8 2024. This secured a base awareness of an important aspect of the identification of SEL issues- namely who may be affected. The SEL workshop was build up upon this awareness as well as preliminary results regarding the values discussed in academic literature on XR (final results documented in Section 4).

SEL Workshop Content and Results

The SEL workshop itself started with an introduction to its purpose and the intention with the work being carried out in Task 3.1 (partly documented in this Deliverable 3.1 and partly in upcoming Deliverable 3.2). Thereafter the stakeholders and the expected values were introduced to increase the participants understanding of the building blocks behind the SEL workshop. Finally, the agenda was introduced.

In the SEL workshop, participants could communicate via Microsoft Teams and write their final thoughts on a common Miro board. Miro is an environment that, in this workshop, was utilize the possibilities you have with multiple physical whiteboards in an online environment. Before the SEL workshop, virtual sticky notes were prepared for each consortium organization, allowing for easy tracking of contributions from each members throughout the various chapters of the SEL workshop. This was done both to enrich the written text with an understanding of its context and so that it would be possible to reach out for further clarification after the workshop. The latter was, in the end, not necessary.

The SEL workshop proceeded after the introduction with six different chapters per participants:

1. Welcome,
2. Individual Identification,
3. Group identification of Social and Ethical issues,
4. Group identification of Legal issues,
5. Final individual thoughts,
6. Goodbye.

Figure 2 shows the overall structure of the SEL workshop. For Chapter 1, 2, 5 and 6, all participants were communicating in the mail Teams environment. For step 3 and 4, three groups were formed and were communicating in separate Teams Break-out rooms. Two of the groups identified social and ethical issues first (Chapter 3) and legal issues (Chapter 4) thereafter. One group did the opposite. Between the two chapters within the groupwork (3 and 4 or 4 and 3), a coffee break was held. This

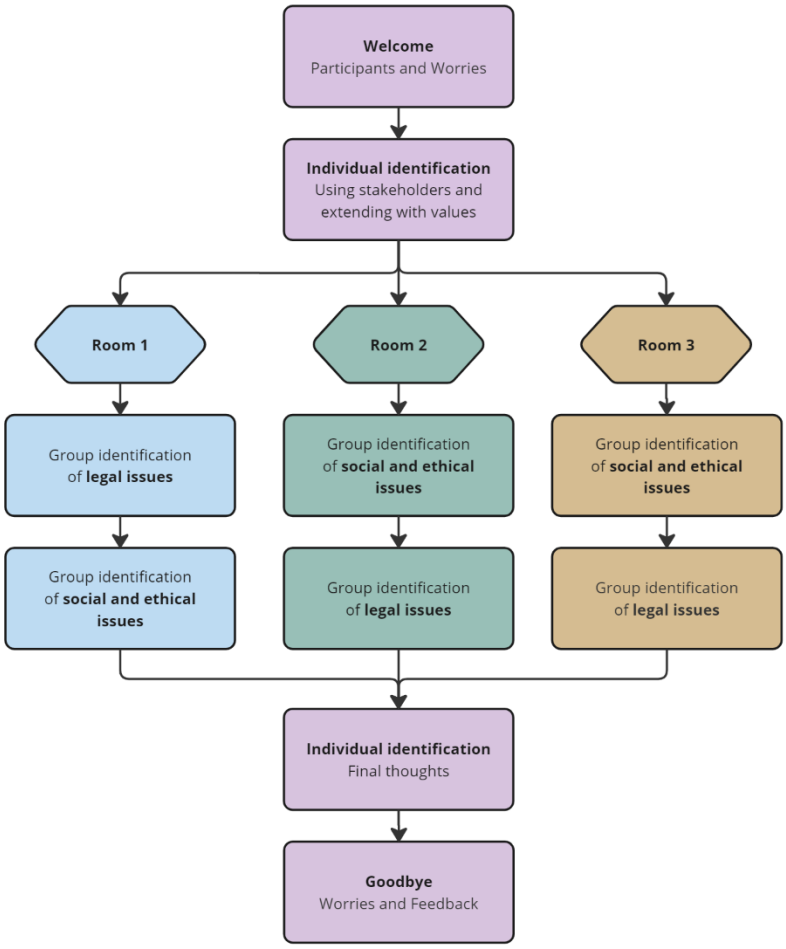


FIGURE 2: STRUCTURE ON THE WORKSHOP FOR IDENTIFYING SOCIAL, ETHICAL AND LEGAL ISSUES

structure was chosen to ensure similar engagement levels for both Chapters. In the following each Chapter will be detailed. A discussion on the results will follow thereafter.

1. Welcome

This chapter contained two parts. Firstly, each participant was asked to find the sticky notes of their organization and write their name. This was done both to ensure people participating in the Teams call anonymously were also captured and to ensure all participants were sufficiently comfortable using Miro. Secondly, participants were asked to write what they believed to be the most significant social, ethical or legal issue to keep an eye on within the Motivate XR project. The Result of Chapter 1 Welcome can be seen in Figure 3.

FIGURE 3: RESULT OF CHAPTER 1 WELCOME

2. Individual Identification

The second chapter also fell in two parts. Firstly, participants were asked to list all the social, ethical and legal issues they individually could identify. Participants were informed that one way to capture more issues is to consider a specific stakeholder group and asking how that group may be unintendedly, negatively affected by the Motivate XR outputs. It was emphasised that it was not required to follow this approach. The list of stakeholders from the map of affected stakeholders was visible for the participants during this exercise and can be seen in Figure 4.

Once a good number of issues was available on the board and participants started to be comfortable with the thought process necessary to identify social, ethical and legal issues, the second part of the framework was revealed. To ensure that the framework addressed more than just the commonly

discussed issues among consortium participants, it was structured around the affected stakeholders and expected values. This provided a clearer way to capture a wider range of concerns. A board of 9 pre-defined expected values were introduced and participants were asked to move their already created sticky notes to the most appropriate value or to a new value they would like to add. By identifying issues using both a list of affected stakeholders and a list of values, participants could progress the identification process by asking how does the Motivate XR outcomes affect the "one of the values" of "one of the stakeholders"? The expected values used were a curated list based on the values identified by SurikaS as being the most discussed in a subset of the articles used for the analysis in Section 4. As discussed in Section 4, safety and security are often considered overlapping and were therefore combined into one value. The values were sorted alphabetically to avoid giving the impression of a hierarchy and participants were encouraged to add values they found were missing. This option was only used once, adding "Intellectual Properties" as a value in one of the group results in Chapter 4 on legal issues. Participants were informed we expected these values to be affected by the Motivate XR outcomes as they were highly present in the academic literature. The list of values was as follows:

End-user (on location or VR glasses side)	Technician in the field, non-expert/general technician/operator
	Student at training location
	Trainers
	General public
	Content creators
	Management & decision makers
End-user (backend/before)	Expert in office/remote support for trained personel
	Trainer for remote training, Trainer for classroom training
	Content creators
	Task support (e.g. note taking)
	Customer support team
	Management & decision makers
Other directly involved users	Health & Safety Department
	Other employees in the same physical space
	Purcurement
	IT
Indirect within user organizations	IT department, IT maintainance department, Technical support
	Call center
	Purcurement, Sales department
	Management & decision makers
Indirect in Value chain of user organization	affected individuals
	affected organizations
	affected sectors
Indirect in broader society	micro-level (citizens)
	mezo-level (organizations)
	macro-level (policy makers, national level, global impact)

FIGURE 4: STAKEHOLDER LIST USED DURING THE WORKSHOP

1. **Access to justice**: the public's right to review by a court or another independent body to ensure that public authorities respect the rights to access to information and public participation, and environmental law in general,
2. **Accessibility**: everyone is able to use the technology when needed,
3. **Accountability**: the goals and intentions behind relevant decisions can be understood even from an outside perspective and those involved are held responsible for these decisions,
4. **Autonomy**: having the capacity to act on one's desires,
5. **Privacy**: being able to control who can see or use information about you,
6. **Safety and security**: the protection against unintended and intended harm,
7. **Social Balance**: the state or condition within a society or community where there is an equitable distribution of resources, opportunities, and responsibilities among its members, leading to harmony, stability, and fairness across different social groups,

8. **Sustainability**: the appropriate access and utilization of biological resources,
9. **Well-Being**: the holistic state of physical, mental, and social health and satisfaction, encompassing more than just the absence of disease or infirmity.

After the second part of Chapter 2, the results of the SEL workshop were as seen in Figure 5 and are in legible format in Appendix D.

FIGURE 5: RESULT OF CHAPTER 2 INDIVIDUAL INDENTIFICATION (ABOVE: FULL EXERCISE CANVAS. BELOW: RESULTS)

3. Group identification of Social and Ethical issues

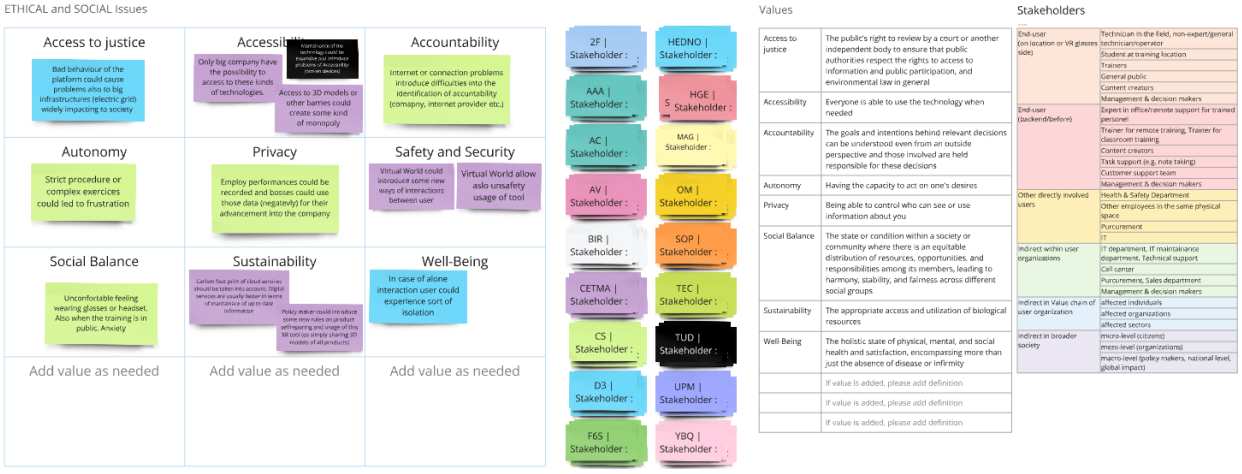
After the participants had the chance to document all the social, ethical and legal issues they could identify individually, they were divided into three groups by random assignment. The composition of the three groups was:

- Room 1: D3 (2 members), SOP, UPM, F6S, CETMA.
- Room 2: D3, SOP, AAA, 2F, HEDNO, AC.
- Room 3: BIR, AV, TEC, MAG, F6S.

Two groups started with Chapter 3, while one group (Room 1) started with Chapter 4. The Workflow in the two chapters was the same, however, the participants in Chapter 3 were asked to focus on social and ethical issues and whereas the participants in Chapter 4 concentrated on legal issues. It was decided to keep social and ethical issues together as they often overlap or are closely interconnected. Legal issues are easier for non-experts to distinguish and tend to draw more focus in groups with many industrial partners.

The groups worked on separate boards and could communicate in separate breakout rooms in teams. The two workshop hosts moved between the breakout rooms and facilitated the conversations when necessary. The same framework for identifying issues was used in Chapter 2, 3, 4 and 5. In Chapter 3 and 4, the issues were identified as a group and thus information on who wrote what gives less context. The results of the SEL workshop for the three groups are available in legible format in Appendix D and below:

Room 1:



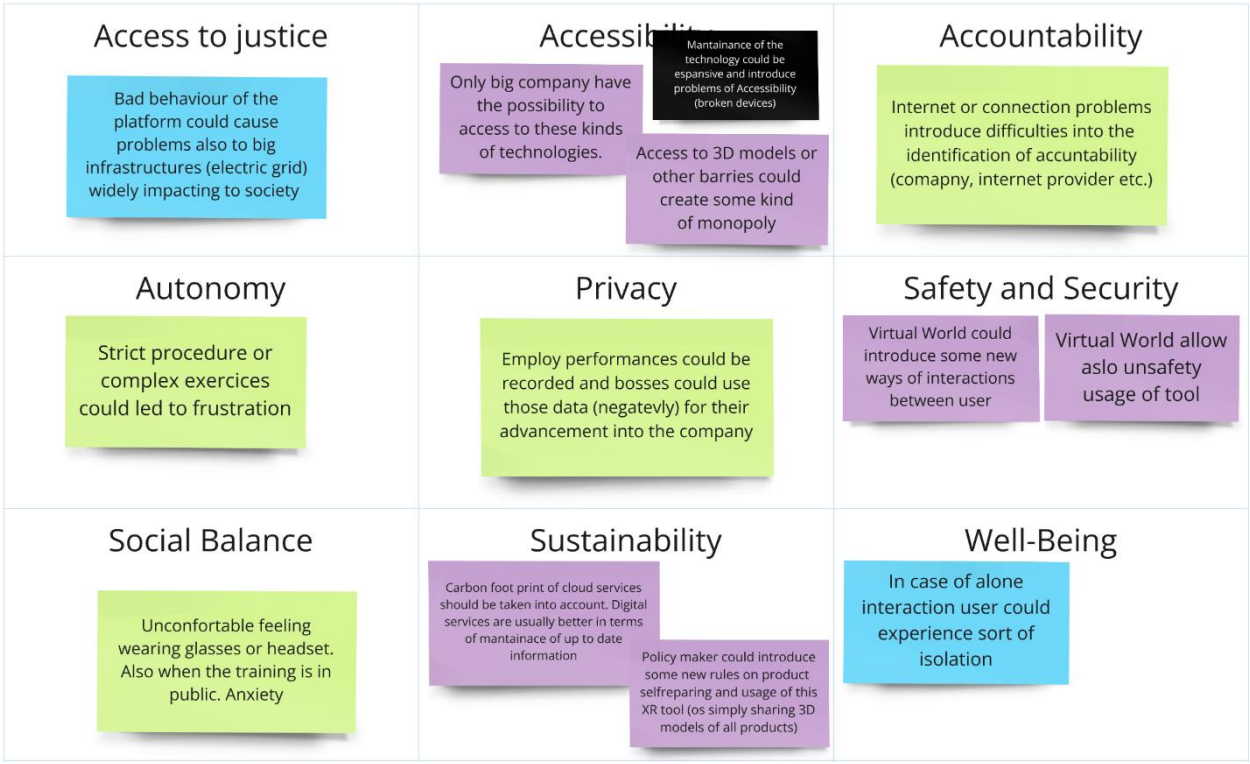


FIGURE 6: RESULT OF CHAPTER 3 GROUP IDENTIFICATION OF SOCIAL AND ETHICAL ISSUES, ROOM 1. (ABOVE: FULL EXERCISE CANVAS. BELOW: RESULTS)

Room 2:

FIGURE 7: RESULT OF CHAPTER 3 GROUP IDENTIFICATION OF SOCIAL AND ETHICAL ISSUES, ROOM 2

Room 3:

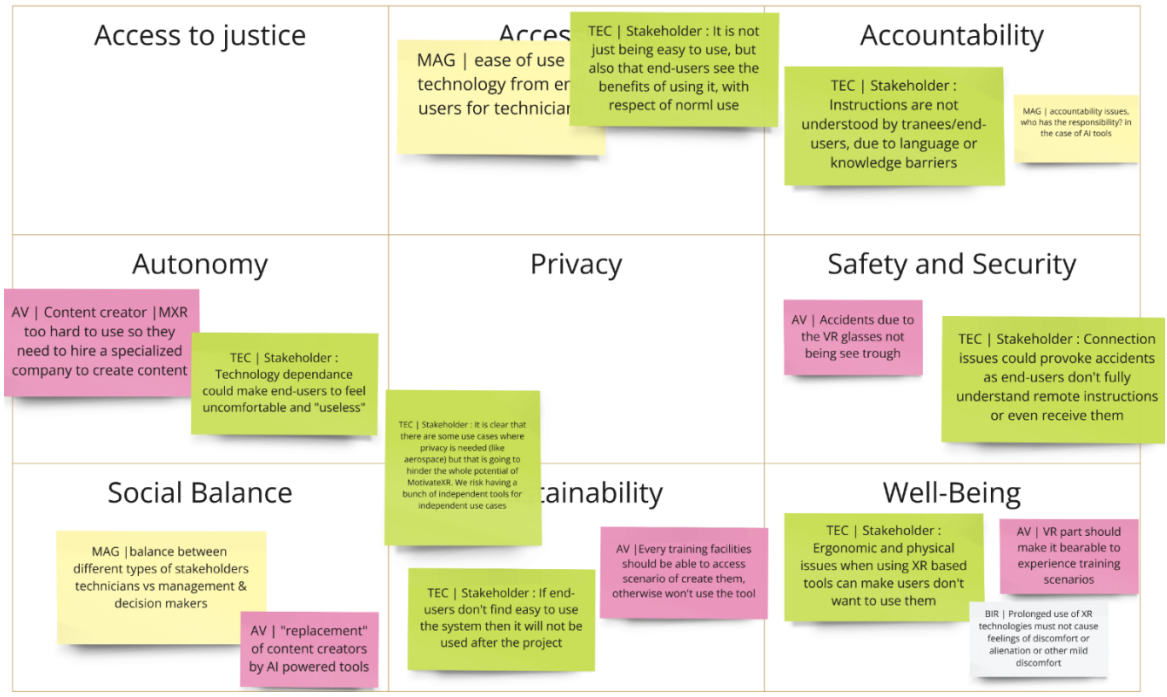


FIGURE 8: RESULT OF CHAPTER 3 GROUP IDENTIFICATION OF SOCIAL AND ETHICAL ISSUES, ROOM 3

4. Group identification of Legal issues

Between Chapter 3 and Chapter 4 there was a short break (for Room 1 it was between Chapter 4 and Chapter 3). Hereafter, the same workflow was followed as for Chapter 3. The results of Chapter 4 can be found in Appendix D and below:

Room 1:

FIGURE 9: RESULT OF CHAPTER 4 GROUP IDENTIFICATION OF LEGAL ISSUES, ROOM 1

Room 2:

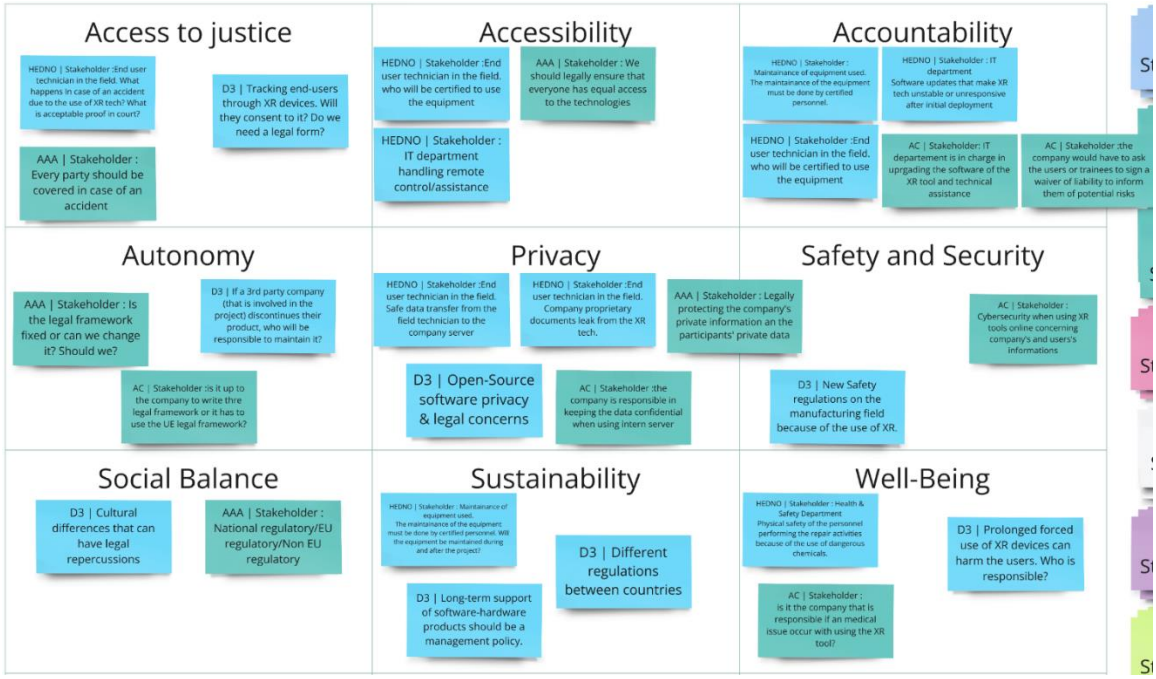


FIGURE 10: RESULT OF CHAPTER 4 GROUP IDENTIFICATION OF LEGAL ISSUES, ROOM 2

Room 3:

