Alliance4XR

Innovation alliance to infuse Extended Reality skills into Higher education and Vocational Training

Attached Documents

XR/AR/MR Technologies - Shared Gaps Across Sectors

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Keywords	Shared gaps, training, knowledge gaps, scaling difficulties, integration challenges
Abstract (for dissemination)	*This document highlights the importance of cross-sector learning to leverage best practices and promote innovation. Collaboration between industries can lead to better standardization, cost-sharing, and the development of unified frameworks to foster broader adoption of XR/AR/MR technologies. It also emphasizes the societal benefits of adopting these technologies, including improved safety and sustainability. Sector-specific challenges and solutions are also explored in detail, ranging from the need for scalable solutions and cost-effective deployment strategies to comprehensive training programs and standardized evaluation methods.*

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EXECUTIVE SUMMARY

The five sectors—Higher Education Institutions, Vocational Education and Training, Structural Engineering and Construction, Maritime Professions, and Grids and Energy—share several common gaps in their adoption of XR/AR/MR technologies:

1. Integration Challenges: Across all sectors, there are difficulties in integrating XR/AR/MR technologies with existing systems (e.g., curriculum in education, BIM in construction, marine systems, and grid management tools). Seamless integration into traditional workflows is a common hurdle.
2. High Initial Costs: Each sector faces the issue of high initial costs for purchasing hardware, software, and content development, which presents a barrier to adoption, particularly in large-scale deployments.
3. Lack of Standardisation: There is a notable lack of standardised methods, frameworks, and certification processes across sectors, making it harder to evaluate the effectiveness of immersive technologies and ensure consistency across different environments.
4. Training and Knowledge Gaps: A recurring issue is the lack of sufficient knowledge and training among staff, educators, or workers to effectively use XR/AR/MR technologies. This hinders the adoption and effective use of these tools.
5. Scaling Difficulties: Implementing and scaling immersive technologies from pilot programs to full-scale applications is a challenge in every sector. This includes making the technologies accessible to a broader audience and ensuring they function in various environments or applications.

These shared gaps highlight the need for strategic approaches in integration, cost reduction, standardisation, training, and scalable deployment of XR/AR/MR technologies.

Nonetheless, familiarity with the challenges faced by other sectors in adopting XR/AR/MR technologies offers significant benefits. It fosters cross-sector learning, allowing industries to adapt successful strategies and avoid common pitfalls.

Understanding these challenges promotes collaboration, enabling resource-sharing and joint problem-solving. Sectors can leverage each other's advancements in training, funding models, and technology integration, saving time and reducing costs.

Cross-sector awareness also drives standardization, helping create unified frameworks that improve the broader adoption of XR/AR/MR technologies. By working together, industries can advocate for policy changes or funding support, addressing common regulatory or financial hurdles. Technological interoperability becomes more achievable as sectors share insights, enabling smoother integration of XR with legacy systems.

This collaborative knowledge exchange helps industries build resilience, anticipate future challenges, and adapt to technological shifts. It also shortens the learning curve, allowing sectors to benefit from solutions already developed elsewhere. Ultimately, this interconnected understanding fosters innovation, accelerates progress, and contributes to broader societal goals, such as safety improvements and environmental sustainability, across sectors like construction, energy, and maritime. On the following pages sector specific challenges and requested industry developments are summarised to aid this collaborative endeavour.

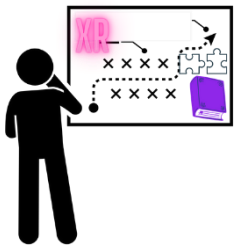
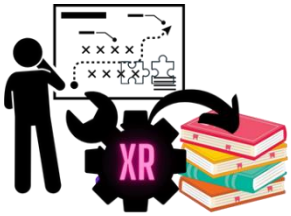
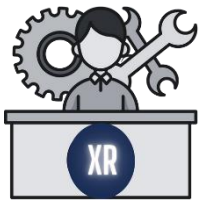
1 SECTOR SPECIFIC GAPS AND REQUESTED INDUSTRY DEVELOPMENTS

1.1 Higher Education Institutions

1.1.1 Gaps

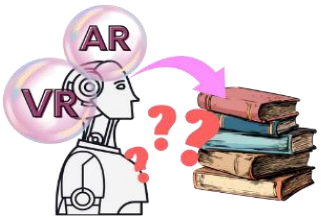
		
The integration of XR technologies into the existing curriculum while aligning with traditional teaching methods and standards could pose a challenge.	Bringing XR tools to thousands of programs and institutions requires a big investment in hardware, software, and faculty training, which can be very resource-intensive.	A critical gap is that faculty and students possess limited knowledge and experience with XR technologies to be able to use them in the process of teaching and learning.
		
