

Summary of Findings from customer/stakeholder interviews

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I. Introduction

The stakeholder interviews were conducted during April and May 2023 to capture the perspectives of industry and government professionals from the Architectural, Engineering, Construction industry on the application of Virtual Reality for workforce development. We have identified five subject matter experts and interviewed them to gauge their interests on the deployment of the technology for workforce development and understand their viewpoints. The interviewees were contacted and recruited from the network of the PIs and are executives and technology officers at major companies that present demonstrated interest in adopting new technologies for enhancing worker safety as well as public sector transportation professionals who provide guidelines for safety to be followed. The interview questions were composed of three parts: 1) General views on VR/AR application for workforce development and safety training, 2) value experts see in using VR/AR platforms increasing safety awareness of their construction workers, and 3) a set of use-cases where the VR platforms can be expanded for workforce development and safety training (i.e., content identification for future VR implementation). A summary of the stakeholder interviews is presented anonymously in the following section.

Participants included a safety training provider, two construction professionals related to worker safety, one public sector expert who oversees construction projects which encounter real-life cases where workers are exposed to dangers from oncoming traffic or vehicle movements around work zone operations on the road, and a professional from a technological startup and a consultancy firm that takes on innovative approaches to bringing novel technologies to improve worker safety for construction projects. The comprehensive list of questions, covering three areas of investigation, is summarized in Table 1.

Table 1 Stakeholder interview questions.

Introduction	
Q1	Could you please introduce yourself and your work, how long have you worked in the industry and your current role?
Part 1. General views on VR/AR application for workforce development and safety training	
Q2	What do you think about Virtual Reality being used as a platform for providing safety training for roadway workers?
Q3	Do you have any experience or knowledge of Virtual Reality being used in worker safety training in your practice or industry? Please give a few examples if so.
Q4	What are advantages or incentives of adopting VR platforms to augment current worker safety training platforms/methods?
Part 2. Understanding values experts see in using VR/AR platforms in increasing safety awareness of construction workers	
Q5	What are some value propositions you can state for VR platforms for improving worker safety awareness?
Q6	What specific scenarios you can think of where VR can enhance worker safety training?
Part 3. Identify a set of use-cases where the VR platforms can be expanded to include workforce development and safety training	
Q7	What level, grade, types of workers do you see are most prone to workplace hazard, where bringing better workplace training program is required?
Q8	What are some workplace hazard situations where it is difficult to train workers due to difficulty of demonstrating a hazardous situation, where it would be appropriate to bring in VR equipment? Please provide specific examples.

II. Interview Results

The stakeholder interviews conducted with professionals from various sectors involved in worker safety training and construction operations provided valuable insights into the potential adoption of Virtual Reality (VR) technologies. The interview results can be summarized as follows:

- Site safety professionals, who provide training to workforce, indicated that the conventional training would involve classroom lectures and on-site demonstration, involving the potential risk of hazards and accidents that may occur in lieu of any common mistakes or mishandling of equipment. Some demonstrations will require a mock setup of operation sites where the workers will be assigned to learn ~~to use~~ the actual tools and equipment involved as well as some of the site-specific characteristics of the construction work. The professionals responsible for providing safety training expressed limited knowledge and awareness regarding the application of VR technologies. They emphasized the need for VR platforms to be comfortable and attention-grabbing for users. While there was strong agreement on the usefulness of VR for multiple screenings of work operations and its potential to enhance safety, emphasis was on the need for realistic representation of job sites within the immersive virtual environment.
- Local government plays a crucial role in establishing and overseeing safety procedures in transportation and construction. Public servants may often oversee and inspect the various construction sites on roadways that require safety treatment and installation. A general view held regarding the nature of dangers extant on roadways is that drivers show erratic behavior and the general movement of vehicles do not always follow the usual trajectories when there is a change

of circumstance on the road. As earlier versions of VR implementations show static or the same simulated trajectories of cars in virtual environments, the perception was that the traffic behavior will not be realistic. This work resulted in a platform where VR is co-simulated with real traffic flows, trajectories, volume, and composition of traffic on the intersections simulated in VR with random erratic behavior by drivers. Given this simulation platform, this concern of the professionals is addressed. Even if the assumption was that VR would not provide realistic traffic simulations, the interviewee indicated that VR would still be useful for beginners to get started with safety training for roadway construction. For deployment of such technology-based training platforms in agencies, the cost associated with adoption and compliance with regulatory standards have been highlighted as important components for consideration.

- Professionals from construction companies in supervisory or managerial roles expressed skepticism due to previous failed attempts to adopt VR for workforce development and safety training. While the discussion of such technological adoption is still open to question and further investigation among AEC firms, a major obstacle faced by construction companies in taking innovative approaches to adopting VR technologies was the cost considerations including the initial cost of purchasing the equipment and putting such practices at scale. Regulatory hurdles like compliance with OSHA standards is another component of the difficulty of adopting wearables or novel technologies that include Virtual Reality technologies, as use of them will sometimes require OSHA approval, which is a difficult regulatory authority from which to gain approval. The major areas of work in site safety that construction companies are interested in is improving the realism of VR to replicate the site as closely and in as much detail as possible so the learning would be useful in actual operations. The big challenge of work zone operations is to keep workers alert to the imminent danger they are exposed at a constant rate on the roadways; humans tend to get comfortable even in a dangerous setting over time. This is still a major task for worker safety training. Technological solutions to solving the issue of improving workers' safety awareness may be an area of work for VR technicians as well.
- Viewpoints of companies that leverage technology were positive as compared to construction professionals. The interviews highlighted that the high risks faced by utility workers near power lines are significant and can result in casualties and life altering injuries. Like other interviewees, the emphasis was on developing VR platforms that closely replicate the specific characteristics of the job site. When the VR products are in use, they will assuredly benefit those who receive such safety training on the job site. However, the economic and regulatory feasibility of such a product will result in another level of concern once there is an agreement to the technological adoption.

In conclusion, the interviews revealed a mixed perspective on the adoption of VR technologies for worker safety training and job site simulations. While there were reservations and skepticism based on past experiences and cost considerations, there was also recognition of the potential benefits of VR in enhancing safety and training outcomes. The emphasis on creating realistic job site simulations emerged as a common theme across sectors. Future developments in VR should focus on addressing these concerns and challenges to increase acceptance and feasibility among stakeholders. The simulation capacity of VR to give an experiential learning of the site without posing users to actual physical danger offers potential success for the technology and the platform to achieve better outcomes in worker safety training.