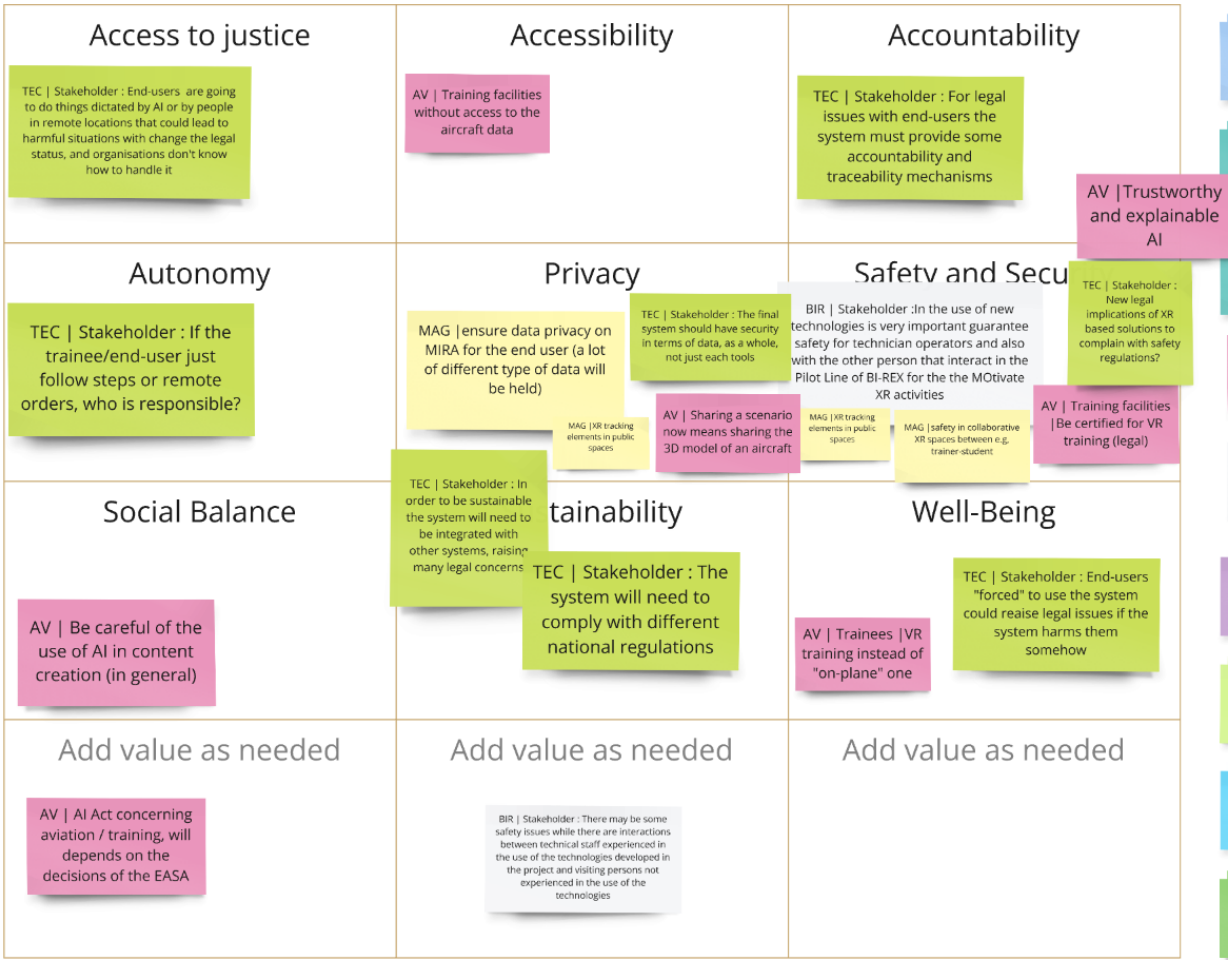


FIGURE 11: RESULT OF CHAPTER 4 GROUP IDENTIFICATION OF LEGAL ISSUES, ROOM 3

5. Final individual thoughts

After convening back into the main Teams room, participants were given a short time to write down additional social, ethical and legal issues if they had some in mind that they had not yet written down on the board. The result hereof can be seen in Appendix D and below:

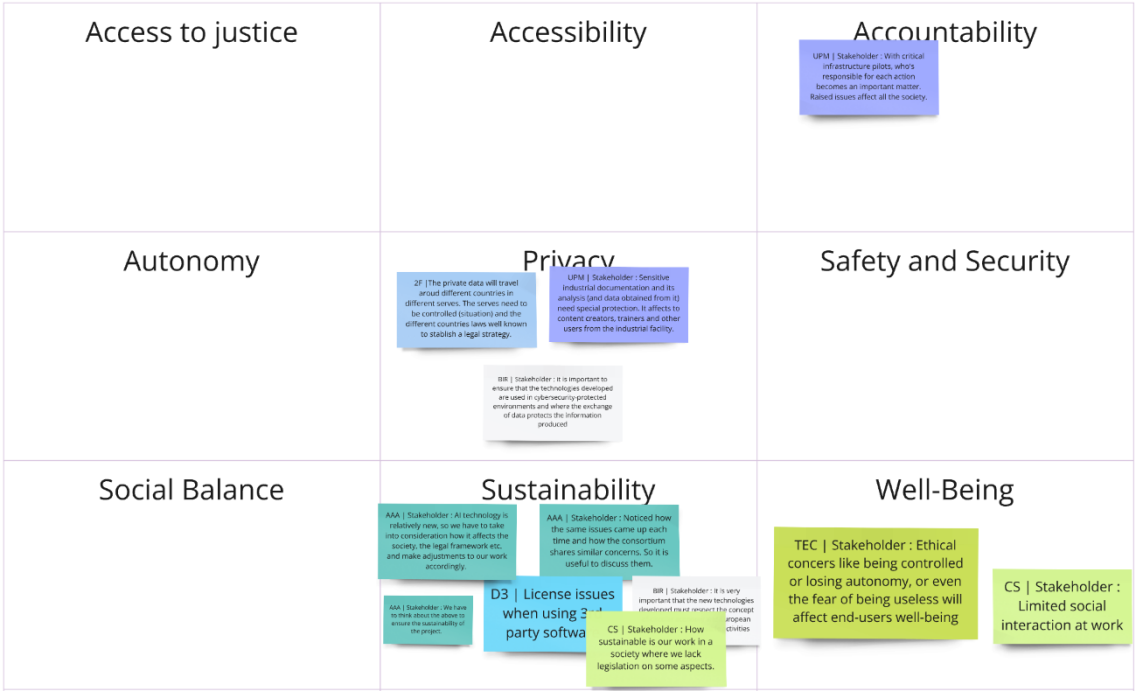


FIGURE 12: RESULT OF CHAPTER 5 FINAL INDIVIDUAL THOUGHTS

6. Goodbye

In the final Chapter of the SEL workshop, the participants were asked to write down what social, ethical or legal issue they now thought to be the biggest worry for Motivate XR. The intention was to see if after having spending two hours concentrating on these aspects the perspective had changed. In addition to documenting the biggest worries, participants were given the opportunity to provide feedback on the workshop. Some participants had to leave the SEL workshop early, leaving 12 participants in the very end of the workshop. Most drop-out happened around the 1,5-hour and 2-hours mark due to other commitments. The output of chapter 6 was as follows:

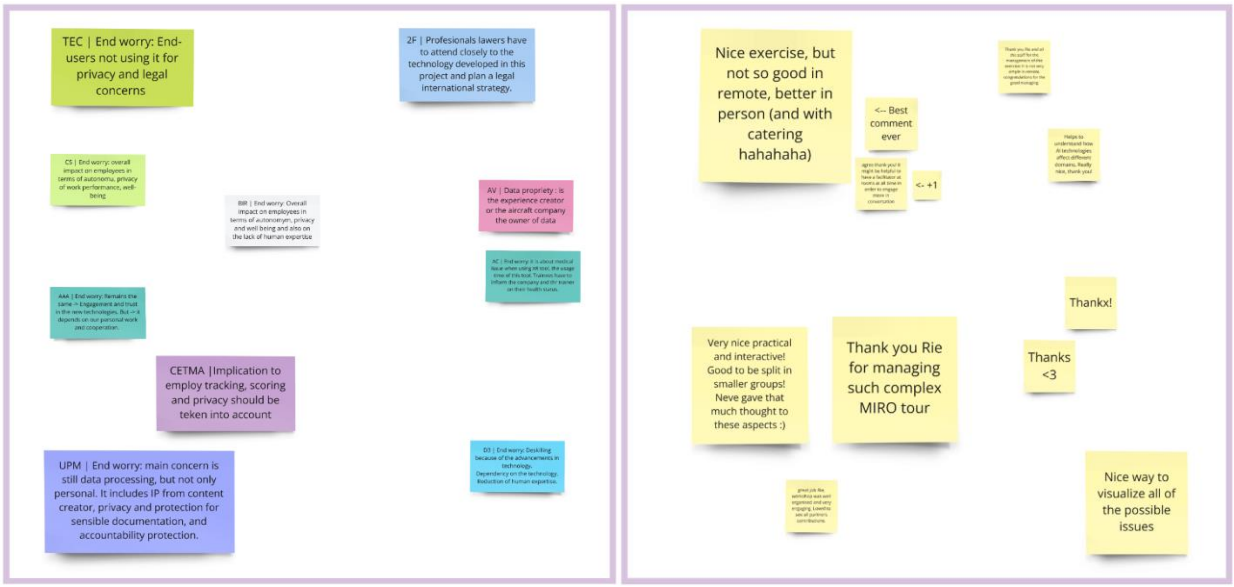


FIGURE 13: RESULT OF CHAPTER 6 GOODBYE

SEL Workshop Results Analysis

Three types of results were collected in the SEL workshop:

1. Social, ethical and legal issues.
2. Insights into what is perceived as main concern.
3. Feedback on the workshop process.

Each type of result was handled differently. In the following section, the analysis and subsequent work with the SEL workshop results will be presented in reverse order. The feedback on the workshop process was mostly positive and expressing a preference for in-person workshops as well as suggesting facilitation of each break-out room. These two points have been considered in the evaluation of the SEL workshop and will be considered for future SEL workshops.

The main worries expressed in the beginning and in the end of the SEL workshop are listed below in their exact formulation, sorted loosely by topic. Worries noted by use case partners are marked as such and some issues are numbered for providing context between the worries recorded at the beginning and the end of the workshop. Each column in Table 4 is sorted thematically independent of each other.

TABLE 4: COMPARISON OF MAIN WORRIES BEFORE AND AFTER SEL WORKSHOP

Worries at beginning of workshop	Worries at end of workshop
Data (Use case)	Data propriety is the experience creator or the aircraft company the owner of data (Use case)
Personal data	Main concern is still data processing, but not only personal. It includes IP from content creator, privacy and protection for sensible documentation, and accountability protection. (2)
Personal Data	Implication to employ tracking, scoring and privacy should be considered
Privacy and data protection	It is about medical issue when using XR tool, the usage time of this tool. Trainees have to inform the company and the trainer on their health status. (Use case)
privacy of data	Overall impact on employees in terms of autonomy, privacy of work performance, well-being
Personal data treatment and processing (2)	Overall impact on employees in terms of autonomy, privacy and well-being and also on the lack of human expertise (Use case)
Personal Data Management	End-users not using it for privacy and legal concerns
Data management	Remains the same -> Engagement and trust in the new technologies. But -> it depends on our personal work and cooperation. (Use case, 1)
Data propriety (Use case)	Deskilling because of the advancements in technology. Dependency on the technology. Reduction of human expertise.
Collecting data	Professional lawyers have to attend closely to the technology developed in this project and plan a legal international strategy.
Start Data	

Data about fabrication manual and data for analysis after pilot.
Capability to certify, secure data privacy
Making fabricators trust the new technologies (Use case, 1)

The worries in the beginning of the SEL workshop were centred around data with three main themes: 1) Privacy and personal data, 2) data management and 3) obtaining the data needed within the project and maintaining access to it. In addition to the data-related worries, capability to certify was mentioned as well as uptake barriers in terms of key stakeholders' trust in the new technologies.

After the SEL workshop, a more diverse list of worries was collected with more elaboration of each issue. This indicates the workshop, next to collecting valuable insights, has increased the awareness of social, ethical and legal issues within the consortium. Data was still mentioned as the largest worry by two participants, with one focusing on the aspects on obtaining and keeping access to the necessary data and the other on the data protection aspects, both related to personal information, IP and sensitive information as well as its relation to accountability. The rights of the users, both employees and trainees, were after the SEL workshop mentioned as the biggest worry by four participants. Concerns here covered the users' privacy and anonymity, especially towards employers, as well as their wellbeing (including medically) and autonomy. The risk of deskilling and lack of human expertise was noted as part of the users' rights and also separately by one participant. The participant that noted the trust of necessary stakeholder organizations as the key worry in the beginning of the SEL workshop maintained that position and elaborated upon it. Another participant gained a similar worry, focusing on user's trust in the results ability to satisfy privacy and legal requirements. Finally, one participant noted the need for a legal international strategy.

The main outcomes of the SEL workshop are the identified social, ethical and legal issues. The exact formulation from the sticky notes used in the SEL workshop can be seen in Appendix D. A total of 243 sticky notes with social, ethical and legal issues were identified with the following distribution:

	Access to Justice	Accessibility	Accountability	Autonomy	Privacy	Safety and Security	Social Balance	Sustainability	Well-being	Intellectual properties	Without value	Total
Number of sticky notes	**13**	**27**	**17**	**16**	**39**	**27**	**21**	**25**	**25**	**1**	**32**	**243**

Given the consortiums initial worry on data-related issues, the large number of notes with privacy-related issues is expectable and the distribution between the values is relatively spread out. This indicates that the workshop participants thought broadly about the social, ethical and legal issues and decreases the risk that issues were overlooked.

Some of the sticky notes did not include a clear issue formulation. To proceed with prioritizing risks, each sticky note was manually reviewed and transformed into one or more social, ethical, or legal issues by the workshop hosts, based on the insights gathered during the SEL workshop. The issues were framed as risks to facilitate prioritization. These risks were first consolidated with other relevant risks associated with the same values and then consolidated and grouped across all identified risks. This resulted in the following 80 risks that could be structured under six categories. Below the full list:

TABLE 5: RISKS IDENTIFIED THROUGH SEL WORKSHOP

Data Collection, Processing and Storage
The increased digital use of sensitive documentation and data caused by the Motivate XR solutions increases the risk of cyber theft
The risk of theft of information (e.g. industrial documentation, private information, and analysis thereof) may increase as the XR headsets are more prone to get stolen than stationary computers
Data may get stolen because the used internet connections are not properly secure
End users' and user organisations' privacy may get compromised because the end users do not know how to use the privacy functionalities within the tools
The security of the full set of Motivate XR solutions gets compromised because it is only considered for each tool, not the full solution/system
Data privacy may be compromised by the use of Open-Source software
Data privacy cannot be guaranteed when data travel around different countries in different servers
User organizations may not be able to gain access to 3D files that are IP protected, limiting which organizations can get the advantages of using the XR
The ability of the Motivate XR solutions to capture data causes users to capture more data than they need and thereby increase the risk of breaching privacy and IP
Users may intentionally use the Motivate XR solutions to gather data for purposes different than what they tell data providers and people in their immediate surroundings
Since the information is available on an XR device, some users may forget that sensitive documentation should not be taken out of company premises, thereby compromising data security
Employee/student rights and safety
Employees may lose their jobs due to the new requirements that XR brings (e.g. language, digital literacy, physical effects)
The requirements of education changes and exclude a new group of students due to the requirements use of XR brings (e.g. language, digital literacy, physical effects)
Technicians and trainees/students are forced to use the XR if they want to keep their job/get their diplomas, even if there is known risks of harm
The XR can cause motion sickness
The XR trigger medical conditions like epileptic episodes
Technology dependence can make end-users to feel uncomfortable and "useless"

The users' safety gets compromised due to the use of XR compared to normal task execution (e.g. physical restricted by XR, entering electric environments with XR capture device or headset)
Use of XR may cause harmful situations due to the users decreased awareness of the surroundings
Wearing the glasses or headset may cause physical discomfort
Wearing the glasses or headset may make the user feel singled out or socially uncomfortable if the training/task the perform happens in public
Wearing the glasses or headset may cause the user to feel anxiety
XR will decrease the social interaction at work leading to sense of isolation
Prolonged use of XR devices can harm the users
The safety of workers cannot be guaranteed by current procedures as XR tech is not covered by Health & Safety Department regulations
The Motivate XR solutions are used incorrectly by unexperienced users (independently or under supervision) and causes harmful situations
The safety of people in the same physical environment as the user of XR gets worse compared to normal task execution
Connection issues could provoke accidents as end-users don't fully understand remote instructions or even receive them
Users may perform tasks that carry higher risks than they would otherwise dare to perform because the XR changes their perspective of risk
Users may perform tasks that carry higher risks than what is advisable because they do not understand that certain instructions are available for users with more experience and the correct equipment
Employees and students will only be able to pursue their careers if they consent to tracking and data collection, they are uncomfortable with
Users may be tracked through the XR devices without being aware of it or consent to it
To ensure safe use of XR, trainees and employees will have to inform their organizations about more health issues than they currently do
XR enables employers to record and misuse information (e.g. tracking, working hours, eye tracking, mistakes) on working hours and mistakes in higher details than traditional environments
Recordings and exercise conduction data of trainers or students/trainees may get misused or shared inappropriately
Manipulating and controlling employees and students become easier with XR
Students and trainees may not get the necessary confidence to do the tasks independently
Standardized training may not fit to the need of all participants' needs (some may e.g. need longer time than others)
Organizations may not be aware on the IP rights connected to content created using the Motivate XR solutions in teaching situations
Work Content and Technical Reliability
The users may rely on the XR instructions generated by AI so much they don't consider if the content is correct

In case certificates of ability to use the equipment are made, they can provide false confidence in skills if the certified technician has not maintained their skills
The remote technician or instructors are not proficient in giving instructions in a way that positively uses the XR
Bad behaviour of the platform could cause problems also to big infrastructures (electric grid) widely impacting to society
Automatic translation could introduce misunderstandings and inaccuracies
Software updates outside the control of the XR tool providers may make XR tech unstable or unresponsive after initial deployment
The use of AI to create content makes it harder to ensure the content presented in the XR is indeed correct
Legal compliance
Current regulation may not be able to adequately rule in situations where XR and AI content generation are used
Uncertainty of legal, insurance and social security status if remote instructions delivered via XR caused or did not prevent an injury for a professional or student/trainee
Unclear how maintenance of the XR equipment will affect responsibilities
The use of XR and AI generated content may make it harder to trace actions and accountabilities
The accountability in case of harmful situations, faulty results or inability to perform contracted job may depend on the status of the internet connection
Responsibility and legal status may change by using Open-Source software
Current legislation is insufficient to identify responsibilities for incorrect use of the XR or use over prolonged periods of time
The Motivate XR solutions may not adhere to cultural norms and legislation in all countries
3D files will be increasingly requested, making it harder to protect designs with secretation and patents
Integration between the Motivate XR solutions and other systems may violate IP and legal requirements
XR experiences may be shared without the creators' consent or compensation
XR experiences may be shared without consent from or compensation to the owners of the underlaying data
Organizational competences
Organizations do not have the knowledge to assess the legal implications of having XR users do things dictated by AI or by people in remote locations (especially regarding harmful situations)
Many Health & Safety Departments do not have sufficient knowledge to protect their workers when introducing XR
The cost of the necessary equipment (inc. servers, headsets, capture devices etc) could make the tools and the XR not widely accessible to all organizations
Some organizations will not have access to sufficient documentation and therefore be disadvantaged
Only big organizations have capacity to access to these kinds of technologies

User organizations are unable to create the content they need themselves because the Motivate XR solutions are so complex that only specialized companies can use them
The balance between different types of stakeholders (e.g. technicians vs management & decision makers) may change in a negative way
The use of XR makes the training feel less trustworthy and discourage students from persuading their education
An organization is unable to continue certain operations if the XR devices break
Learning how to use the XR and the tools to develop content may take so long very few people/organizations will be able to get to use it
Improper or missing maintenance of equipment and update of the software may create harmful situation
Societal structures and environmental impact
Unemployment of content creators because of the AI powered tools
Technology may support monopolies as barrier to entry increases
Education using XR amplify social inequality, as socio-economically challenged groups has lower level of knowledge and digital literacy
The Motivate XR solutions may normalize the decrease in human expertise due to overreliance on digital guidance
The Motivate XR solutions may be designed in such a way that they do not fulfil the technologies' potential to improve the opportunities of impaired people and users with special needs
Elements in public spaces (including people) can be tracked
The public is harmed as a consequence of theft or misuse of information from the Motivate XR solutions (e.g. attacks on electricity system, sabotage of aircrafts)
The Motivate XR solutions increases the power consumption and need for rare earth materials for performing tasks that earlier had small environmental impacts
Lacking long-term support and longevity of XR software and hardware products will create more waste
Cloud serving can have high carbon footprint
The environmental impact from using the XR may be sufficient to impact sustainable tax cost (RSE) and ESG/CSRD reporting

5.2 PRIORITIZATION OF SOCIAL, ETHICAL AND LEGAL CHALLENGES

To identify which of the 80 social, ethical and legal challenges are most relevant to Motivate XR a prioritization survey was developed. The survey asked participants to evaluate each risk by indicating both the likelihood of its occurrence and the severity of its consequences should it materialize. The possible choices were “No”, “Low”, “Medium” and “High”. The survey can be seen in Appendix E. It was distributed among consortium partners on 16/9 2024 with deadline of 24/9 2024. On 26/9 2024, the survey was responded by 6 individuals. The survey was anonymous. Besides assessing the likelihood of occurrence and severity of consequences for each of the 80 risks, respondents were asked to write any social, ethical and legal risks they found were missing in the survey. No respondents used this opportunity.