The initial costs for hardware, as well as for software and content development are high, which some of the institutions will find hard to fund.	Ensuring XR systems are functioning effectively and continuously requires ongoing technical support and system maintenance throughout its lifespan.	Standardized assessment methods to measure the effectiveness of XR-enhanced learning experiences and their impact on educational outcomes ought to be developed.

1.1.2 Requested industry developments

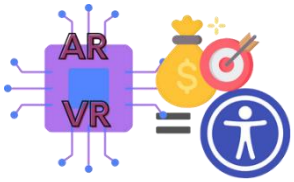
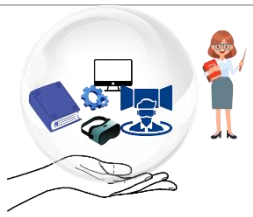
		
Develop strategies for the seamless addition of XR tech to traditional curricula in a manner that is in alignment with academic standards and then builds on traditional teaching methods	Develop a scalable plan for deploying XR tools into multiple programs that lean on efficient resource usage and cost-effective measures.	Provide faculty and students with training programs in XR technologies and learning use cases.
		
Identify low-cost solutions and cost-sharing and funding opportunities to leverage initial investment and long-term maintenance of XR technologies.	Provide a robust technical support structure to help manage and maintain our suite of XR tools.	Create evaluation frameworks for measuring the effect that XR-enhanced learning has on educational outcomes, establishing universal standards for evaluation.

1.2 Vocational Education and Training

1.2.1 Gaps

		
There is a lack of standardized implementation models and certification processes for immersive technology-based training across different vocational disciplines.	Connecting VR/AR technologies to traditional training methods can also be difficult to implement, leading to potential gaps in comprehensive skill development.	Lack of affordability, as well as the often-high entry-point and advanced level of technological proficiency required, further restricts these training tools to only certain disciplines and universities, potentially excluding other institutions or student populations.
		
Minimal research to date has explored how immersive technology training may help or hinder employability and/or career progression.	Educators may lack preparation and support to educate with great exposure to innovation.	

1.2.2 Requested industry developments

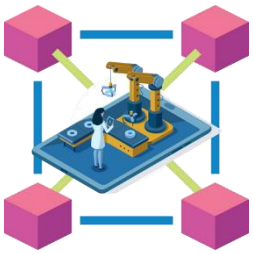
		
Standardized curricula and certification processes that establish uniform recognition and meaning of the skills acquired through VR and AR training programs across employers.	Guiding principles for the beneficial incorporation of immersive technologies alongside traditional teaching methodologies for a continuous learning journey.	Creating affordable solutions and improving ease of access to VR & AR to promote its use in a variety of educational environments.
		
Conduct longitudinal studies to verify the effectiveness of VR and AR training and its impact on students' employability and skill retention highlights the immense potential that remains in this field.	Offering VR/AR resources and professional development programs for teachers to use these tools in the classroom.	

1.3 Structural Engineering and Construction

1.3.1 Gaps

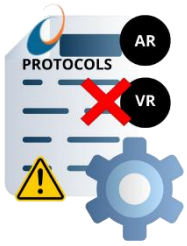
		
Combining these new immersive technologies can be difficult to integrate into their existing BIM, CAD, and GIS systems, ultimately affecting this interconnected and interdependent environment leading to inefficiencies and data silos.	Immersive technologies have shown promise in pilots but scaling these solutions to full-scale, real-world applications can be challenging.	While VR and AR tools can be immensely helpful, engineers and construction workers may not be trained to properly apply these tools in their everyday tasks.
		
The initial costs and ongoing investment in using immersive technologies for structural engineering can be a hurdle to it being widely adopted.	Though VR and AR can enhance safety training, companies will need a fully integrated risk-management strategy to confront the possible safety hazards of using these technologies on-site.	