The survey presented the respondents with the options "No", "Low", "Medium" and "High". Such scales are often interpreted linearly, but some researchers argue this is not always a true reflection of the perception of the respondents[5,6]. Therefore, a non-linear weighting of the options has been used for the numerical analysis of the results. It is assumed that the distances in importance from "Low" to "Medium" and "Medium" to "High" are interpreted linearly by the respondents with the average of the three being the weighting of Medium". "No" is assumed to be considered much less likelihood and consequence severity than "Low". The scale used for the numerical analysis is thus as follow:

Option	No	Low	Medium	High
Points	0	2	3	4

Since the number of respondents were low, the response behaviour was considered. Respondent 1 had a more optimistic attitude, evaluating both likelihood and consequences significantly lower than the others. Respondent 6 did not use the "No" option, but refrained from assessing more risks than the other participants. Only one risk was answered by five respondents (Risk on legal compliance: Unclear how maintenance of the XR equipment will affect responsibilities). 13 risks were answered in full by five respondents. Due to the low number of respondents, the conclusions need further validation in the next stage of the project.

The severity of the consequences of the risks were generally assessed to be higher (average 2.7) than the likelihood of the risks occurring (average 2.4). This is expected as the risks that are identified through non-expert user participation in SEL workshop tend to focus on more severe risks and the optimism bias in multiple cases has been shown to decrease people's perception of the likelihood of negative events happening[7]. When respondents answered no to either likelihood or consequences, they answered no to both in many (27), but not all of the cases (total of 76 "No" answers).

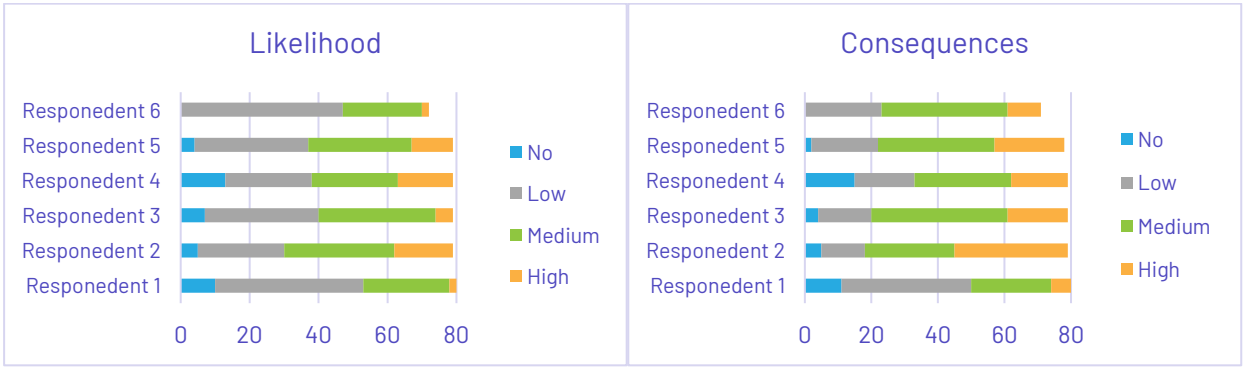


FIGURE 14: RESPONS SUMMARIES

[5] Anjaria, K. (2022). Knowledge derivation from Likert scale using Z-numbers. *Information Sciences, 590*, 234-252. https://doi.org/10.1016/j.ins.2022.01.024.

[6] Knapp, T. R. (1990). Treating ordinal scales as interval scales: an attempt to resolve the controversy. *Nursing research*, *39*(2), 121-123.

[7] Sharot, T. (2011). The optimism bias. Current Biology, 21(23), R941-R945. https://doi.org/10.1016/j.cub.2011.10.030

The responses received for each risk can be seen in Appendix F. To prioritize what risks are more critical to work on mitigating within Motivate XR, the average perceived likelihood of occurrence and severity of consequences of each risk were plotted against each other. In Figure 15 this map is shown per category of risk. The different sizes of the markers are for legibility as some risks had same likelihood/consequences rating. The consequences of risks related to data collection, protection and storage were rated the highest (average 3,0), while the likelihood of occurrences was perceived to vary, with many of the data related risks being assessed slightly more likely (average 2,5) than the average of all the risks. Risks on employee and students' rights and safety were interestingly scored a bit lower than the average of all risks on both likelihood (average 2,3) and consequences (2,6). This category of risks is the largest, which can explain the proximity to the overall mean. Risks related to the work content and the technical reliability are on average considered almost as important as data-related risks with average consequence score of 2,8 and average likelihood of 2,5. Legal compliance risks are seen to be the most likely (average likelihood of 2,7) and their consequences on par with those of technical reliability (average 2,3). Risks related to organizational competences are seen to be as likely as those related to data, with an average likelihood score of 2,5 but are seen to have less severe, but still considerably high consequences (average 2,7). Risks to societal structures and environmental impact are seen as the least likely (average 2,2) and with slightly lower consequences (average 2,6) than the average of all risks.

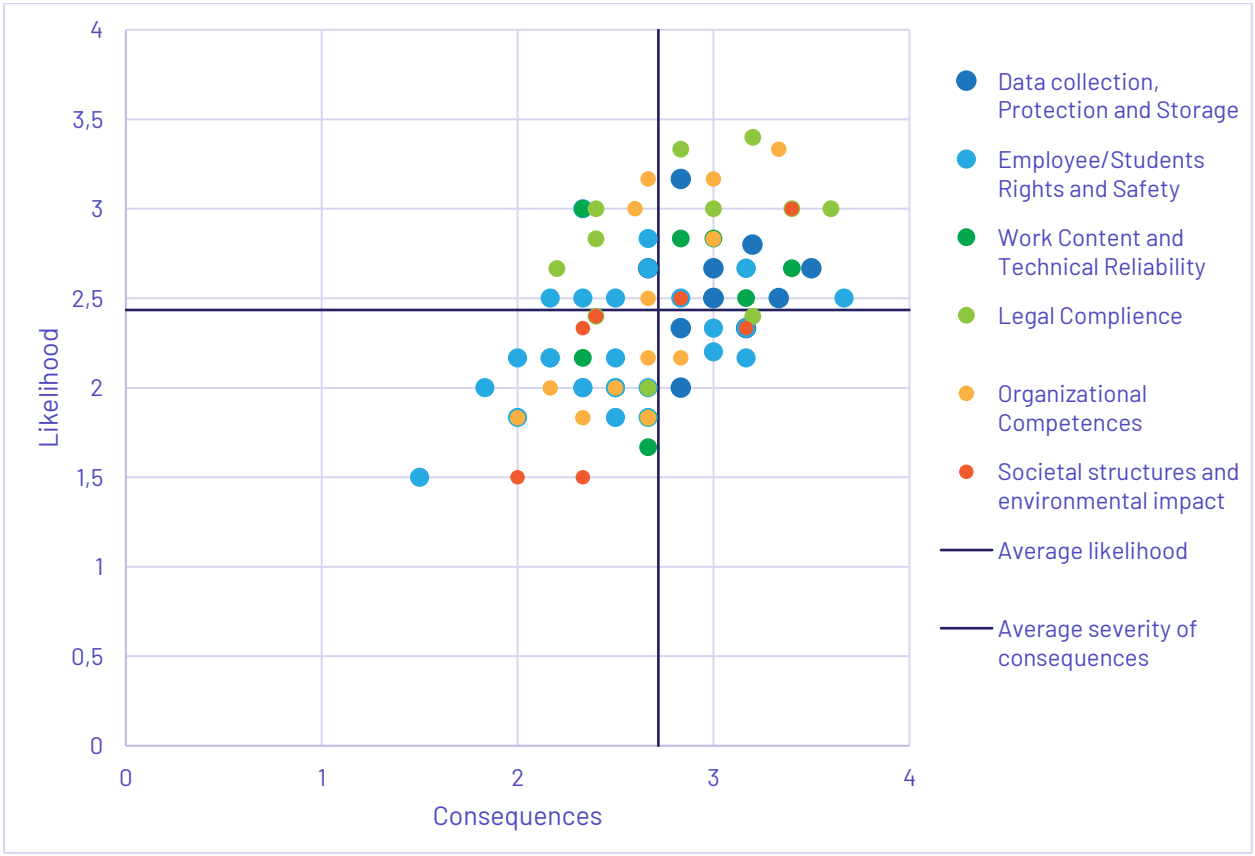


FIGURE 15 SEVERITY AND CONSEQUENCES BY RISK CATEGORY

The prioritized list of all social, ethical and legal risks can be found in Appendix G, where the impact of likelihood and consequences are weighted equal. The five risks that are identified as being the most impactful with a separation to the main body of issues are:

1. Organizational Competences: Organizations do not have the knowledge to assess the legal implications of having XR users do things dictated by AI or by people in remote locations (especially regarding harmful situations).
2. Legal Compliance: Uncertainty of legal, insurance and social security status if remote instructions delivered via XR caused or did not prevent an injury for a professional or student/trainee.
3. Legal Compliance: Current legislation is insufficient to identify responsibilities for incorrect use of the XR or use over prolonged periods of time.
4. Legal Compliance: Integration between the Motivate XR solutions and other systems may violate IP and legal requirements.
5. Environmental Impact: Cloud serving can have high carbon footprint.

6 LIST OF SOCIAL, ETHICAL AND LEGAL ISSUES RELEVANT FOR THE MOTIVATE XR PROJECT

At this early stage of the Motivate XR project many potential social, ethical and legal issues and who they may affect have been identified. Due to the diversity of the use cases within the Motivate XR project, many different groups may be affected by the project's outcome, both directly and indirectly. In Section 3, the identified stakeholders can be seen. The focus is on users and other functions within the user organizations, but potentially affected stakeholders have also been identified within the supply chain and society at large.

Two different methods were used to identify social, ethical and legal issues that may be caused by the outputs of the Motivate XR project. In the following, first the issue areas identified using the AI-based tool SurikaS on academic literature and second the issues identified by the Motivate XR consortium within the context of the use cases.

The results from using SurikaS to analyse the academic literature on XR showed that the key values discussed in connection to social, ethical and legal issues in XR were in the academic literature:

1) Safety and security,
2) Accountability,
3) Social balance,
4) Solidarity.

In the following are first a list of issue areas identified using SurikaS from academia. Both values and issue areas are elaborated upon in Section 4. Hereafter follows, in order of priority, the risks are that

were identified through a SEL workshop for consortium members, refined manually and prioritized by consortium members through a survey. These are elaborated in Section 5.

Issue areas identified from academic literature using SurikaS and manually found relevant for the Motivate XR contexts:

The Accessibility of Emerging Technologies
Legal Standardization and Liability in Extended Reality Applications
Privacy and Security Challenges in the Ethical Adoption of Extended Reality Technologies
User Privacy and Data Security Risks in Extended Reality Applications
The Transformation of Social Networks and Communication in the Age of Extended Reality
Legal and Intellectual Property Challenges in Virtual Economies and XR Environments
The Challenges of Leadership and Team Dynamics in Virtual Environments
The Impact of Digital Communication on Society and the Post-Truth Era
The Impact of Distraction and Technology Use on Walking Safety in Adults
Ethical Challenges of Data Security and Resource Management in Virtualized Cloud Environments
Data Privacy and Security Risks in the Internet of Things (IoT) and 5G/6G Networks
The Integration of XR in Smart Cities and Its Impact on Civic Engagement and Urban Life
The Ethical and Public Consequences of Augmented and Mixed Reality Technologies
Human-Robot Interaction and the Ethical Implications of Robotics in Industrial and Social Environments
Privacy and Security Risks in Online Platforms and Information Sharing
Trust and Human-Agent Interaction in Virtual Environments
Remote Collaboration and Expert Assistance in Healthcare and Mechatronics
The Challenge of Motion Sickness and Sensory Feedback in Virtual Environments
Participatory Design and User Interaction in XR: Evaluating Inclusivity and Research Practices
Harassment and User Safety in Immersive Virtual Spaces

Prioritized issues identified through Motivate XR SEL workshop (highest priority appears first)

Organizations do not have the knowledge to assess the legal implications of having XR users do things dictated by AI or by people in remote locations (especially regarding harmful situations).
Uncertainty of legal, insurance and social security status if remote instructions delivered via XR caused or did not prevent an injury for a professional or student/trainee.
Current legislation is insufficient to identify responsibilities for incorrect use of the XR or use over prolonged periods of time.
Integration between the Motivate XR solutions and other systems may violate IP and legal requirements.
Cloud serving can have high carbon footprint.
3D files will be increasingly requested, making it harder to protect designs with secrecy and patents.
The increased digital use of sensitive documentation and data caused by the Motivate XR solutions increases the risk of cyber theft.

The safety of workers cannot be guaranteed by current procedures as XR tech is not covered by Health & Safety Department regulations.
Many Health & Safety Departments do not have sufficient knowledge to protect their workers when introducing XR.
The use of AI to create content makes it harder to ensure the content presented in the XR is indeed correct.
Data privacy may be compromised by the use of Open-Source software.
The ability of the Motivate XR solutions to capture data causes users to capture more data than they need and thereby increase the risk of breaching privacy and IP.
Current regulation may not be able to adequately rule in situations where XR and AI content generation are used.
Since the information is available on an XR device, some users may forget that sensitive documentation should not be taken out of company premises, thereby compromising data security.
Automatic translation could introduce misunderstandings and inaccuracies.
Some organizations will not have access to sufficient documentation and therefore be disadvantaged.
Improper or missing maintenance of equipment and update of the software may create harmful situation.
The Motivate XR solutions may normalize the decrease in human expertise due to overreliance on digital guidance.
Use of XR may cause harmful situations due to the users decreased awareness of the surroundings.
Recordings and exercise conduction data of trainers or students/trainees may get misused or shared inappropriately.
The cost of the necessary equipment (inc. servers, headsets, capture devices etc) could make the tools and the XR not widely accessible to all organizations.
The users may rely on the XR instructions generated by AI so much they don't consider if the content is correct.
Data may get stolen because the used internet connections are not properly secure.
Software updates outside the control of the XR tool providers may make XR tech unstable or unresponsive after initial deployment.
The accountability in case of harmful situations, faulty results or inability to perform contracted job may depend on the status of the internet connection.
Technology may support monopolies as barrier to entry increases.
The risk of theft of information (e.g. industrial documentation, private information and analysis thereof) may increase as the XR headsets are more prone to get stolen than stationary computers.
Data privacy cannot be guaranteed when data travel around different countries in different servers.
Users may intentionally use the Motivate XR solutions to gather data for purposes different than what they tell data providers and people in their immediate surroundings.
Prolonged use of XR devices can harm the users.

To ensure safe use of XR, trainees and employees will have to inform their organizations about more health issues than they currently do.

The Motivate XR solutions may be designed in such a way that they do not fulfil the technologies' potential to improve the opportunities of impaired people and users with special needs.

Unclear how maintenance of the XR equipment will affect responsibilities.

Connection issues could provoke accidents as end-users don't fully understand remote instructions or even receive them.

Users may perform tasks that carry higher risks than they would otherwise dare to perform because the XR changes their perspective of risk.

Standardized training may not fit to the need of all participants' needs (e.g. some may need longer time than others).

The remote technician or instructors are not proficient in giving instructions in a way that positively uses the XR.

Lacking long-term support and longevity of XR software and hardware products will create more waste.

User organizations may not be able to gain access to 3D files that are IP protected, limiting which organizations can get the advantages of using the XR.

The users' safety gets compromised due to the use of XR compared to normal task execution (e.g. physical restricted by XR, entering electric environments with XR capture device or headset).

Organizations may not be aware on the IP rights connected to content created using the Motivate XR solutions in teaching situations.

The Motivate XR solutions may not adhere to cultural norms and legislation in all countries.

The XR triggers medical conditions like epileptic episodes.

End users' and user organisations' privacy may get compromised because the end users do not know how to use the privacy functionalities within the tools.

User organizations are unable to create the content they need themselves because the Motivate XR solutions are so complex that only specialized companies can use them.

The XR causes motion sickness.

Education using XR amplifies social inequality, as socio-economically challenged groups has lower level of knowledge and digital literacy.

The use of XR and AI generated contents may make it harder to trace actions and accountabilities.

The security of the full set of Motivate XR solutions gets compromised because it is only considered for each tool, not the full solution/system.

Wearing the glasses or headset may cause physical discomfort.

The balance between different types of stakeholders (e.g. technicians vs management & decision makers) may change in a negative way.

Responsibility and legal status may change by using Open-Source software.

The environmental impact from using the XR may be sufficient to impact sustainable tax cost (RSE) and ESG/CSRD reporting.

Elements in public spaces (including people) can be tracked.

Employees may lose their jobs due to the new requirements that XR brings (e.g. language, digital literacy, physical effects).

The requirements of education change and exclude a new group of students due to the requirements use of XR brings (e.g. language, digital literacy, physical effects).
Wearing the glasses or headset may make the user feel singled out or socially uncomfortable if the training/task to perform happens in public.
XR experiences may be shared without the creators' consent or compensation.
Technicians and trainees/students are forced to use the XR if they want to keep their job/get their diplomas, even if there is known risks of harm.
The Motivate XR solutions are used incorrectly by unexperienced users (independently or under supervision) and causes harmful situations.
Students and trainees may not get the necessary confidence to do the tasks independently.
In case certificates of ability to use the equipment are made, they can provide false confidence in skills if the certified technician has not maintained their skills.
XR experiences may be shared without consent from or compensation to the owners of the underlying data.
Only big organizations have capacity to access to these kinds of technologies.
An organization is unable to continue certain operations if the XR devices break.
XR will decrease the social interaction at work leading to sense of isolation.
Manipulating and controlling employees and students become easier with XR.
Wearing the glasses or headset may cause the user to feel anxiety.
Users may perform tasks that carry higher risks than what is advisable because they do not understand that certain instructions are available for users with more experience and the correct equipment.
Employees and students will only be able to pursue their careers if they consent to tracking and data collection, they are uncomfortable with.
Bad behaviour of the platform could cause problems also to big infrastructures (electric grid) widely impacting to society.
The use of XR makes the training feel less trustworthy and discourage students from persuading their education.
XR enables employers to record and misuse information (e.g. tracking, working hours, eye tracking, mistakes) on working hours and mistakes in higher details than traditional environments.
Learning how to use the XR and the tools to develop content may take so long very few people/organizations will be able to get to use it.
The public is harmed as a consequence of theft or misuse of information from the Motivate XR solutions (e.g. attacks on electricity system, sabotage of aircrafts).
Technology dependence can make end-users to feel uncomfortable and "useless".
Users may be tracked through the XR devises without being aware of it or consent to it.
Unemployment of content creators because of the AI powered tools.
The Motivate XR solutions increases the power consumption and need for rare earth materials for performing tasks that earlier had small environmental impacts.
The safety of people in the same physical environment as the user of XR gets worse compared to normal task execution.

7 CONCLUSIONS

This report provides an essential foundation for addressing the social and ethical concerns related to extended reality technologies within the Motivate XR project. By establishing a comprehensive framework for identifying, mapping, and analysing societal, ethical, and legal (SEL) issues, we have taken the first steps towards ensuring that the project's innovations are not only compliant with existing regulations but also aligned with societal expectations and values, particularly those encapsulated in the "Do No Significant Harm" (DNSH) principle.

At this early stage of the Motivate XR project, a variety of potential SEL issues and their associated stakeholders have been identified. These issues, affecting both direct users and the wider society, include concerns around safety, security, accountability, social balance, and solidarity. Identified issues range from privacy and security challenges, legal standardization, and intellectual property concerns to broader societal impacts such as the transformation of social networks and the implications of AI-driven decision-making within XR environments. These issues were highlighted through both academic literature and a consortium-driven workshop. The former was performed using an AI-driven tool (SurikaS[8] developed by YAGHMA B.V.[9]) to capture general issues and the latter highlighting Motivate XR specific issues. The specific issues includes the knowledge gap in assessing legal implications, the risk of over-reliance on AI, and data security vulnerabilities. The prioritized risks identified through consortium participation reflect a need for clearer regulatory frameworks, technical safeguards, and ethical guidance. Lists of relevant SEL issues can be found in Section 6 on page 44.

In the next phase, detailed in Deliverable 3.2 (due in month 19), this foundation will be expanded by integrating insights from academia with the consortium driven insights and enriched with results from other ongoing EU projects (such as iRECS and TechEthos). This iterative process will refine the SEL issue map and further prioritization help specify the most critical challenges to address. Further, mitigation strategies will be monitored, with a focus on practical solutions that the Motivate XR project can implement in both its activities and in the tools it aims to create.

A crucial element of this ongoing work will be fostering awareness and active engagement with the SEL challenges among all partners involved—both technical and use case partners. This will ensure that ethical considerations are embedded at every stage of technological development and deployment, promoting responsible innovation and minimizing potential harm.

As such, this deliverable marks the beginning of an ongoing process aimed at aligning technological advancement with societal values. Future work will not only continue to refine our understanding of the SEL issues but also develop actionable recommendations that contribute to the responsible deployment of XR technologies, both within the project and in wider industrial contexts.

[8] www.SurikaS.com

[9] https://yaghma.nl/

APPENDIX A – STAKEHOLDER MAP

Map of potentially affected stakeholders with connections to use cases

	Potentially affected	Aerospace Industry	Home appliance Industry	Aluminum Industry	Electric Distribution Industry	Robot-human hybrid manufacturing
End-user (on location or VR	Technician in the field		x	x	x	
	Student at training location	x		x	x	
	non-expert/ general technician/operator		x			x
	General public		x			
	Content creators		x			
	Management & decision makers	x	x	x	x	x
	Trainer	x			x	
End-user (backend/before)	Expert in office/ remote support for trained personnel		x	x	x	
	Trainer for remote training				x	
	Trainer for classroom training	x		x	x	
	Content creators	x	x	x	x	
	Task support (e.g. note taking)				x	
	Customer support team		x			
	Management & decision makers					
Other directly	Health & Safety Department	x			x	
	Other employees/ students in the same physical space	x				x
	Procurement	x				
	IT	x				
Indirect within user	IT department	x	x		x	
	IT maintenance department	x			x	x
	Technical support		x			
	Call centre		x			
	Procurement					
	Sales department	x	x			
	Management & decision makers					

Indirect in Value chain of user organization	Affected individuals	Aircraft technician	Service technicians providing service on the field	Potential students that currently have to low literate skills?	Assistant workers that used to take notes in the field	
	Affected organizations	OEM, Engine manufacturers, System suppliers, Aircraft companies, Maintenance companies, Aircraft manufacturer, Certified maintenance organisations, Standardization bodies, Training centres	Part suppliers	Part producers and suppliers	Energy consumers	Shuttle robot supplier, Equipment suppliers
	Affected sectors	Aero training sector, Maintenance sector, Manufacturing sector	Repair industry (balance between certified, uncertified and DIY), Second hand market	Construction sector	Energy sector	
Indirect in broader society	Micro-level (citizens)		Consumers of second-hand products		Citizens accidentally recorded as part of XR	Workers for whom the tasks were earlier too complex
	Mezzo-level (organizations)		Liability organizations (insurance) related to remote support	Liability organizations (insurance) related to remote support		
	Macro-level (policy makers, national level, global impact)			National construction regulations		

Map of potentially affected stakeholders with connections to use cases

	Potentially affected	D3	SOP	TEC	MAG	YBQ	2F
End-user (on location or	Technician in the field	x		x		x	x
	Student at training location	x	x	x		x	
	non-expert/general technician/operator			x		x	x
	General public			x			x
	Content creators			x	x	x	x
	Management & decision makers						
	Trainer						
End-user (backend/before)	Expert in office/ remote support for trained personal	x		x	x	x	
	Trainer for remote training					x	
	Trainer for classroom training	x				x	
	Content creators	x	x	x			
	Task support (e.g. note taking)						
	Customer support team						
	Management & decision makers			x	x		
Other directly	Health & Safety Department					x	
	Other employees/ students in the same physical space						x
	Procurement					x	x
	IT					x	x
Indirect within user	IT department					x	
	IT maintenance department	x	x	x	x	x	x
	Technical support	x					
	Call centre						
	Procurement		x	x	x	x	
	Sales department			x			
	Management & decision makers						
Indirect in Value	Affected individuals	Trainers from D3, Support team	Suppor t team	Support team	Support team	Support team	Support team
	Affected organizations					Robot supplier	Part suppliers
	Affected sectors					Logistic sector, Aerospace	

						sector, Construction sector	
Indirect in broader	Micro-level (citizens)					Other workers accidentally recorded as part of XR	
	Mezzo-level (organizations)	Part providers					
	Macro-level (policy makers, national level, global impact)						

APPENDIX B – TOPICS IN ACADEMIC LITERATURE

Topic	Count	Name	Topic category
0	246	0_vr_experience_reality_ethical	ethical concern
1	174	1_metaverse_metaverses_potential_challenges	social concern
2	157	2_game_games_players_video	societal group
3	103	3_pandemic_covid19_health_coronavirus	social concern
5	97	5_students_student_course_engineering	societal group
6	95	6_world_cyberspace_life_identity	social concern
7	94	7_ar_augmented_technology_reality	technology
8	92	8_heritage_cultural_museum_digital	social concern
9	89	9_training_trainees_skills_trials	undefined
10	88	10_driving_drivers_vehicle_vehicles	social concern
11	82	11_ai_intelligence_artificial_aipowered	ethical concern
12	82	12_community_communities_members_online	social concern
13	81	13_haptic_force_feedback_device	technology
14	75	14_surgery_surgical_invasive_imaging	technology
15	74	15_agents_agent_multiagent_trust	social concern
16	71	16_avatars_avatar_appearance_social	social concern
17	66	17_compounds_screening_binding_inhibitors	societal group
18	66	18_design_space_architectural_spaces	social concern
19	61	19_robot_robots_humanrobot_humanoid	social concern
20	61	20_privacy_data_users_mar	ethical concern
21	61	21_digital_twin_placemaking_technologies	social concern
22	60	22_3d_garment_steganalysis_steganography	technology
23	60	23_user_users_fitness_interaction	technology
24	58	24_industry_40_industrial_technologies	technology
25	57	25_human_humans_interaction_humancomputer	societal group
26	55	26_worlds_virtual_world_property	technology
27	55	27_colon_abduction_humeral_volume	social concern
28	53	28_surgery_preoperative_mm_ct	technology
29	52	29_social_networks_tpu_media	social concern
30	52	30_internet_addiction_charitable_students	social concern
31	50	31_data_maps_visualization_spatial	technology
32	47	32_xr_extended_privacy_ethical	ethical concern
33	47	33_rehabilitation_stroke_motor_patients	social concern
34	46	34_feature_recognition_depth_pose	technology
35	45	35_based_optimization_design_analysis	technology
36	42	36_hmd_display_view_headmounted	technology

37	41	37_education_learning_higher_educational	societal group
38	41	38_display_image_distortion_holographic	technology
39	40	39_simulation_forest_simulator_soil	technology
40	39	40_treatment_anxiety_therapy_exposure	social concern
41	38	41_technologies_accessibility_emerging_ethical	ethical concern
42	37	42_iot_things_internet_5g	ethical concern
43	35	43_legal_law_criminal_property	legal concern
45	35	45_body_ownership_illusion_embodiment	social concern
46	34	46_learning_elearning_lifelong_ves	technology
47	34	47_augmented_reality_mixed_sphere	social concern
48	33	48_cloud_virtualization_computing_security	ethical concern
49	32	49_tissue_soft_water_planetary	undefined
51	31	51_facial_characters_expressions_human	technology
52	31	52_tourism_destination_travel_tourist	undefined
53	29	53_network_service_sdn_resource	technology
54	29	54_mental_health_care_digital	social concern
55	29	55_children_childrens_parents_child	social concern
56	28	56_media_social_folkloric_political	social concern
57	28	57_smart_cities_glasses_city	social concern
58	28	58_mobile_augmented_devices_applications	technology
59	27	59_teaching_students_courses_course	technology
60	27	60_gender_women_men_stem	social concern
61	27	61_optical_metasurfaces_light_fig	technology
62	26	62_enterprise_adoption_systems_service	social concern
63	26	63_urban_city_cities_planning	social concern
64	25	64_video_watermarking_compression_360	technology
65	24	65_group_patients_p005_plaque	social concern
66	24	66_communication_digital_sphere_society	social concern
67	23	67_care_health_patient_patients	social concern
71	22	71_remote_eeg_collaboration_arthroscope	social concern
72	21	72_creativity_csr_forestry_chorography	social concern
73	21	73_harassment_vr_social_pts	social concern
74	20	74_arvr_ar_vrar_adoption	societal group
75	20	75_surgical_training_simulators_simulation	technology
76	20	76_learning_education_students_proceedings	technology
77	19	77_teams_team_leadership_management	social concern
78	19	78_virtualization_vms_kernel_pages	technology
79	19	79_design_interaction_evaluation_participatory	social concern
80	18	80_assistive_technology_computing_bci	technology
82	18	82_reality_proceedings_contain_papers	technology

83	17	83_vcs_union_european_life	social concern
84	17	84_motion_sickness_autoencoder_bra	social concern
85	17	85_second_life_nurses_sl	social concern
86	17	86_systems_mrpreviz_grid_distributed	societal group
87	17	87_healthcare_telemedicine_cv_patient	societal group
88	17	88_pain_chronic_distraction_vr	social concern
90	16	90_social_exclusion_symptoms_participants	social concern
91	16	91_pnf_anxiety_exposed_guilty	social concern
93	16	93_journalism_news_immersive_journalistic	ethical concern
94	15	94_assembly_augmentation_dfa_validation	technology
95	15	95_walking_adults_older_messages	social concern
96	14	96_medical_operation_aneurysm_telemedicine	social concern
97	14	97_embryonic_pregnancies_ci_95	social concern
98	13	98_nd_ohs_anaesthesia_litigation	legal concern
101	13	101_users_security_sharing_platforms	social concern
102	13	102_ar_privacy_permission_bystanders	ethical concern
103	12	103_gambling_online_gamblers_cs	societal group
104	12	104_design_health_patients_app	social concern
105	12	105_children_vergence_plasticity_accommodation	social concern
107	11	107_environments_humancomputer_computer_computer based	social concern
108	11	108_hmds_hmd_users_nonhmd	social concern
109	11	109_mesh_illumination_polytope_surfaces	technology
110	10	110_cyberbullying_adolescents_phubbing_pornography	social concern
111	10	111_project_rampage_vbbc_ocean	social concern
112	10	112_ii_digital_marketing_labour	social concern

APPENDIX C – DESCRIPTIONS OF SEL ISSUES FROM ACADEMIC LITERATURE

Cluster 1: Equitable Access and Regulatory Standardization in Emerging Extended Reality Technologies

The Accessibility of Emerging Technologies (Topic 41)

This issue focuses on how societies can manage the introduction of new, disruptive technologies in ways that ensure equal access for all, uphold ethical standards, and address the challenges posed by their rapid advancement. This includes ensuring that marginalized groups, individuals with disabilities, or those in lower socioeconomic conditions have the same opportunities to benefit from technological advancements.

- Top values: Safety, Solidary, Fairness, Human Dignity, Security

Legal Standardization and Liability in Extended Reality Applications (Topic 98)

This issue revolves around the challenges of integrating XR technology into high-stakes sectors like healthcare (e.g., anaesthesia) and transportation (e.g., trucks), where occupational health and safety (OHS) standards are critical. The lack of clear regulatory frameworks for XR adoption creates significant risks of litigation, particularly regarding the safe implementation of XR tools and the liability of organizations if these tools lead to health or safety breaches. Standardizing XR technology while addressing its novel risks is crucial to ensure legal protection and public safety.

- Top values: Accountability, Solidarity, Social Balance, Safety, Well-Being

Cluster 2: Ethical and Privacy Challenges in Extended Reality

Privacy and Security Challenges in the Ethical Adoption of Extended Reality Technologies (Topic 32)

This issue focuses on the growing concerns around the privacy and security of users' personal data as XR technologies, such as virtual, augmented, and mixed reality, become more widespread. As these immersive experiences capture sensitive and extensive user data, including physical movements, environments, and interactions, the potential for misuse, data breaches, and privacy violations increases. Ethical considerations must address how XR technologies can protect users while harnessing their full potential, balancing innovation with safeguarding personal privacy and ensuring secure technological environments for future adoption.

- Top values: Safety, Security, Privacy

User Privacy and Data Security Risks in Extended Reality Applications. (Topic 20)

This issue centers on the growing concerns surrounding the collection, use, and protection of personal data in XR environments, where technologies like Virtual Reality (VR) and Augmented Reality (AR) increasingly integrate into consumer applications and websites. As XR tools capture detailed user information, including sensitive biometric data and behavioural patterns, the risks of data breaches, unauthorized access, and privacy violations escalate. These security threats and the absence of clear data protection policies pose significant risks to users, requiring stricter regulations and ethical frameworks to safeguard consumer privacy in the rapidly expanding XR landscape.

- Top values: Privacy, Safety, Security

Ethical Implications of AI-Powered Applications in Medical Extended Reality (Topic 11)

This issue addresses the intersection of artificial intelligence (AI) and extended reality (XR) in the medical field, where AI-driven tools and applications are increasingly used to enhance diagnosis, treatment (e.g., sepsis detection), and patient care. The integration of AI-powered systems raises ethical concerns about the use and protection of medical data, the transparency of AI-based decision-making processes, and the potential for bias in machine learning algorithms. These technologies offer significant future potential, but without careful ethical oversight, they could compromise patient privacy, safety, and the reliability of medical interventions.

- Top values: Safety, Accountability, Social Balance

Privacy and Security Challenges in the Emergent Metaverse Ecosystem (Topic 1)

This issue revolves around the rapid development of the metaverse and other immersive digital platforms, where users engage in virtual worlds. These platforms offer enormous potential for social interaction, business, and entertainment, but they also present significant challenges related to privacy and security. As people increasingly immerse themselves in these virtual environments, concerns about how personal data is collected, stored, and used become paramount. The issue also includes the ethical and social risks of digital surveillance and manipulation, as well as the potential for breaches in virtual privacy, which could affect users' real-world lives. The evolving nature of these technologies demands new standards and protections to ensure safe and secure user experiences in the metaverse.

- Top values: Safety, Security, Privacy

Cluster 3: Transformation of Social Networks and Community Dynamics

The Transformation of Social Networks and Communication in the Age of Extended Reality (Topic 29)

This issue focuses on how XR technologies are reshaping social networks, interpersonal communication, and the way people interact in online environments. As XR platforms create immersive virtual spaces, the traditional boundaries of networking and communication are changing, allowing for deeper, more interactive experiences but also raising concerns about the authenticity of information, the erosion of interpersonal relationships, and the potential for social isolation in a hyper-connected digital world. This transformation impacts society at large, as individuals increasingly engage with content and others in fully virtual or augmented spaces, leading to both opportunities and challenges in maintaining real-world social cohesion and meaningful interactions.

- Top values: Social Balance, Safety, Accountability, Solidarity, Security

Community Building and Social Participation in Virtual Environments (Topic 12)

This issue revolves around how XR technologies are transforming online communities and the dynamics of social participation. As individuals engage with virtual spaces and digital platforms, the ways in which they form connections, share knowledge, and demonstrate loyalty to online communities and brands evolve. While XR offers enriched interaction and collaboration opportunities, it also raises questions about the depth of relationships and the balance between individual identity and community belonging in fully virtual or hybrid spaces. The challenge lies in maintaining meaningful community participation and ensuring that virtual connections foster genuine engagement and social cohesion.

- Top values: Social Balance, Safety, Solidarity, Accountability

Psychological Impacts and Behavioural Addictions in Virtual and Online Environments (Topic 30)
This issue focuses on the growing concern over internet addiction and its psychological effects on vulnerable groups, such as students and teenagers. As people, particularly younger individuals, increasingly engage in online activities through XR platforms, their social behaviour can be affected, leading to issues like social isolation, anxiety, and addictive patterns. Additionally, while XR offers new opportunities for educational and charitable causes, the overuse of these technologies in libraries and other spaces raises concerns about mental well-being and the potential for addictive behaviours in immersive environments. This issue underscores the need for awareness and intervention to address the psychological consequences of excessive engagement in XR technologies.

- Top values: Social Balance, Safety, Solidarity, Accountability

Disinformation and Political Manipulation in XR and Social Media Platforms (Topic 56)
This issue highlights the growing concern over the spread of disinformation and political manipulation within social media and smartphone-based XR platforms. As users engage with rich and immersive media environments, the potential for misleading or false information to influence public opinion and social behaviour increases. The visibility of disinformation on these platforms poses a serious threat to socialization, trust in news sources, and the health of political discourse. This issue underscores the need for media literacy, regulation, and technological solutions to curb the impact of disinformation in XR environments, protecting both users and the democratic process from harmful narratives.

- Top values: Safety, Accountability, Social Balance, Solidarity

Legal and Intellectual Property Challenges in Virtual Economies and XR Environments (Topic 43)
This issue revolves around the complexities of applying existing laws and creating new regulations for XR technologies, particularly concerning intellectual property, criminal law, and economic relations within virtual worlds. As XR platforms facilitate new forms of digital interaction, property rights and financial transactions take on unique challenges, including identity protection, ownership of digital assets, and the legality of virtual betting and other economic activities. The evolving nature of these technologies necessitates legal frameworks to address the protection of virtual goods and identities, as well as how courts handle disputes in these digitally mediated environments.

- Top values: Safety, Security, Accountability, Social Balance, Fairness, Privacy

Cluster 4: The Influence of Extended Reality on Social Narratives, Identity, and Political Discourses

The Impact of XR on Social Narratives and Political Discourses in Contemporary Society (Topic 72)
This issue focuses on how XR technologies influence creativity, political discourses, and the expression of contemporary stories, particularly in areas such as corporate social responsibility (CSR), religion, and local governance (municipal and intermunicipal relations). XR enables immersive storytelling that reshapes societal narratives, but it also raises concerns about how these technologies might deepen feelings of loneliness or reinforce specific political or religious ideologies in digital spaces. Governments and local bodies are increasingly adopting XR for policy-making and community engagement, further blurring the lines between physical and virtual environments in addressing public issues.

- Top values: Accountability, Social Balance, Safety, Inclusiveness, Solidarity

The Blurring of Identity and Reality in Cyberspace (Topic 6)

This issue addresses the profound impact that XR technologies have on human identity, subjectivity, and the way people perceive both the virtual and real worlds. As individuals increasingly interact within cyberspace, the boundaries between virtual experiences and real-life identities become blurred, raising questions about the meaning of human existence and consciousness in digital environments. The ability to construct and project alternate identities in XR spaces challenges traditional notions of the self, society, and the human experience, influencing how people form connections, establish a sense of place, and derive meaning from their interactions in both physical and virtual worlds.

- Top values: Social Balance, Accountability, Solidarity, Safety, Human dignity

Cluster 5: The Impact of Virtualization on Team Dynamics

The Impact of the COVID-19 Pandemic on Virtual Interactions and Social Adaptation (Topic 3)

This issue highlights how the COVID-19 pandemic accelerated the adoption of virtual technologies to address challenges such as social distancing, healthcare, and education. The widespread shift to virtual platforms for in-person interactions, including job interviews, medical consultations, and academic activities, has redefined how people engage in social and professional environments. As the virus necessitated remote solutions in 2020 and 2021, it brought both opportunities and challenges in adapting to a new virtual landscape, raising questions about the long-term effects of this transition on social structures, mental health, and accessibility to critical services.

- Top values: Accountability, Safety, Social Balance, Solidarity, Well-Being

The Challenges of Leadership and Team Dynamics in Virtual Environments (Topic 77)

This issue focuses on the complexities that arise when teams and leadership structures shift to virtual environments, especially in fields like engineering, construction, and crisis management. As organizations adopt virtual teams (e.g., GVTS and e-teams), they face challenges related to decision-making, coordination, and maintaining effective leadership. The lack of physical presence and the reliance on digital tools can impact shared tactics, influence dynamics, and team member engagement, potentially endangering project outcomes in high-stakes environments. This issue highlights the need for new strategies and management practices to ensure effective leadership and collaboration in virtual and hybrid workspaces.

- Top values: Accountability, Social Balance, Solidarity, Safety

Cluster 6: The Impact of Extended Reality and Digital Media on Child Development and Parental Concerns

Parental Concerns and Child Development Risks in the Age of Digital and Social Media Influence (Topic 55)

This issue focuses on the impact of XR and digital environments on children's well-being, particularly related to parental roles, bullying, body image (BMI), and eating behaviours. As children engage with virtual characters and digital platforms, parents express concerns over the potential risks, such as cyberbullying, unhealthy eating habits, and the influence of media on self-perception. The issue also touches on how mothers and fathers navigate guilt and the feeding practices of their children in the face of increasingly pervasive digital content, contributing to societal challenges around child development in a tech-driven world.

- Top values: Safety, Accountability, Solidarity, Well-Being, Human dignity

Impact of Extended Reality on Children's Visual and Cognitive Development (Topic 106)

This issue addresses the concerns regarding how immersive XR experiences, particularly those that involve vergence (eye alignment) and accommodation (focusing), affect the developmental plasticity of children's visual and cognitive systems. As children, especially preschool and young ones, spend more time engaging with digital games and virtual environments, there are potential risks to their visual health and accommodative abilities, which can influence overall developmental outcomes. Additionally, the way XR technologies shape children's learning (literacies) and adaptation to stimuli compared to adults raises important questions for parents and educators about balancing screen time with healthy developmental practices.