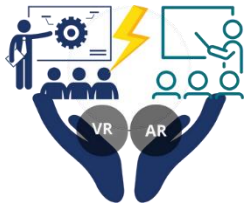
1.3.2 Requested industry developments

		
Improving interoperability standards and solutions to extend the usability of existing engineering tools in a compatible form with the use of VR and AR.	Scalable VR / AR project examples; Successful use case studies with VR/AR in big engineering projects.	Designing training for professionals who want to gain skills in immersive technologies.
		
Creating comprehensive safety measures and management guidelines to introduce immersive technologies in engineering projects	Ensuring the delivery of cost-effective solutions that can be repaid, with identifying possible funding streams to support the uptake and maintenance of VR / AR technologies.	

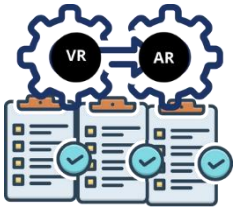
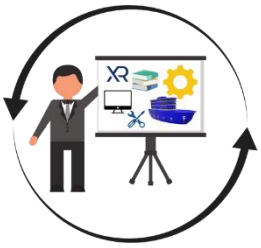
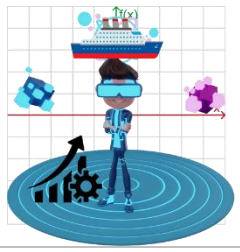
1.4 Maritime Professions

1.4.1 Gaps

	
An area lacking in skills is the integration of VR and AR technologies with marine systems and protocols. For example, the integration of the Wärtsilä BridgeMate AR system with existing navigational data sources, true real-time synchronization is still an issue. Likewise, figuring out how to bring VR-based training to shipyard safety policies can be messy - it must be finely tuned to align with physical reality.	This solution's limitations stem from its numerous applications and diverse maritime environments that VR and AR can touch, making it difficult to scale - as illustrated by the white paper. For instance, global deployment of the K-Sim Maritime Simulation systems adds complexity to the infrastructure and maintenance, to ensure the level of training quality is consistent throughout all training facilities. Furthermore, these technologies also require optimization for different environmental conditions (e.g., offshore or coastal).

	
While the tools for VR and AR can lay the foundations for specialized training programs, more work is needed to address the current training incompatibility that exists at sea. These will be your VR equipment, how to get around the different simulation interfaces, and how to interpret the simulation results. The effectiveness of these immersive tools can be limited without proper user training.	Rollout of VR and AR applications like the Morild Ship & Bridge Simulator or VR inception projects for shipyard safety training means investing in hardware, software, and development upfront. Wider adoption hinges on the ability to justify this outlay through detailed cost-benefit analyses and potential funding streams.
	
They are still a long way off from making sure the virtual simulations have real-world characteristics like maritime needs. In addition, the VR application for safety training at shipyards will have little effect unless the shipyard hazards are accurately simulated. To bridge the gap between virtual training and real maritime operations, even more realistic and high-fidelity simulations.	While many VR applications provide real-time feedback, a limitation is the current lack of standardized methods to evaluate trainee performance between different simulations. For example, if it is needed to measure the efficacy of training in VR automobiles that are designed for both LPG emergency handling or maritime firefighting, standard performance metrics and assessment standards are required.

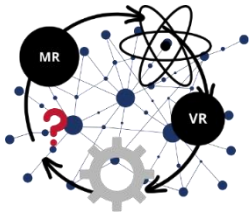
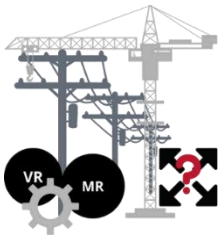
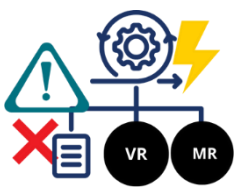
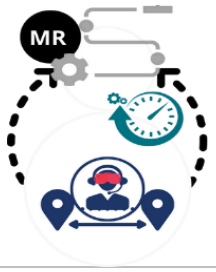
1.4.2 Requested industry developments

		
Creating seamless integrations into VR / AR systems to maritime systems with relevant maritime protocols. This will also involve making connections to navigational data feeds for the Wärtsilä BridgeMate AR system. Moreover, there is a need to integrate VR-based safety training applications with existing safety standards within shipyards.	Design scalable deployment strategies of VR and AR technologies that allow adaptation to various maritime scenarios. This means customizing those technologies for different types of ships, training environments, and geographical locations so that the training outcomes will be as consistent and effective as possible.	Introduce a holistic training program to ensure the workforce has the knowledge to use VR and AR tools correctly. Thus, these programs should instruct how to work with VR equipment, how to navigate simulation interfaces, and how to read and use the results of the training to get the most value out of immersive technologies.
		