- Top values: Well-Being, Social Balance, Autonomy

Cluster 7: Cultural, Ethical, and Communication Challenges in the Age of Digital Twins and Extended Reality (authenticity, accuracy and rights)

Cultural and Ethical Implications of Digital Twins in Heritage, Farming, and Product Design (Topic 21)

This issue focuses on how digital twin technologies, which create virtual replicas of real-world environments, objects, and systems, are influencing placemaking, farming, music, and museum experiences. The use of digital twins raises important questions about rights over digital replicas, especially in sensitive contexts like holocaust memorials or animal farming. The transformation of these domains through digital tools and technologies not only impacts product design and user experiences but also challenges the ethical boundaries of how digital replicas are created, used, and interpreted within society.

- Top values: Accountability, Safety, Social Balance, Solidarity, Security

The Digitization and Preservation of Cultural Heritage in the Age of Extended Reality (Topic 8)

This issue revolves around how XR technologies are transforming the ways in which cultural heritage, archaeological sites, and historical works of art are preserved, displayed, and experienced in museums and other cultural institutions. While digital tools offer new ways for visitors to engage with art and archaeology, they also raise concerns about the authenticity and integrity of the sites and paintings being represented. The challenge lies in balancing technological innovation with the responsibility to maintain and preserve the original cultural and historical value of these heritage assets, while addressing the potential for competing interpretations and representations in virtual spaces.

- Top values: Solidarity, Social Balance, Accountability, Inclusiveness

The Impact of Digital Communication on Society and the Post-Truth Era (Topic 66)

This issue explores how XR and digital technologies are reshaping communication in the modern digital sphere, influencing how information is shared and perceived in contemporary society. The rise of immersive media and digital spaces has created new challenges in distinguishing between reality and manipulation, contributing to the rise of the post-truth era, where subjective emotions often take precedence over objective facts. This shift impacts various aspects of life, from family dynamics to broader cultural trends, while also raising concerns about the hygiene of digital information and the subconscious influence of media on individuals. Addressing this issue requires

a critical reevaluation of how information is managed and communicated in digital and extended reality environments.

- Top values: Accountability, Social Balance, Trust, Safety

Cluster 8: Mental Health and Psychological Risks in Immersive Extended Reality Environments

Social Exclusion and Mental Health Risks in Virtual Environments (Topic 90)

This issue examines how XR experiences can exacerbate feelings of social exclusion, particularly among vulnerable groups such as the elderly and individuals with mental health conditions like paranoia or psychotic symptoms. Virtual interactions may lead to unintended consequences such as cybersickness, feelings of defeat, or heightened isolation, especially for those prone to social anxieties or alcohol dependence. While XR offers immersive social opportunities, it also risks reinforcing exclusionary behaviours and contributing to mental health challenges in users who struggle with real-world interactions. Addressing this issue involves understanding the psychological impacts of XR technology and designing more inclusive, supportive virtual spaces.

- Top values: Well-Being, Accountability, Safety

The Emotional and Psychological Impact of Immersive Virtual Experiences (Topic 91)

This issue focuses on how XR environments, particularly those involving gamified or immersive experiences, affect users' anxiety, emotional arousal, and mood. Participants exposed to threatening or high-stress virtual scenarios may experience heightened paranoia, freezing responses, or increased emotional distress, such as guilt and fear, which can exacerbate underlying psychological conditions. While XR technologies have great potential in therapeutic contexts (e.g., for treating phobias or anxiety), their misuse or overexposure to emotionally charged content may trigger negative mental health outcomes. Understanding and mitigating these psychological risks are essential to ensuring safe and supportive virtual environments.

- Top values: Safety, Accountability, Human dignity, Solidarity

Cluster 9: Extended Reality in Pain Management

The Use of Virtual Reality for Pain Management and Its Effectiveness in Chronic and Acute Conditions (Topic 88)

This issue focuses on how virtual reality (VR) is increasingly being explored as a tool for distraction and pain relief in cases of chronic pain, such as chronic low back pain (CLBP), and acute pain management scenarios. While some studies suggest that VR has beneficial effects on reducing pain intensity and increasing tolerance, the low-certainty evidence and variable outcomes raise questions about its long-term efficacy and applicability. VR's potential in offering non-invasive pain relief highlights its promise, but further research is needed to solidify its role in medical practice, particularly in managing movement-evoked pain and other sensory challenges.

- Top values: Accountability, Human dignity, Sustainability, Solidarity, Safety

The Evolution of Telehealth and Patient Care in the Age of Extended Reality (Topic 67)

This issue focuses on how XR technologies, including telehealth and virtual care platforms, are transforming patient care, especially during the pandemic. These technologies offer expanded access to healthcare services, enabling patients to receive care remotely and empowering self-care management. However, the quality of care, mental health support, and the experiences of both providers and families need careful consideration to ensure effective and equitable healthcare

delivery. The growing reliance on telehealth for routine and emergency visits raises questions about long-term indicators of success, patient-provider relationships, and access to care for vulnerable populations.

- Top values: Safety, Accountability, Solidarity, Social Balance

The Integration of Extended Reality in Medical Operations and Telemedicine (Topic 96)

This issue addresses how XR technologies, such as headsets and telemedicine, are being incorporated into medical procedures, including complex surgeries like aneurysm operations and urology care. XR offers innovative solutions to enhance patient outcomes and reduce the burden on healthcare systems, particularly in intensive care and genetic medical fields. However, the challenges of securing adequate funding, ensuring the success of these technologies, and addressing the burden of implementation on healthcare providers highlight the ongoing need for investment and adaptation to make XR a viable and equitable tool in modern medical practice.

- Top values: Safety, Accountability, Solidarity, Social Balance, Human dignity, Fairness

The Role of Virtual Reality Exposure Therapy (VRET) in Treating Anxiety and Mental Health Disorders (Topic 40)

This issue highlights how XR technology, particularly Virtual Reality Exposure Therapy (VRET), is being used to treat various anxiety disorders, including PTSD, social anxiety disorder (SAD)**,** and eating disorders. While VRET has shown promise in reducing fear, improving posttreatment outcomes, and enhancing the efficacy of CBT for conditions such as phobias and speaking anxiety, there are ongoing concerns about stigma and the long-term sustainability of these treatments. Further research is needed to establish the full potential of XR in addressing mental health symptoms and disorders, as well as to ensure its accessibility and acceptance within the broader therapeutic landscape.

- Top values: Well-Being, Safety, Accountability, Solidarity

Cluster 10: Extended Reality in Healthcare and Rehabilitation (including for women and adolescents)

Technological Advances in Medical Imaging and Surgical Precision Through Extended Reality (Topic 27)

This issue highlights the role of XR technologies in improving medical imaging techniques such as computed tomography (CT) and segmentation for surgeries involving the colon, humeral bones, and other critical areas. By integrating these technologies, surgeons can enhance incision accuracy, assess lumen volume, and track the velocity of tools during procedures, contributing to better results and outcomes for complex surgeries. However, these innovations also raise questions about accessibility, the need for specialized training, and ensuring that such advanced techniques are available across diverse healthcare settings.

- Top values: Accountability, Safety, Solidarity, Social Balance

The Role of Extended Reality in Enhancing Intraoperative Navigation and Postoperative Outcomes (Topic 65)

This issue focuses on the integration of XR technologies in intraoperative settings, where they aid in navigation during complex surgeries such as maxillectomy and procedures involving lesions and plaque removal. XR assists in reducing operation time, improving precision, and enhancing postoperative recovery for patients. Despite these benefits, there are concerns about the

differences in access to this advanced technology, the learning curve for medical professionals, and the need to ensure equitable healthcare outcomes across diverse patient groups.

- Top values: Accountability, Safety, Solidarity, Social Balance

The Integration of XR in Post-Stroke Rehabilitation for Motor Recovery (Topic 33)

This issue addresses the growing use of XR technologies in neurorehabilitation to assist stroke survivors with motor recovery, particularly for upper limb functionality. XR-based therapy and training programs, often combined with robotic assistance, aim to enhance exercise routines and improve functional outcomes for patients dealing with post-stroke disabilities. These innovations provide immersive and engaging rehabilitation experiences, but challenges remain in ensuring widespread clinical adoption, equal access for all patients, and long-term effectiveness in improving brain and limb recovery.

- Top values: Safety, Accountability, Social Balance

The Use of XR in Maternal Health and Pregnancy Monitoring (Topic 97)

This issue focuses on the application of XR technologies in monitoring and managing pregnancies, particularly in tracking fetal and embryonic development. XR tools provide immersive ways to visualize maternal and fetal health, aiding in the diagnosis and management of complications like placental abnormalities, the effects of smoking, and risks such as miscarriage. While these technologies offer promising advances in pregnancy care, ensuring accessibility and accuracy in diverse healthcare settings remains a challenge, especially for women in under-resourced areas.

- Top values: Accountability, Social Balance, Safety, Solidarity, Fairness, Human dignity, Inclusiveness

The Impact of Distraction and Technology Use on Walking Safety in Adults (Topic 95)

This issue addresses the growing concerns around how the use of devices, such as smartphones, for tasks like texting or listening to audio messages, affects gait, speed, and obstacle avoidance in both young and older adults. As individuals engage with technology while walking, they face increased risks of collisions and accidents, particularly when navigating complex environments such as inclined surfaces or busy streets. XR technologies, such as treadmills and virtual environments, are being used to study these effects and explore interventions to improve walking safety and message management while walking, especially for vulnerable groups like the elderly.

- Top values: Accountability, Safety, Social Balance, Well-Being, Solidarity

Gender Representation and Diversity in STEM and Virtual Environments (Topic 60)

This issue explores the disparities between men and women in fields such as STEM, where female representation remains low. The use of XR technology offers opportunities for gender-switching and immersive experiences that can address gender-based inequalities and diversity challenges. However, it also highlights concerns related to sexual violence, gender differences in leadership roles, and how these dynamics are reinforced or challenged in virtual spaces. XR technologies could serve as tools for promoting gender equality and encouraging more women and female scientists to engage in male-dominated fields, but addressing gender-based violence and bias remains critical to creating truly inclusive digital environments.

- Top values: Accountability, Safety, Solidarity, Social Balance, Fairness

The Impact of Cyberbullying, Sexual Content, and Online Aggression on Adolescents (Topic 110)

This issue focuses on the growing risks adolescents face in digital environments, particularly concerning cyberbullying, sexual aggression, and exposure to inappropriate content such as

pornography. The influence of phubbing (ignoring others by focusing on mobile devices), the emotional consequences of online interactions, and the challenges of parenting in the digital age further complicate the landscape. These concerns highlight the need for stronger protective measures, familial involvement, and the role of educators and librarians in fostering safe online behaviours and preventing the harmful effects of online aggression on young individuals.

- Top values: Security, Safety

Cluster 11: Resource Management in Virtualized Cloud Environments

Ethical Challenges of Data Security and Resource Management in Virtualized Cloud Environments (Topic 48)

This issue highlights the concerns surrounding the use of virtualization and cloud computing for managing resources, data storage, and service migration in virtualized environments. As more services and virtual machines (VMs) rely on cloud infrastructure, ensuring data security, proper allocation of computing resources, and ethical management of sensitive information becomes critical. The challenge lies in maintaining robust security protocols while managing the vast amounts of data and services in virtualized environments, raising concerns about privacy, data integrity, and equitable resource distribution across users and service providers

- Top values: Safety, Security, Accountability

Cluster 12: Extended Reality in Urban planning and City Surveillance

Data Privacy and Security Risks in the Internet of Things (IoT) and 5G/6G Networks (Topic 42)

This issue focuses on the ethical concerns arising from the widespread adoption of IoT devices and smart technologies, which rely on 5G and future 6G networks for seamless communication and data exchange. The integration of IoT in critical sectors like healthcare raises significant challenges related to the security of personal and sensitive information, as well as the ethical management of the vast amounts of data generated by interconnected devices. Ensuring robust security measures while maintaining user privacy and protecting against potential breaches in wireless networks is crucial as the reliance on smart technologies continues to grow across various applications and services.

- Top values: Safety, Security, Accountability, Privacy

The Integration of XR in Smart Cities and Its Impact on Civic Engagement and Urban Life (Topic 57)

This issue explores how XR technologies, such as smart glasses and immersive platforms, are being integrated into smart cities to enhance services, improve tourism, and create more sentient urban environments. While these technologies offer the potential for more connected and efficient city life, they also raise concerns about citizens' privacy, access to digital tools, and equitable participation in urban innovation. The role of XR in shaping how people interact with their homes, workplaces, and public spaces must be critically examined to ensure that smarter cities do not alienate or marginalize certain groups of consumers or residents, fostering inclusive civic participation.

- Top values: Safety, Security, Social Balance, Accountability, Privacy, Trust

The Role of XR in Urban Planning and Digital City Design (Topic 63)

This issue explores how XR technologies are transforming urban and city planning by allowing designers and planners to create virtual models of public spaces and infrastructures. These tools offer new ways to visualize future city developments, engage citizens in the planning process, and adapt architectural designs to meet 21st-century needs. However, there are concerns about how digital planning processes may impact public involvement, transparency, and the inclusivity of urban design, especially for marginalized communities. The use of XR must be balanced to ensure that the future of cities is shaped with diverse input and serves the broadest spectrum of urban residents

- Top values: Safety, Social Balance, Inclusiveness, Accountability, Solidarity

Cluster 13: The use of Augmented Reality in Robotics (Social and behavioural changes within industry and society)

The Ethical and Public Consequences of Augmented and Mixed Reality Technologies (Topic 47)

This issue centers on the societal impact of augmented reality (AR) and mixed reality technologies, which are becoming increasingly prevalent across various fields, including education and public spaces. As these technologies are rapidly developing and gaining widespread use, ethical concerns arise regarding public rights, privacy, and the unintended consequences of immersive digital experiences in the public sphere. Organizations like IEEE and events such as symposiums (e.g., ISMAR) are addressing these challenges, but the broader societal implications of AR and mixed reality technologies, such as their influence on human behaviours, privacy, and the balance between virtual and real-world engagement, demand further attention.

- Top values: Safety, Accountability, Security

Human-Robot Interaction and the Ethical Implications of Robotics in Industrial and Social Environments (Topic 19)

This issue explores the increasing integration of robots and humanoids in both industrial and everyday settings, raising concerns about human-robot interactions, task automation, and the ethical dimensions of robotic control. As robots become more involved in complex tasks, including collaborative roles with humans, there are challenges related to safety, job displacement, and the ethical programming of robotic systems to ensure responsible and safe use. Additionally, mixed-reality environments that incorporate robotic systems require careful debugging and human oversight to prevent malfunctions during operations, further complicating the evolving relationship between humans and machines.

- Top values: Safety, Accountability, Solidarity

Privacy and Security Risks in Online Platforms and Information Sharing (Topic 101)

This issue focuses on how users interact with XR platforms, where personal information is often shared, stored, or accessed through online channels. With growing concerns over security breaches, authentication vulnerabilities, and the misuse of personal data, users are increasingly aware of the risks involved in sharing sensitive data on platforms that rely on XR technologies. The ethical responsibility of maintaining secure environments, ensuring data coding, and protecting access to shared information remains critical as internet and o2o (online-to-offline) applications evolve, particularly in the use of intelligent virtual assistants (IVAs) and other XR-driven services.

- Top values: Safety, Security

Cluster 14: Trust and Human-Agent Interaction in Virtual Environments (Decision support systems)

Trust and Human-Agent Interaction in Virtual Environments (Topic 15)

This issue focuses on the ethical and social implications of using embodied agents and multi-agent systems in virtual environments, where human interactions with agents (digital or AI-driven) play a key role in decision-making and behaviours modelling. As these agents become integral to evacuation simulations, social interactions, and spatial reasoning tasks, ensuring trust between humans and agents is critical. The challenge lies in balancing the accuracy of agent behaviours, the reliability of modelling, and the human ability to trust and effectively collaborate with these systems in various scenarios, from crisis management to everyday social interactions.

- Top values: Safety, Accountability, Social Balance

Cluster 15: The Psychological and Social Impact of Avatars, Body Perception, and Relationships in Virtual Worlds

The Influence of Avatars on Identity, Social Behaviour, and Representation in Virtual Environments (Topic 16)

This issue explores how avatars—digital representations of users—impact social behaviours, self-presence, and perceptions of ethnic and gender identity in virtual spaces. The appearance and embodiment of these avatars shape how participants interact, influencing behaviours such as avoidance or engagement, especially among vulnerable groups like the elderly. The way avatars are designed and presented can reinforce or challenge stereotypes, affecting users' sense of presence and connection in digital environments. This raises questions about the ethical responsibility of virtual platforms in promoting inclusivity and addressing the social consequences of avatar representation.

- Top values: Accountability, Social Balance, Solidarity, Fairness, Safety, Human dignity

Body Ownership, Perception, and Idealization in Virtual Environments (Topic 45)

This issue examines how XR experiences influence users' perceptions of their bodies, including issues of body ownership, embodiment, and illusion. The use of avatars in virtual spaces can shape how individuals, particularly men and those with varying BMI levels, perceive their body size and appearance. These experiences may reinforce or challenge societal standards of beauty, affecting how participants—including those who identify as gay or overweight—relate to their virtual and real bodies. Concerns around cosmetic idealization, weight stigma, and the implicit biases embedded in virtual representations call attention to the psychological and social consequences of embodied illusions in XR environments.

- Top values: Safety, Accountability, Social Balance, Human dignity, Well-Being

Social Relationships, Grief, and Ethical Concerns in Virtual Worlds (Topic 85)

This issue revolves around how users engage with immersive virtual worlds like Second Life (SL) and other 3D platforms, where interactions such as courtship, peer support, and storytelling take place. These environments offer unique opportunities for communication and relationship building, especially for groups such as nurses in oncology, people with aphasia, or those dealing with grief. However, these virtual spaces also raise concerns about inappropriate behaviours, such as paedophilia and sexual misconduct, highlighting the need for ethical guidelines to ensure the safety and well-being of participants in these expansive digital communities.

- Top values: Safety, Solidarity, Social Balance, Accountability, Inclusiveness

Cluster 16: Remote Collaboration and Expert Assistance in Healthcare and Mechatronics

Remote Collaboration and Expert Assistance in Healthcare and Mechatronics (Topic 71)

This issue addresses the challenges and opportunities presented by XR technologies for remote collaboration between experts, such as dermatologists, instructors, and specialists using tools like arthroscopes and mechatronic devices. The ability to project signals and use EEG and other sensory data allows experts to guide procedures and offer assistance to local teams, improving patient outcomes in areas like arthroscopy or wheelchair adaptation. However, the reliance on remote communication and signal accuracy raises concerns about ensuring seamless and effective collaboration, especially in high-stakes medical procedures or technical projects where real-time precision and interaction are critical.

- Top values: Safety, Accountability, Solidarity

Cluster 17: The Use of Extended Reality Technology for Autonomous Vehicles and Driving Simulations on Road Safety and Behaviour

The Impact of Autonomous Vehicles and Driving Simulations on Road Safety and Behaviour (Topic 10)

This issue explores how XR technologies are used to simulate driving behaviours, test autonomous vehicles, and improve traffic safety for both drivers and pedestrians. While these simulations provide valuable insights for vehicle design and road safety improvements, they also highlight challenges around driver behaviours, the interaction between pedestrians and autonomous cars, and the mental demands placed on drivers during testing and real-world applications. Ensuring that these technologies enhance safety while minimizing accidents and providing realistic behaviours modelling is critical to their ethical and social integration into transportation systems.

- Top values: Safety, Accountability

Cluster 18: User Safety and motion sickness in Virtual Environments

The Ethical Implications of Immersion and Empathy in Virtual Reality Experiences (Topic 0)

This issue explores how virtual reality (VR) and immersive technologies are used to create powerful, emotional experiences that enhance empathy among participants. While these immersive environments offer valuable opportunities for research, education, and social impact, they also raise significant ethical concerns. These include the potential manipulation of participants' emotions, the psychological effects of prolonged exposure, and the blurring of boundaries between virtual and real-life experiences. The need for ethical guidelines in designing and implementing VR experiences is crucial to avoid harmful effects while ensuring that empathy-building and other goals are achieved responsibly.

- Top values: Safety, Accountability, Social Balance, Solidarity, Fairness

The Ethical Challenges of Immersive Journalism and News Storytelling (Topic 93)

This issue examines how immersive technologies, such as 360-degree video and virtual reality, are transforming journalism and news storytelling. While these innovations allow journalists to create more engaging and impactful stories for audiences, they also introduce significant ethical concerns. These include the potential manipulation of audiences' emotions, maintaining journalistic integrity in immersive environments, and ensuring transparency in reporting. Media organizations such as the Guardian are developing new guidelines to navigate these challenges, but the balance

between compelling storytelling and ethical responsibility remains a critical issue for the future of journalistic practices in the media landscape.

- Top values: Safety, Accountability

The Challenge of Motion Sickness and Sensory Feedback in Virtual Environments (Topic 84)

This issue explores how motion sickness and discomfort are significant barriers to user engagement in XR experiences, particularly in environments relying on motion capture (mocap) and visual or auditory feedback systems. Users experience disorientation due to mismatches between visual and task-related sensory inputs, which can result in motion sickness, loss of balance, or nausea. As XR technologies continue to evolve, addressing discomforts through better feedback mechanisms, improved positioning, and innovations such as autoencoders and decoders in sensory data processing will be crucial to ensuring a more seamless and comfortable user experience.

- Top values: Safety, Accountability

The Intersection of Virtual and Physical Spaces in Architectural Design and Public Engagement (Topic 18)

This issue focuses on how XR technologies are transforming architectural design by allowing designers to create and visualize spaces that blend the virtual and physical worlds. These tools offer new opportunities for exploring underground environments, crafting public and personal spaces, and experimenting with innovative design elements such as batik patterns in a virtual context. However, this evolution also raises questions about accessibility, the democratization of design through eDesign tools, and how these virtual spaces interact with the physical world, influencing how people experience and engage with architecture in the 21st century.

- Top values: Accountability, Social Balance, Solidarity, Safety

Participatory Design and User Interaction in XR: Evaluating Inclusivity and Research Practices (Topic 79)

This issue examines the growing importance of participatory design in the development of XR technologies, where user interaction plays a critical role in shaping virtual environments and experiences. Conferences and proceedings often feature research papers that explore various topics, such as Kansai (emotional design), button layouts, and user elicitation processes, to enhance user engagement. However, challenges remain in ensuring that design and evaluation processes are inclusive, taking into account diverse user needs and addressing biases. The focus on special research practices and user-centered approaches reflects the ongoing effort to make XR technologies more accessible and responsive to a broad spectrum of users.

- Top values: Safety, Accountability, Solidarity, Well-Being, Social Balance

Harassment and User Safety in Immersive Virtual Spaces (Topic 73)

This issue addresses the increasing incidents of harassment and harmful behaviours within VR platforms, where users experience inappropriate interactions that can cause psychological harm, including PTSD. As immersive environments grow in popularity, the lack of clear social norms, consent mechanisms, and user protections in online virtual spaces poses significant challenges. Embodied experiences in VR make incidents of harassment feel more real, leading to deeper emotional impacts on users. Research is needed to better understand these dynamics and develop solutions to ensure that virtual platforms are safe and inclusive, minimizing harm while fostering healthy social interactions.

- Top values: Safety, Social Balance, Security, Privacy, Well-Being, Solidarity

APPENDIX D – RESULT OF SEL WORKSHOP

Chapter 1: Individual identification of social, ethical and legal issues

No value		
MAG	Stakeholder	all end users that are involved
MAG	Stakeholder	management & decision makers
HEDNO	Stakeholder	End user technician in the field. who will be certified to use the equipment
HEDNO	Stakeholder	Maintainance of equipment used
HEDNO	Stakeholder	Health & Safety Department
HEDNO	Stakeholder	IT department handling remote control/assistance
Access to Justice		
TEC	Stakeholder	Responsibility identification to "cover" wrong or harmful decisions
D3	Stakeholder	justice responsibilities due to user movement-eye tracking while wearing the XR device.
SOP	Stakeholder	responsibility of issues due to use of AI in training and in operations
Accessibility		
CETMA	Stakeholder	Final customer - Socially involved into good practice of mantainance
D3		End-users. accessibility for students at training location
AV		Training facilities without access to the aircraft data
HEDNO	Stakeholder	IT department handling remote control/assistance
UPM	Stakeholder	students at training location
MAG		ease of use of technology from end users
HEDNO	Stakeholder	End user technician in the field. who will be certified to use the equipment
AAA	Stakeholder	Learning how to use the new technologies
Accountability		
HEDNO	Stakeholder	Maintainance of equipment used. The maintainance of the equipment must be done by certified personnel.
TEC	Stakeholder	Trainees don't understand what they need to do and/or how to do it
SOP	Stakeholder	trainers - how to be self confidence to ensure that XR algorithms are not biais
Autonomy		
HEDNO	Stakeholder	End user technician in the field. who will be certified to use the equipment
D3		Backend. handling remote assistance (new system to learn and interact with, new way to give instructions - not directly in the field)
CS	Stakeholder	Experienced personnel feels permanenly supervised lack
AV		Content creator MXR too hard to use so they need to hire a specialized company to create content

Privacy

CETMA	Stakeholder	Legal office - secretation and possible patent pending on 3D files
2F		Private Data in servers
TEC	Stakeholder	the tools are too difficult for the end-users
MAG		data/manuals/reports that are shared
TEC	Stakeholder	legal/privacy problems sharing data between partners
D3		IT department. data protection on the internet connection
CETMA	Stakeholder	R&D department - sharing 3D models and privata files
CS	Stakeholder	Trainer recording of his guidance and advice
CETMA	Stakeholder	Students and Trainers - handling personal data on executed excercise
CS	Stakeholder	Trainer recording of his guidance and advice
SOP	Stakeholder	aero trainers (data privacy)
AAA	Stakeholder	Sharing private information
D3		sharing information of the company like manuals, 3d models
SOP	Stakeholder	aero dept r&d (data privacy)
CETMA	Stakeholder	IT department - Internet connecontion and data protection

Safety and Security

D3		Tech Support. handling technical issues (e.g Data breaches, connection latency)
UPM	Stakeholder	technicians in the field
BIR	Stakeholder	learning to use the new technologies
SOP	Stakeholder	internal airworthiness authority (data & process)
AV		Training facilities. Be certified for VR training (legal)
HEDNO	Stakeholder	End user technician in the field. who will be certified to use the equipment
UPM	Stakeholder	affected individuals for data treatment
F6S	Stakeholder	companies that would like to use the system

Social Balance

AV		Content creators. Less useful if anyone can create experience (soc / ethic)
2F		Society dont understand this tech
MAG		technicians on the field cannot use the tech
AAA	Stakeholder	Fabricators' cultural differences
D3		end users (trainers) have the knowledg to interact with this new technology
F6S	Stakeholder	general public
TEC	Stakeholder	End-users not seeing the benefits of MOTIVATEXR
AAA	Stakeholder	Fabricators' trust in new technlogies
CETMA	Stakeholder	Mantainance services and subcontracting - They me be want to don't share their knowledge

Sustainability

TEC	Stakeholder	No interest outside the consortium

SOP	Stakeholder	aero company -effective cost and sustainable tax cost (RSE) when using XR
CETMA	Stakeholder	Marketing - Presentaning the advantages of reparing product instead of buying a new one
HEDNO	Stakeholder	Maintainance of equipment used. The maintainance of the equipment must be done by certified personnel.

Well being

AV		Trainees. VR training instead of "on-plane" one
TEC	Stakeholder	End-users are not physically comfortable using XR based tools
CS	Stakeholder	trainee. permanent record of working hours, mistakes
CS	Stakeholder	Management deciding on employee future based on registered data
SOP	Stakeholder	operators - capability to adopt new technologies and confidence in AI
D3		end users aren't familiar with th e new technology or they don;t want to try
HEDNO	Stakeholder	Health & Safety Department. Physical safety of the personnel performing the repair activities because of the use of dangerous chemicals.
AAA	Stakeholder	Proper facilities for the training
D3		End-users. Safety-issues at the field

Chapter 3: Identifying Social and Ethical issues in groups

Room	Sticky note content		
Access to Justice			
Room 1			Bad behaviour of the platform could cause problems also to big infrastructures (electric grid) widely impacting to society
Room 2	HEDNO	Stakeholder	End user technician in the field. What happens In case of an accident due to the use of XR tech? What is acceptable proof in court?
Room 2	D3		Tracking of end-users through XR devices
Accessibility			
Room 1			Mantainance of the technology could be espansive and introduce problems of Accessibility (broken devices)
Room 1			Only big company have the possibility to access to these kinds of technologies.
Room 1			Access to 3D models or other barries could create some kind of monopoly
Room 2	HEDNO	Stakeholder	End user technician in the field. The work done with XR tech takes longer than before XR use
Room 2	AC	Stakeholder	following a course on using the XR tool
Room 2	HEDNO	Stakeholder	End user technician in the field. Technician not able to use XR technologies
Room 2	D3		ease of use of technology for end-users
Room 2	AAA	Stakeholder	Learning how to use the technologies
Room 2	2F		cost of servers, headsets, capture devices... prices.

Room 3	TEC	Stakeholder	It is not just being easy to use, but also that end-users see the benefits of using it, with respect of norml use
Room 3	MAG		ease of use of technology from end users for technicians

Accountability

Room 1			Internet or connection problems introduce difficulties into the identification of accuntability (comapny, internet provider etc.)
Room 2	SOP	Stakeholder	confidence AI algorithms (biais/safety) - capability to assess and to analyze any calculations
Room 3	TEC	Stakeholder	Instructions are not understood by tranees/end-users, due to language or knowledge barriers
Room 3	MAG		accountability issues, who has the responsibility? in the case of AI tools

Autonomy

Room 1			Strict procedure or complex exercices could led to frustration
Room 2	HEDNO	Stakeholder	End user technician in the field. Technician relies blindly on the measurements/suggestions provided by the XR tech.
Room 2	AAA	Stakeholder	Ability to adjust the trainings based on the participants' needs
Room 2	D3		Continuation of software products relies on 3rd party companies
Room 2	AC	Stakeholder	Creating database of scenarios
Room 3	AV		Content creator. MXR too hard to use so they need to hire a specialized company to create content
Room 3	TEC	Stakeholder	Technology dependance could make end-users to feel uncomfortable and "useless"

Privacy

Room 1			Employ performances could be recorded and bosses could use those data (negatevly) for their advancement into the company
Room 2	AC	Stakeholder	Using confidential data from aircraft manufacturers, trainees don't have to upload them
Room 2	SOP	Stakeholder	secure privacy when using 3D models
Room 2	AAA	Stakeholder	Participants' personal data
Room 2	AAA	Stakeholder	Company's private information
Room 2	2F		Private info (images, docs, 3d) in servers
Room 2	SOP	Stakeholder	ensure security of data privacy for trainees
Room 2	HEDNO	Stakeholder	End user technician in the field.
Room 2			Safe data transfer from the field technician to the company server

Safety and Security

Room 1			Virtual World could introduce some new ways of interactions between user
Room 1			Virtual World allow aslo unsafety usage of tool
Room 2	D3		Safety concerns for technicians at the field (Mind your surroundings!)

Room 2	AAA	Stakeholder	Proper facilities for the students (minding the surroundings)
Room 2	AC	Stakeholder	On medical field, the usage time of XR tech. for example, trainee with epiliptic issue cause our scenario last few hours
Room 2	HEDNO	Stakeholder	Health & Safety Department. XR tech might not be in line with Health&Safety Department regulations.
Room 2	2F		use capture devices/headsets in electric or dangerous enviroments.
Room 2	HEDNO	Stakeholder	Health & Safety Department. Users not aware of surrounding
Room 3	AV		Accidents due to the VR glasses not being see trough
Room 3	TEC	Stakeholder	Connection issues could provoke accidents as end-users don't fully understand remote instructions or even receive them

Social Balance

Room 1			Unconfortable feeling wearing glasses or headset. Also when the training is in public. Anxiety
Room 2	AC	Stakeholder	Trainees with different level of knowledge / digital nativeness
Room 2	D3		language gap between trainers and trainees
Room 2	AAA	Stakeholder	Cultural differences - students around the world
Room 2	HEDNO	Stakeholder	End user technician in the field. Technician not able to use XR technologies due to language barrier
Room 2	D3		end-users have no knowledge to interact with the new technology
Room 3	MAG		balance between different types of stakeholders technicians vs management & decision makers
Room 3	AV		"replacement" of content creators by AI powered tools

Sustainability

Room 1			Carbon foot print of cloud services should be taken into account. Digital services are usually better in terms of mantainace of up to date information
Room 1			Policy maker could introduce some new rules on product selfreparing and usage of this XR tool (os simply sharing 3D models of all products)
Room 2	AAA	Stakeholder	Will to participate and continue with the trainings (based on the quality of the facilities and the trainings and the trust on the technologies)
Room 2	D3		end-users not seeing the impact of XR technology
Room 2	SOP	Stakeholder	effective sustainable cost for aero company to use such XR / AI technologies in their ESG/CSRD reporting
Room 2	AC	Stakeholder	feedback from trainees and trainers of using the XR technology
Room 3	TEC	Stakeholder	It is clear that there are some use cases where privacy is needed (like aerospace) but that is going to hinder the whole potential of MOTIVATEXR. We risk having a bunch of independent tools for independent use cases
Room 3	AV		Every training facilities should be able to access scenario of create them, otherwise won't use the tool
Room 3	TEC	Stakeholder	If end-users don't find easy to use the system then it will not be used after the project

Well being

Room 1			In case of alone interaction user could experience sort of isolation
Room 2	AC	Stakeholder	Proper facility
Room 2	AAA	Stakeholder	Proper facilities (again)
Room 2	HEDNO	Stakeholder	Health & Safety Department. XR tech might not be in line with Health&Safety Department regulations.
Room 2	D3		Well-Being of end-users after too much training-wearing the XR device
Room 2	HEDNO	Stakeholder	Health & Safety Department. Users not aware of surrounding
Room 3	TEC	Stakeholder	Ergonomic and physical issues when using XR based tools can make users don't want to use them
Room 3	AV		VR part should make it bearable to experience training scenarios
Room 3	BIR		Prolonged use of XR technologies must not cause feelings of discomfort or alienation or other mild discomfort

Chapter 4: Identifying Legal issues in groups

Room	Sticky note content		
Access to Justice			
Room 1			Students and professional: Discrimination due to motion sickness
Room 1			XR user - Legals problems related to law in case of injuries determined by not valuabale instructions
Room 1			Trainee gets injured --> social security, proofs in courr
Room 2	HEDNO	Stakeholder	End user technician in the field. What happens In case of an accident due to the use of XR tech? What is acceptable proof in court?
Room 2	D3		Tracking end-users through XR devices. Will they consent to it? Do we need a legal form?
Room 2	AAA	Stakeholder	Every party should be covered in case of an accident
Room 3	TEC	Stakeholder	End-users are going to do things dictated by AI or by people in remote locations that could lead to harmful situations with change the legal status, and organisations don't know how to handle it
Accessibility			
Room 1			Languages and translation could determine problems. Automatic translation could improve accessability but introuce mis-undertanding o legal issue
Room 1			Cost related to techonologie and possibility to bring them at home. "smartworking" gurantee.
Room 1			Documentation couldn't be taken at home on other premises and out of the company and those legal aspect can reduce accessability to to legal issue.
Room 1			Impared people and user with special needs should be able to use the tool. XR tool could improve or reduce their final accessibility.

Room 2	HEDNO	Stakeholder	End user technician in the field. who will be certified to use the equipment
Room 2	AAA	Stakeholder	We should legally ensure that everyone has equal access to the technologies
Room 2	HEDNO	Stakeholder	IT department handling remote control/assistance
Room 3	AV		Training facilities without access to the aircraft data

Accountability

Room 1			Resposability due to remote assitance to trainee or oparator inculde Legal problems reltated to the fact that remotly you dont have a complete vision of what is happanening, especially in case of wrong comand and provoced injury
Room 2	HEDNO	Stakeholder	Maintainance of equipment used.
Room 2			The maintainance of the equipment must be done by certified personnel.
Room 2	HEDNO	Stakeholder	IT department
Room 2			Software updates that make XR tech unstable or unresponsive after initial deployment
Room 2	HEDNO	Stakeholder	End user technician in the field. who will be certified to use the equipment
Room 2	AC	Stakeholder	IT departement is in charge in uprgading the software of the XR tool and technical assistance
Room 2	AC	Stakeholder	the company would have to ask the users or trainees to sign a waiver of liability to inform them of potential risks
Room 3	TEC	Stakeholder	For legal issues with end-users the system must provide some accountability and traceability mechanisms

Autonomy

Room 1			May be final user should obtain a sort of certification for the correct usage of the provided equipment. Legal issue include mantainance of those certifcates
Room 2	D3		If a 3rd party company (that is involved in the project) discontinues their product, who will be responsible to maintain it?
Room 2	AAA	Stakeholder	Is the legal framework fixed or can we change it? Should we?
Room 2	AC	Stakeholder	is it up to the company to write thre legal framework or it has to use the UE legal framework?
Room 3	TEC	Stakeholder	If the trainee/end-user just follow steps or remote orders, who is responsible?

Privacy

Room 1			Sensible documentation cannot physically leave the pilot premises (nor the analysis of that documentation). Security measures should be implemented to not affect the Motivate XR platform with legal problems.
Room 2	HEDNO	Stakeholder	End user technician in the field.
Room 2			Company proprietary documents leak from the XR tech.

Room 2	HEDNO	Stakeholder	End user technician in the field.
Room 2			Safe data transfer from the field technician to the company server
Room 2	AAA	Stakeholder	Legally protecting the company's private information an the participants' private data
Room 2	D3		Open-Source software privacy & legal concerns
Room 2	AC	Stakeholder	the company is responsible in keeping the data confidential when using intern server
Room 3	TEC	Stakeholder	The final system should have security in terms of data, as a whole, not just each tools
Room 3	MAG		ensure data privacy on MIRA for the end user (a lot of different type of data will be held)
Room 3	AV		Sharing a scenario now means sharing the 3D model of an aircraft
Room 3	MAG		XR tracking elements in public spaces

Safety and Security

Room 1			If the final custumer is allowed to do some "risky" reparations. Equipment highligts and manual's risks compriension is very important
Room 2	AC	Stakeholder	Cybersecurity when using XR tools online concerning company's and users's informations
Room 2	D3		New Safety regulations on the manufacturing field because of the use of XR.
Room 3	AV		Trustworthy and explainable AI
Room 3	TEC	Stakeholder	New legal implications of XR based solutions to complain with safety regulations?
Room 3	BIR	Stakeholder	In the use of new technologies is very important guarantee safety for technician operators and also with the other person that interact in the Pilot Line of BI-REX for the the Motivate XR activities
Room 3	AV		Training facilities. Be certified for VR training (legal)
Room 3	MAG		safety in collaborative XR spaces between e.g, trainer-student
Room 3	MAG		XR tracking elements in public spaces

Social Balance

Room 1			Mantainance services and subcontracting - Probably the don't share their knowledge
Room 2	AAA	Stakeholder	National regulatory/EU regulatory/Non EU regulatory
Room 2	D3		Cultural differences that can have legal repercussions
Room 3	AV		Be careful of the use of AI in content creation (in general)

Sustainability

Room 2	HEDNO	Stakeholder	Maintainance of equipment used.
Room 2			The maintainance of the equipment must be done by certified personnel. Will the equipment be maintained during and after the project?
Room 2	D3		Different regulations between countries

Room 2	D3		Long-term support of software-hardware products should be a management policy.
Room 3	TEC	Stakeholder	In order to be sustainable the system will need to be integrated with other systems, raising many legal concerns
Room 3	TEC	Stakeholder	The system will need to comply with different national regulations

Well being

Room 2	HEDNO	Stakeholder	Health & Safety Department. Physical safety of the personnel performing the repair activities because of the use of dangerous chemicals.
Room 2	D3		Prolonged forced use of XR devices can harm the users. Who is responsible?
Room 2	AC	Stakeholder	is it the company that is responsible if an medical issue occur with using the XR tool?
Room 3	TEC	Stakeholder	End-users "forced" to use the system could reaise legal issues if the system harms them somehow
Room 3	AV		Trainees . VR training instead of "on-plane" one

Intellectual properties (added value)

Room 1			**Intellectual Properties - If the tool will use some material and content created by students or trainee the company should be aware of content rights and authoring**

Without value

Room 3	AV		AI Act concerning aviation / training, will depends on the decisions of the EASA
Room 3	BIR	Stakeholder	There may be some safety issues while there are interactions between technical staff experienced in the use of the technologies developed in the project and visiting persons not experienced in the use of the technologies

Chapter 5: Final individual thoughts

Access to Justice

Accessibility

Accountability

UPM	Stakeholder	With critical infrastructure pilots, who's responsible for each action becomes an important matter. Raised issues affect all the society.

Autonomy

Privacy

UPM	Stakeholder	Sensitive industrial documentation and its analysis (and data obtained from it) need special protection. It affects to content creators, trainers and other users from the industrial facility.