Creation of economic realization plans that justify the initial cost for the adoption of VR and AR technologies. This involves in-depth cost-benefit modeling that potentially shows new sources of funding and demonstrates the long-term savings and improvements in operations that these technologies have to offer.	Further improvement of VR/AR simulations to increase their realism and fidelity. This involves the construction of robust physics-based models for maritime firefighting and evacuation training, as well as the accurate reproduction of shipyard hazards in VR safety training applications.	Developing universally applicable performance metrics and evaluation standards to measure how well a trainee performs on a VR or AR simulation. Such proof-of-concept deployment will provide consistent, objective measurements of the effectiveness of these immersive tools in developing maritime skills.

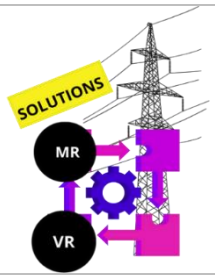
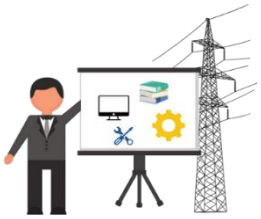
1.5 Grids and Energy

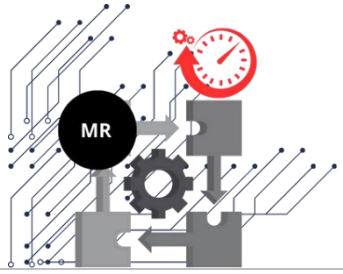
1.5.1 Gaps

		
Integrating VR and MR systems with existing grid management tools, crane operation databases, and nuclear facility protocols is complex. There are challenges in ensuring that VR/MR environments are connected directly to the real-time data and operations of SCADA, GIS, and CAD.	The scale of the VR and MR applications (extending across significant areas or involving a large and varied number of objects, such as a complex power grid or multiple types of cranes), presents difficulties. Deploying these technologies at a global level or across different sub-station setups will need to be significantly improved.	Personnel in the energy sector are not specially trained to work with VR and MR systems. There is a gap in comprehensive training programs tailored to the unique needs of grid and energy operations.
		
The initial costs of deploying proprietary VR and MR systems (i.e., purchasing hardware,	There is a gap in developing multidimensional risk management	The robust remote collaboration relies on live MR workflows, involving the streaming

developing bespoke simulations, and integrating capability with at-scale infrastructure) are extremely high.	frameworks for VR-MR simulations in the energy sector. These simulations are required to realistically encompass hazards plausible to occur in the real-world and resources for mitigation training.	of real-time data to ensure reliable data transmission. Improvements are required to accommodate complex multi-user interactions and long-distance remote monitoring and supervision.

1.5.2 Requested industry developments

		
Development of solutions that enable effective integration of VR and MR systems with existing grid management tools and protocols. This includes ensuring compatibility and real-time data synchronization with systems such as SCADA, GIS, and CAD to avoid data silos.	Creation of scalable VR and MR solutions that can handle large-scale and complex environments, including extensive power grids and diverse crane fleets. Optimization for varied conditions, especially for outdoor applications, is necessary to broaden the use of MR technologies.	Implementation of training programs tailored to the energy sector, focusing on the operation of VR/MR tools and interpretation of their outputs. These programs should aim to equip personnel with the necessary skills to use these technologies effectively.

		
Strategies to ensure these technologies are accessible to all workforce levels, including those in remote or less technologically advanced areas.	Development of cost-effective strategies and potential funding sources to support the initial investment and ongoing maintenance of VR and MR technologies. Detailed cost-benefit analyses can help justify these investments by demonstrating long-term savings and operational improvements.	Formulation of comprehensive risk management strategies and safety protocols for using VR and MR technologies in training environments. These frameworks should address the simulation of real-world hazards and provide effective risk mitigation training specific to the energy sector.
		
Enhancement of MR capabilities to support complex real-time interactions, including multi-user environments and remote supervision of simultaneous tasks. Improvements in network reliability and bandwidth, particularly in remote or industrial areas, are needed to support these functionalities effectively.		