2F		The private data will travel aroud different countries in different serves. The serves need to be controlled (situation) and the different countries laws well known to stablish a legal strategy.
BIR	Stakeholder	it is important to ensure that the technologies developed are used in cybersecurity-protected environments and where the exchange of data protects the information produced

Safety and Security

Social Balance

Sustainability

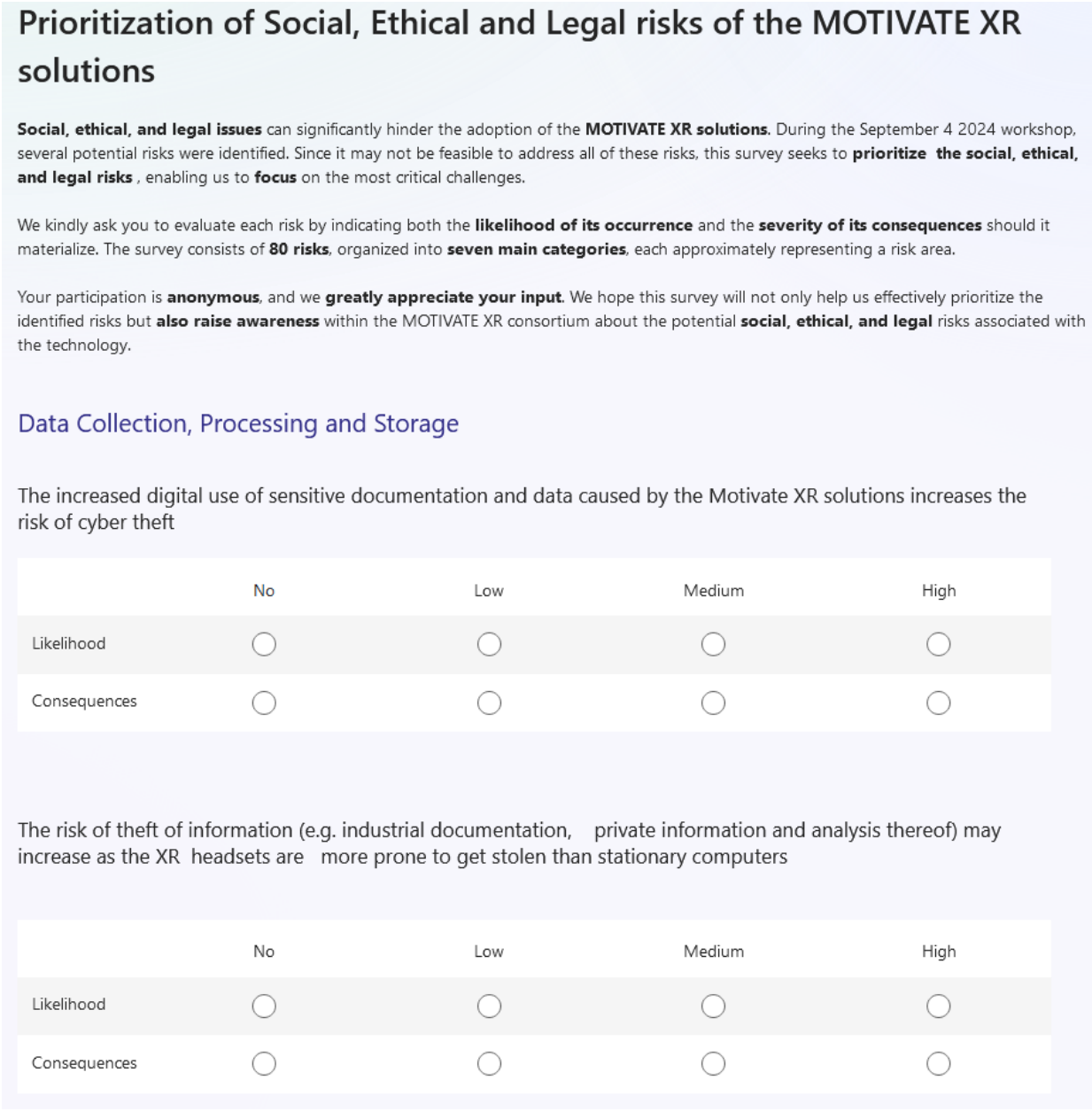
AAA	Stakeholder	AI technology is relatively new, so we have to take into consideration how it affects the society, the legal framework etc. and make adjustments to our work accordingly.
AAA	Stakeholder	Noticed how the same issues came up each time and how the consortium shares similar concerns. So it is useful to discuss them.
D3		License issues when using 3rd party software
BIR	Stakeholder	It is very important that the new technologies developed must respect the concept of circular economy and European Taxnomy for sustainable activities
AAA	Stakeholder	We have to think about the above to ensure the sustainability of the project.
CS	Stakeholder	How sustainable is our work in a society where we lack legislation on some aspects.

Well being

TEC	Stakeholder	Ethical concers like being controlled or losing autonomy, or even the fear of being useless will affect end-users well-being
CS	Stakeholder	Limited social interaction at work

APPENDIX E – PRIORITIZATION SURVEY

First a screenshot of the beginning of survey distributed via Microsoft Forms:



Prioritization of Social, Ethical and Legal risks of the MOTIVATE XR solutions

Social, ethical, and legal issues can significantly hinder the adoption of the **MOTIVATE XR solutions**. During the September 4 2024 workshop, several potential risks were identified. Since it may not be feasible to address all of these risks, this survey seeks to **prioritize the social, ethical, and legal risks** , enabling us to **focus** on the most critical challenges.

We kindly ask you to evaluate each risk by indicating both the **likelihood of its occurrence** and the **severity of its consequences** should it materialize. The survey consists of **80 risks**, organized into **seven main categories**, each approximately representing a risk area.

Your participation is **anonymous**, and we **greatly appreciate your input**. We hope this survey will not only help us effectively prioritize the identified risks but **also raise awareness** within the MOTIVATE XR consortium about the potential **social, ethical, and legal** risks associated with the technology.

Data Collection, Processing and Storage

The increased digital use of sensitive documentation and data caused by the Motivate XR solutions increases the risk of cyber theft

	No	Low	Medium	High
Likelihood	○	○	○	○
Consequences	○	○	○	○

The risk of theft of information (e.g. industrial documentation, private information and analysis thereof) may increase as the XR headsets are more prone to get stolen than stationary computers

	No	Low	Medium	High
Likelihood	○	○	○	○
Consequences	○	○	○	○

In the following, the introduction and questions asked are shown as plain text (for each risk, the likelihood and consequences were asked as shown in screenshot above):

Prioritization of Social, Ethical and Legal risks of the Motivate XR solutions

Social, ethical, and legal issues can significantly hinder the adoption of the **Motivate XR solutions**. During the September 4th 2024 workshop, several potential risks were identified. Since it may not be feasible to address all of these risks, this survey seeks to **prioritize the social, ethical, and legal risks**, enabling us to **focus** on the most critical challenges.

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Data Collection, Processing and Storage
The increased digital use of sensitive documentation and data caused by the Motivate XR solutions increases the risk of cyber theft
The risk of theft of information (e.g. industrial documentation, private information and analysis thereof) may increase as the XR headsets are more prone to get stolen than stationary computers
Data may get stolen because the used internet connections are not properly secure
End users' and user organisations' privacy may get compromised because the end users do not know how to use the privacy functionalities within the tools
The security of the full set of Motivate XR solutions gets compromised because it is only considered for each tool, not the full solution/system
Data privacy may be compromised by the use of Open-Source software
Data privacy cannot be guaranteed when data travel around different countries in different serves
User organizations may not be able to gain access to 3D files that are IP protected, limiting which organizations can get the advantages of using the XR
The ability of the Motivate XR solutions to capture data causes users to capture more data than they need and thereby increase the risk of breaching privacy and IP
Users may intentionally use the Motivate XR solutions to gather data for purposes different than what they tell data providers and people in their immediate surroundings
Since the information is available on an XR device, some users may forget that sensitive documentation should not be taken out of company premises, thereby compromising data security
Employee/student rights and safety
Employees may lose their jobs due to the new requirements that XR brings (e.g. language, digital literacy, physical effects)
The requirements of education changes and exclude a new group of students due to the requirements use of XR brings (e.g. language, digital literacy, physical effects)
Technicians and trainees/students are forced to use the XR if they want to keep their job/get their diplomas, even if there is known risks of harm

The XR can cause motion sickness
The XR trigger medical conditions like epileptic episodes
Technology dependence can make end-users to feel uncomfortable and "useless"
The users' safety gets compromised due to the use of XR compared to normal task execution (e.g. physical restricted by XR, entering electric environments with XR capture device or headset)
Use of XR may cause harmful situations due to the users decreased awareness of the surroundings
Wearing the glasses or headset may cause physical discomfort
Wearing the glasses or headset may make the user feel singled out or socially uncomfortable if the training/task the perform happens in public
Wearing the glasses or headset may cause the user to feel anxiety
XR will decrease the social interaction at work leading to sense of isolation
Prolonged use of XR devices can harm the users
Employee/student rights and safety (part 2)
The safety of workers cannot be guaranteed by current procedures as XR tech is not covered by Health & Safety Department regulations
The MOTIVATE solutions are used incorrectly by unexperienced users (independently or under supervision) and causes harmful situations
The safety of people in the same physical environment as the user of XR gets worse compared to normal task execution
Connection issues could provoke accidents as end-users don't fully understand remote instructions or even receive them
Users may perform tasks that carry higher risks than they would otherwise dare to perform because the XR changes their perspective of risk
Users may perform tasks that carry higher risks than what is advisable because they do not understand that certain instructions are available for users with more experience and the correct equipment
Employees and students will only be able to pursue their careers if they consent to tracking and data collection, they are uncomfortable with
Users may be tracked through the XR devises without being aware of it or consent to it
To ensure safe use of XR, trainees and employees will have to inform their organizations about more health issues than they currently do
XR enables employers to record and misuse information (e.g. tracking, working hours, eye tracking, mistakes) on working hours and mistakes in higher details than traditional environments
Recordings and exercise conduction data of trainers or students/trainees may get misused or shared inappropriately
Manipulating and controlling employees and students become easier with XR
Students and trainees may not get the necessary confidence to do the tasks independently
Standardized training may not fit to the need of all participants'' needs (some may e.g. need longer time than others)
Organizations may not be aware on the IP rights connected to content created using the Motivate XR solutions in teaching situations
Work Content and Technical Reliability

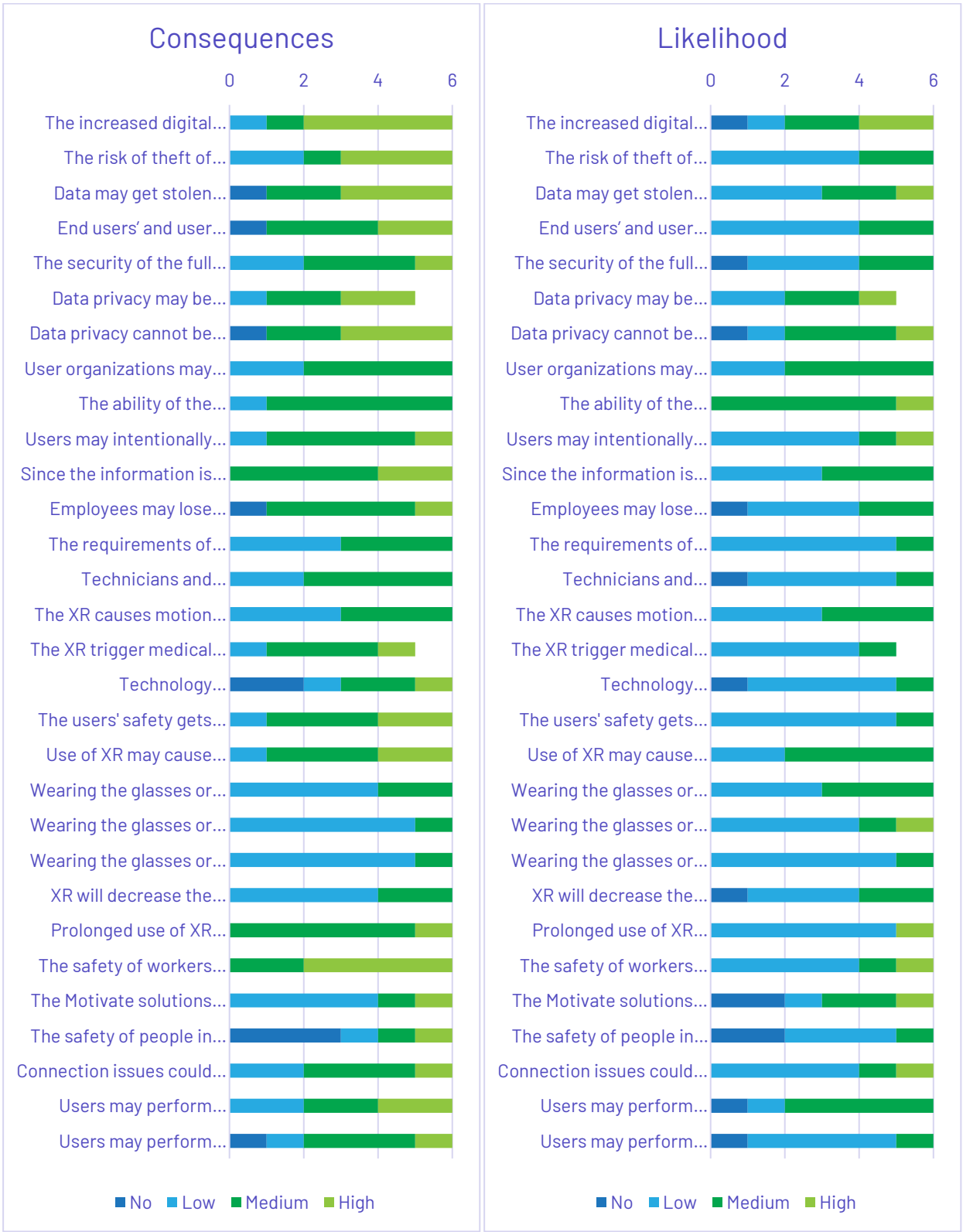
The users may rely on the XR instructions generated by AI so much they don't consider if the content is correct
In case certificates of ability to use the equipment are made, they can provide false confidence in skills if the certified technician has not maintained their skills
The remote technician or instructors are not proficient in giving instructions in a way that positively uses the XR
Bad behaviour of the platform could cause problems also to big infrastructures (electric grid) widely impacting to society
Automatic translation could introduce mis-understandings and inaccuracies
Software updates outside the control of the XR tool providers may make XR tech unstable or unresponsive after initial deployment
The use of AI to create content makes it harder to ensure the content presented in the XR is indeed correct
Legal compliance
Current regulation may not be able to adequately rule in situations where XR and AI content generation are used
Uncertainty of legal, insurance and social security status if remote instructions delivered via XR caused or did not prevent an injury for a professional or student/trainee
Unclear how maintenance of the XR equipment will affect responsibilities
The use of XR and AI generated content may make it harder to trace actions and accountabilities
The accountability in case of harmful situations, faulty results or inability to perform contracted job may depend on the status of the internet connection
Responsibility and legal status may change by using Open-Source software
Current legislation is insufficient to identify responsibilities for incorrect use of the XR or use over prolonged periods of time
The Motivate XR solutions may not adhere to cultural norms and legislation in all countries
3D files will be increasingly requested, making it harder to protect designs with secretation and patents
Integration between the Motivate XR solutions and other systems may violate IP and legal requirements
XR experiences may be shared without the creators' consent or compensation
XR experiences may be shared without consent from or compensation to the owners of the underlaying data
Organizational competences
Organizations do not have the knowledge to assess the legal implications of having XR users do things dictated by AI or by people in remote locations (especially regarding harmful situations)
Many Health & Safety Departments do not have sufficient knowledge to protect their workers when introducing XR
The cost of the necessary equipment (inc. servers, headsets, capture devices etc) could make the tools and the XR not widely accessible to all organizations
Some organizations will not have access to sufficient documentation and therefore be disadvantaged
Only big organizations have capacity to access to these kinds of technologies

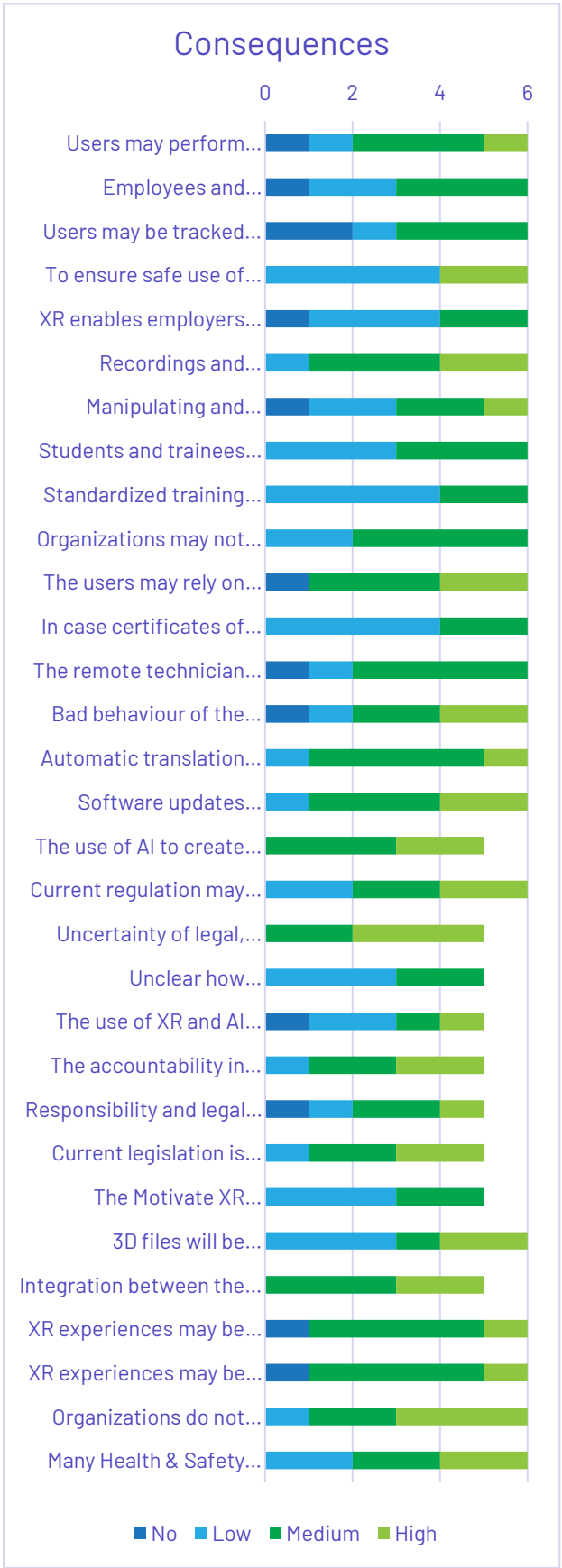
User organizations are unable to create the content they need themselves because the Motivate XR solutions are so complex that only specialized companies can use them
The balance between different types of stakeholders (e.g. technicians vs management & decision makers) may change in a negative way
The use of XR makes the training feel less trustworthy and discourage students from persuading their education
An organization is unable to continue certain operations if the XR devices break
Learning how to use the XR and the tools to develop content may take so long very few people/organizations will be able to get to use it
Improper or missing maintenance of equipment and update of the software may create harmful situation
Societal structures and environmental impact
Unemployment of content creators because of the AI powered tools
Technology may support monopolies as barrier to entry increases
Education using XR amplify social inequality, as socio-economically challenged groups has lower level of knowledge and digital literacy
The Motivate XR solutions may normalize the decrease in human expertise due to overreliance on digital guidance
The Motivate XR solutions may be designed in such a way that they do not fulfil the technologies' potential to improve the opportunities of impaired people and users with special needs
Elements in public spaces (including people) can be tracked
The public is harmed as a consequence of theft or misuse of information from the Motivate XR solutions (e.g. attacks on electricity system, sabotage of aircrafts)
The Motivate XR solutions increases the power consumption and need for rare earth materials for performing tasks that earlier had small environmental impacts
Lacking long-term support and longevity of XR software and hardware products will create more waste
Cloud serving can have high carbon footprint
The environmental impact from using the XR may be sufficient to impact sustainable tax cost (RSE) and ESG/CSRD reporting

Thank you for your contribution!

If you find that any social, ethical and legal risks are missing, please write them below:

APPENDIX F – PRIORITIZATION SURVEY RESULTS




Consequences
0
2
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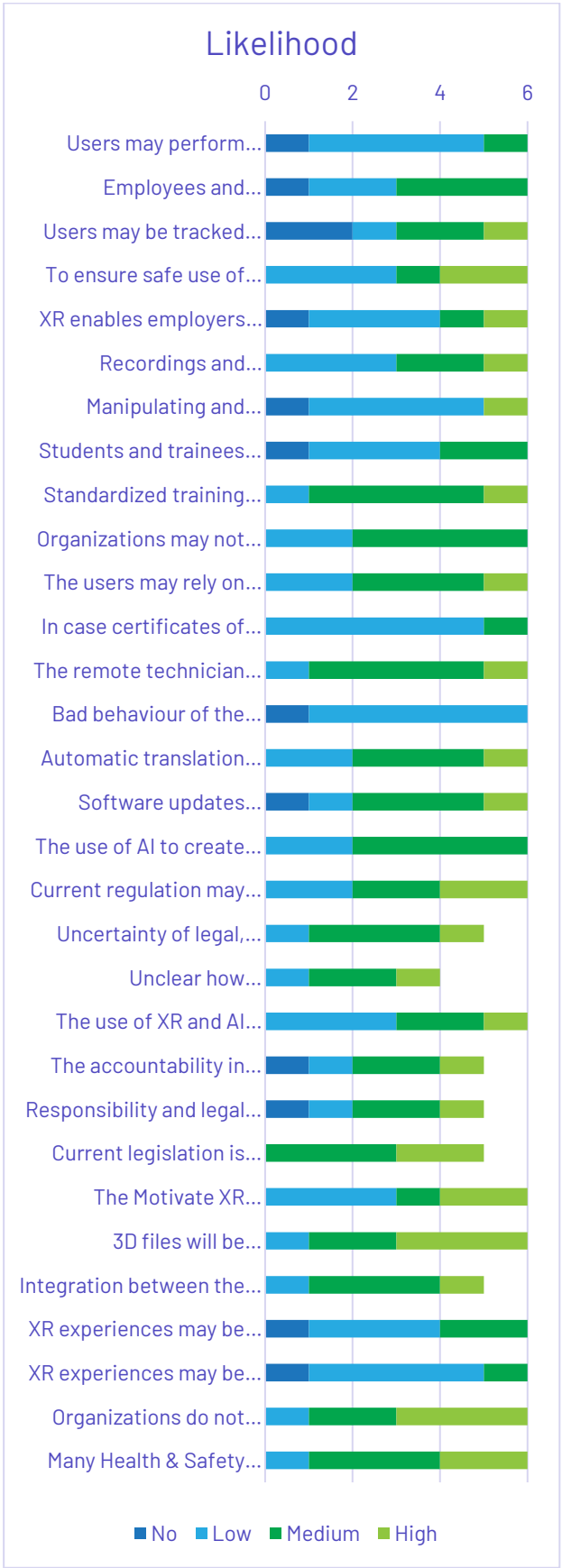
Users may perform...
Employees and...
Users may be tracked...
To ensure safe use of...
XR enables employers...
Recordings and...
Manipulating and...
Students and trainees...
Standardized training...
Organizations may not...
The users may rely on...
In case certificates of...
The remote technician...
Bad behaviour of the...
Automatic translation...
Software updates...
The use of AI to create...
Current regulation may...
Uncertainty of legal,...
Unclear how...
The use of XR and AI...
The accountability in...
Responsibility and legal...
Current legislation is...
The Motivate XR...
3D files will be...
Integration between the...
XR experiences may be...
XR experiences may be...
Organizations do not...
Many Health & Safety...
No
Low
Medium
High


Likelihood
0
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Users may perform...
Employees and...
Users may be tracked...
To ensure safe use of...
XR enables employers...
Recordings and...
Manipulating and...
Students and trainees...
Standardized training...
Organizations may not...
The users may rely on...
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Software updates...
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Current regulation may...
Uncertainty of legal,...
Unclear how...
The use of XR and AI...
The accountability in...
Responsibility and legal...
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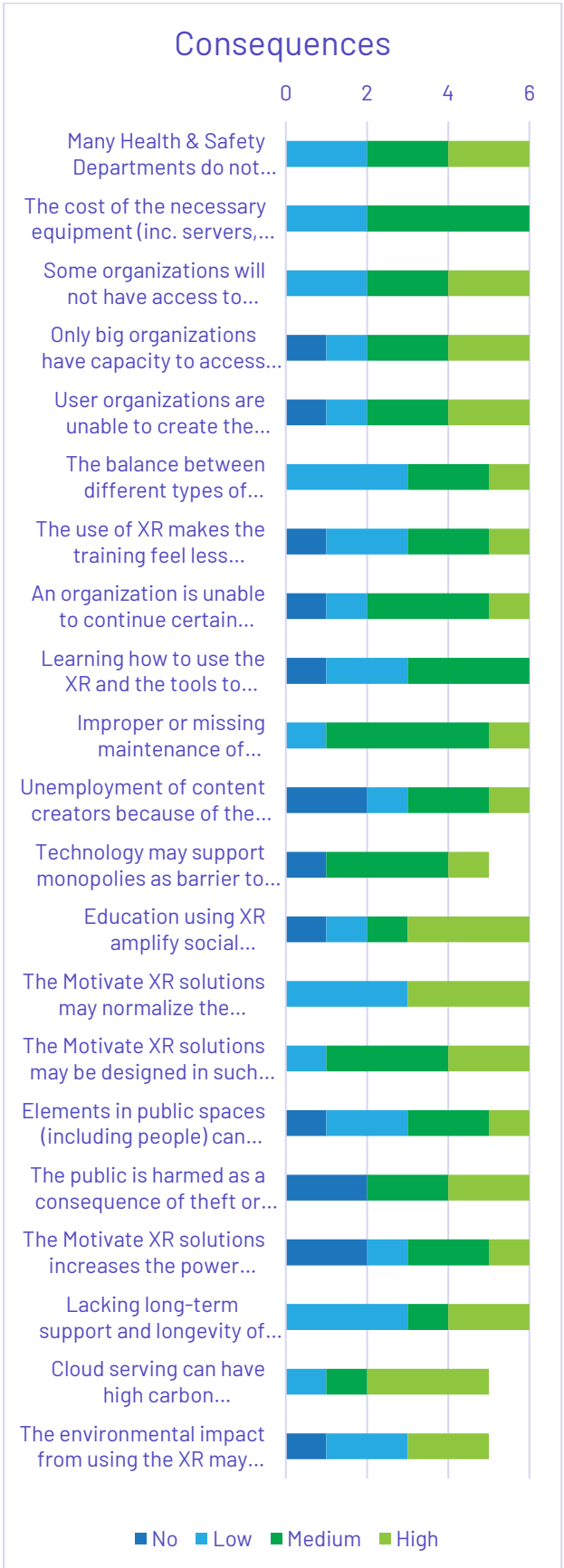
3D files will be...
Integration between the...
XR experiences may be...
XR experiences may be...
Organizations do not...
Many Health & Safety...
No
Low
Medium
High


Consequences
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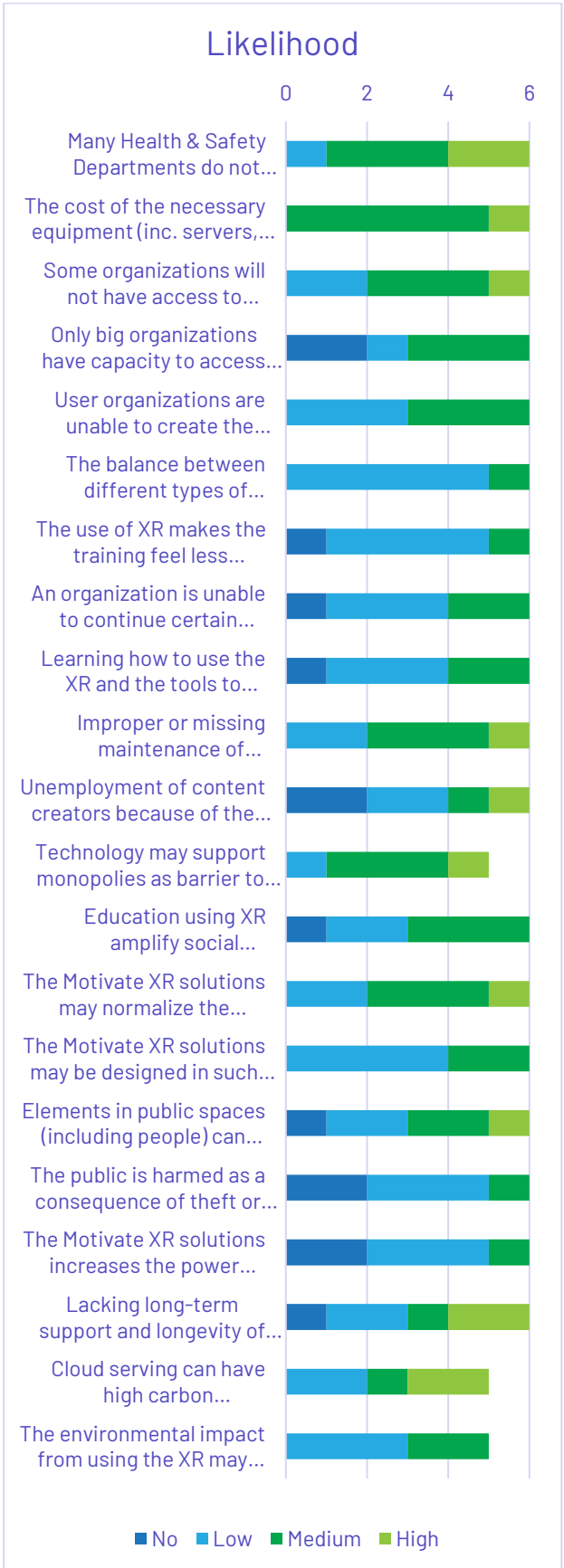
Many Health & Safety Departments do not...
The cost of the necessary equipment (inc. servers,...
Some organizations will not have access to...
Only big organizations have capacity to access...
User organizations are unable to create the...
The balance between different types of...
The use of XR makes the training feel less...
An organization is unable to continue certain...
Learning how to use the XR and the tools to...
Improper or missing maintenance of...
Unemployment of content creators because of the...
Technology may support monopolies as barrier to...
Education using XR amplify social...
The Motivate XR solutions may normalize the...
The Motivate XR solutions may be designed in such...
Elements in public spaces (including people) can...
The public is harmed as a consequence of theft or...
The Motivate XR solutions increases the power...
Lacking long-term support and longevity of...
Cloud serving can have high carbon...
The environmental impact from using the XR may...
No
Low
Medium
High


Likelihood
0
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The public is harmed as a consequence of theft or...
The Motivate XR solutions increases the power...
Lacking long-term support and longevity of...
Cloud serving can have high carbon...
The environmental impact from using the XR may...
No
Low
Medium
High

APPENDIX G – PRIORITIZED MOTIVATE XR SPECIFIC SEL RISKS

Risk category	Risk	Average consequences	Average Likelihood	Total Impact
Organizational Competences	Organizations do not have the knowledge to assess the legal implications of having XR users do things dictated by AI or by people in remote locations (especially regarding harmful situations).	3,3	3,3	6,7
Legal Compliance	Uncertainty of legal, insurance and social security status if remote instructions delivered via XR caused or did not prevent an injury for a professional or student/trainee.	3,6	3,0	6,6
Legal Compliance	Current legislation is insufficient to identify responsibilities for incorrect use of the XR or use over prolonged periods of time.	3,2	3,4	6,6
Legal Compliance	Integration between the Motivate XR solutions and other systems may violate IP and legal requirements.	3,4	3,0	6,4
Societal structures and environmental impact	Cloud serving can have high carbon footprint.	3,4	3,0	6,4
Legal Compliance	3D files will be increasingly requested, making it harder to protect designs with secrecy and patents.	2,8	3,3	6,2
Data collection, Protection and Storage	The increased digital use of sensitive documentation and data caused by the Motivate XR solutions increases the risk of cyber theft.	3,5	2,7	6,2
Employee/Students Rights and Safety	The safety of workers cannot be guaranteed by current procedures as XR tech is not covered by Health & Safety Department regulations.	3,7	2,5	6,2
Organizational Competences	Many Health & Safety Departments do not have sufficient knowledge to protect their workers when introducing XR.	3,0	3,2	6,2
Work Content and Technical Reliability	The use of AI to create content makes it harder to ensure the content presented in the XR is indeed correct.	3,4	2,7	6,1
Data collection, Protection and Storage	Data privacy may be compromised by the use of Open-Source software.	3,2	2,8	6,0
Data collection, Protection and Storage	The ability of the Motivate XR solutions to capture data causes users to capture more data than they need and thereby increase the risk of breaching privacy and IP.	2,8	3,2	6,0
Legal Compliance	Current regulation may not be able to adequately rule in situations where XR and AI content generation are used.	3,0	3,0	6,0
Data collection, Protection and Storage	Since the information is available on an XR device, some users may forget that sensitive documentation should not be taken out of company premises, thereby compromising data security.	3,3	2,5	5,8
Work Content and Technical Reliability	Automatic translation could introduce misunderstandings and inaccuracies.	3,0	2,8	5,8
Organizational Competences	Some organizations will not have access to sufficient documentation and therefore be disadvantaged.	3,0	2,8	5,8
Organizational Competences	Improper or missing maintenance of equipment and update of the software may create harmful situation.	3,0	2,8	5,8

Organizational Competences	The Motivate XR solutions may normalize the decrease in human expertise due to overreliance on digital guidance.	3,0	2,8	5,8
Employee/Students Rights and Safety	Use of XR may cause harmful situations due to the users decreased awareness of the surroundings.	3,2	2,7	5,8
Employee/Students Rights and Safety	Recordings and exercise conduction data of trainers or students/trainees may get misused or shared inappropriately.	3,2	2,7	5,8
Organizational Competences	The cost of the necessary equipment (inc. servers, headsets, capture devices etc) could make the tools and the XR not widely accessible to all organizations.	2,7	3,2	5,8
Work Content and Technical Reliability	The users may rely on the XR instructions generated by AI so much they don't consider if the content is correct.	2,8	2,8	5,7
Data collection, Protection and Storage	Data may get stolen because the used internet connections are not properly secure.	3,0	2,7	5,7
Work Content and Technical Reliability	Software updates outside the control of the XR tool providers may make XR tech unstable or unresponsive after initial deployment.	3,2	2,5	5,7
Legal Compliance	The accountability in case of harmful situations, faulty results or inability to perform contracted job may depend on the status of the internet connection.	3,2	2,4	5,6
Organizational Competences	Technology may support monopolies as barrier to entry increases.	2,6	3,0	5,6
Data collection, Protection and Storage	The risk of theft of information (e.g. industrial documentation, private information and analysis thereof) may increase as the XR headsets are more prone to get stolen than stationary computers	3,2	2,3	5,5
Data collection, Protection and Storage	Data privacy cannot be guaranteed when data travel around different countries in different serves.	3,0	2,5	5,5
Data collection, Protection and Storage	Users may intentionally use the Motivate XR solutions to gather data for purposes different than what they tell data providers and people in their immediate surroundings.	3,0	2,5	5,5
Employee/Students Rights and Safety	Prolonged use of XR devices can harm the users.	3,2	2,3	5,5
Employee/Students Rights and Safety	To ensure safe use of XR, trainees and employees will have to inform their organizations about more health issues than they currently do.	2,7	2,8	5,5
Societal structures and environmental impact	The Motivate XR solutions may be designed in such a way that they do not fulfil the technologies' potential to improve the opportunities of impaired people and users with special needs.	3,2	2,3	5,5
Legal Compliance	Unclear how maintenance of the XR equipment will affect responsibilities.	2,4	3,0	5,4
Employee/Students Rights and Safety	Connection issues could provoke accidents as end-users don't fully understand remote instructions or even receive them.	2,8	2,5	5,3
Employee/Students Rights and Safety	Users may perform tasks that carry higher risks than they would otherwise dare to perform because the XR changes their perspective of risk.	3,0	2,3	5,3
Employee/Students Rights and Safety	Standardized training may not fit to the need of all participants" needs (some may e.g. need longer time than others).	2,3	3,0	5,3

Work Content and Technical Reliability	The remote technician or instructors are not proficient in giving instructions in a way that positively uses the XR.	2,3	3,0	5,3
Societal structures and environmental impact	Lacking long-term support and longevity of XR software and hardware products will create more waste.	2,8	2,5	5,3
Data collection, Protection and Storage	User organizations may not be able to gain access to 3D files that are IP protected, limiting which organizations can get the advantages of using the XR.	2,7	2,7	5,3
Employee/Students Rights and Safety	The users' safety gets compromised due to the use of XR compared to normal task execution (e.g. physical restricted by XR, entering electric environments with XR capture device or headset).	3,2	2,2	5,3
Employee/Students Rights and Safety	Organizations may not be aware on the IP rights connected to content created using the Motivate XR solutions in teaching situations.	2,7	2,7	5,3
Legal Compliance	The Motivate XR solutions may not adhere to cultural norms and legislation in all countries.	2,4	2,8	5,2
Employee/Students Rights and Safety	The XR trigger medical conditions like epileptic episodes.	3,0	2,2	5,2
Data collection, Protection and Storage	End users' and user organisations' privacy may get compromised because the end users do not know how to use the privacy functionalities within the tools.	2,8	2,3	5,2
Organizational Competences	User organizations are unable to create the content they need themselves because the Motivate XR solutions are so complex that only specialized companies can use them.	2,7	2,5	5,2
Employee/Students Rights and Safety	The XR causes motion sickness.	2,5	2,5	5,0
Organizational Competences	Education using XR amplify social inequality, as socio-economically challenged groups has lower level of knowledge and digital literacy.	2,8	2,2	5,0
Legal Compliance	The use of XR and AI generated content may make it harder to trace actions and accountabilities.	2,2	2,7	4,9
Data collection, Protection and Storage	The security of the full set of Motivate XR solutions gets compromised because it is only considered for each tool, not the full solution/system.	2,8	2,0	4,8
Employee/Students Rights and Safety	Wearing the glasses or headset may cause physical discomfort.	2,3	2,5	4,8
Organizational Competences	The balance between different types of stakeholders (e.g. technicians vs management & decision makers) may change in a negative way.	2,7	2,2	4,8
Legal Compliance	Responsibility and legal status may change by using Open-Source software.	2,4	2,4	4,8
Societal structures and environmental impact	The environmental impact from using the XR may be sufficient to impact sustainable tax cost (RSE) and ESG/CSRD reporting.	2,4	2,4	4,8
Societal structures and environmental impact	Elements in public spaces (including people) can be tracked.	2,3	2,3	4,7
Employee/Students Rights and Safety	Employees may lose their jobs due to the new requirements that XR brings (e.g. language, digital literacy, physical effects).	2,7	2,0	4,7
Employee/Students Rights and Safety	The requirements of education changes and exclude a new group of students due to the requirements use	2,5	2,2	4,7

	of XR brings (e.g. language, digital literacy, physical effects).			
Employee/Students Rights and Safety	Wearing the glasses or headset may make the user feel singled out or socially uncomfortable if the training/task the perform happens in public.	2,2	2,5	4,7
Legal Compliance	XR experiences may be shared without the creators' consent or compensation.	2,7	2,0	4,7
Employee/Students Rights and Safety	Technicians and trainees/students are forced to use the XR if they want to keep their job/get their diplomas, even if there is known risks of harm.	2,7	1,8	4,5
Employee/Students Rights and Safety	The MOTIVATE solutions are used incorrectly by unexperienced users (independently or under supervision) and causes harmful situations.	2,5	2,0	4,5
Employee/Students Rights and Safety	Students and trainees may not get the necessary confidence to do the tasks independently.	2,5	2,0	4,5
Work Content and Technical Reliability	In case certificates of ability to use the equipment are made, they can provide false confidence in skills if the certified technician has not maintained their skills.	2,3	2,2	4,5
Legal Compliance	XR experiences may be shared without consent from or compensation to the owners of the underlying data.	2,7	1,8	4,5
Organizational Competences	Only big organizations have capacity to access to these kinds of technologies.	2,7	1,8	4,5
Organizational Competences	An organization is unable to continue certain operations if the XR devices break.	2,5	2,0	4,5
Employee/Students Rights and Safety	XR will decrease the social interaction at work leading to sense of isolation.	2,3	2,0	4,3
Employee/Students Rights and Safety	Manipulating and controlling employees and students become easier with XR.	2,3	2,0	4,3
Employee/Students Rights and Safety	Wearing the glasses or headset may cause the user to feel anxiety .	2,2	2,2	4,3
Employee/Students Rights and Safety	Users may perform tasks that carry higher risks than what is advisable because they do not understand that certain instructions are available for users with more experience and the correct equipment.	2,5	1,8	4,3
Employee/Students Rights and Safety	Employees and students will only be able to pursue their careers if they consent to tracking and data collection, they are uncomfortable with.	2,2	2,2	4,3
Work Content and Technical Reliability	Bad behaviour of the platform could cause problems also to big infrastructures (electric grid) widely impacting to society .	2,7	1,7	4,3
Organizational Competences	The use of XR makes the training feel less trustworthy and discourage students from persuading their education .	2,3	1,8	4,2
Employee/Students Rights and Safety	XR enables employers to record and misuse information (e.g. tracking, working hours, eye tracking, mistakes) on working hours and mistakes in higher details than traditional environments.	2,0	2,2	4,2
Organizational Competences	Learning how to use the XR and the tools to develop content may take so long very few people/organizations will be able to get to use it.	2,2	2,0	4,2
Societal structures and environmental impact	The public is harmed as a consequence of theft or misuse of information from the Motivate XR solutions (e.g. attacks on electricity system, sabotage of aircrafts).	2,3	1,5	3,8
Employee/Students Rights and Safety	Technology dependence can make end-users to feel uncomfortable and "useless".	2,0	1,8	3,8

Employee/Students Rights and Safety	Users may be tracked through the XR devises without being aware of it or consent to it.	1,8	2,0	3,8
Organizational Competences	Unemployment of content creators because of the AI powered tools.	2,0	1,8	3,8
Societal structures and environmental impact	The Motivate XR solutions increases the power consumption and need for rare earth materials for performing tasks that earlier had small environmental impacts.	2,0	1,5	3,5
Employee/Students Rights and Safety	The safety of people in the same physical environment as the user of XR gets worse compared to normal task execution.	1,5	1,5	3,0