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Comprehensive needs analysis for the development of construction safety education tools in immersive reality

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INTRODUCTION

- Construction is consistently amongst the most dangerous industries
- Need to reduce the number of accidents
  - ❑ Construction worker safety training
  - ❑ Potential of augmented and virtual reality solutions

PROJECT BACKGROUND

- Construction Safety with Education and Training using Immersive Reality – CSETIR
- Erasmus+ funded project
- 3-year duration
- 5 project partners
  - ❑ 4 universities
  - ❑ 1 construction company
  - ❑ Support from relevant organizations

PROJECT BACKGROUND

- ## Specific aims of the project:

  ❑ Developing, implementing, validating and tuning of interactive IR approaches to promote multidiscipline creativity, innovative thinking, and practical skills in the digital era;

  ❑ Ensuring education and research are mutually reinforcing, and strengthening the role of institutions in their local and regional environments;

  ❑ Exploring synergies and stimulating greater dialogue between HE, enterprises and VET schools, in the scope of community and outreach activities;

  ❑ Supporting the civic and social responsibility of students, workers, engineers and technicians.

PROJECT BACKGROUND

- Beneficiaries:
  - ❑ Construction workers
  - ❑ Safety personel
  - ❑ Site engineers
  - ❑ Students

OVERVIEW OF EXISTING AR/VR TOOLS

- Focus on available and readily applicable tools
- Purpose to identify:
  - ❑ Applicability to the CSETIR project goals
  - ❑ Intended use of the tool
  - ❑ Tools used for 3D modeling
  - ❑ BIM integration
  - ❑ Gamification software used
  - ❑ Hardware possibilities and requirements

OVERVIEW OF EXISTING AR/VR TOOLS

- Following tools were identified for further study:
  1. 3M - Construction Safety Virtual Reality Programs for Hands-on Learning (3M, 2020);
  2. CAT Safety VR module (Caterpillar Safety Services, 2020);
  3. SRI International Augmented Reality Solutions for Construction Inspection (SRI International, 2020);
  4. Safety Compass - Augmented Reality Workplace Safety (Safety Compass, 2020);
  5. VR Safety Training for Construction companies – LandMark VR (LandMark VR, 2020);
  6. FULmax cube (FULmax, 2020);
  7. Role of Visualization Technologies in Safety Planning and Management at Construction Jobsites (Azhar, 2017);
  8. A framework for construction safety management and visualization system – SMVS (Park and Kim, 2013)
  9. OSHA PIXO safety compliance Virtual Reality (PIXOVR, 2020);
  10. Web-based Collaborative Virtual Environments (LIRKIS G-CVE, 2020).

OVERVIEW OF EXISTING AR/VR TOOLS

- Role of Visualization Technologies in Safety Planning and Management at Construction Jobsites (Azhar, 2017);
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- Web-based Collaborative Virtual Environments (LIRKIS G-CVE, 2020).

NEEDS ANALYSIS

- ## Selection criteria

  - ❑ Is the tool available for use
  - ❑ Is the tool proprietary or freely available, and if proprietary is it affordable
  - ❑ What are the hardware requirements (for computing power)
  - ❑ Is any additional special hardware needed (i.e. special hardware elements, not including Head Mounted Displays (HMD))
  - ❑ Does the tool have a desktop version in addition to a full virtual environment
  - ❑ Does the tool have a smartphone version (i.e. for Samsung Gear) in addition to a full virtual environment
  - ❑ Does the tool support multiple platforms (supports more HMD's such as HTC Vive, Oculus Rift…)
  - ❑ Does the tool require additional supporting software, and if yes, is it available to use
  - ❑ How detailed and realistic can the virtual environment be

  - ❑ How simple is the tool to install and to use
  - ❑ Does the tool support multiple users in VR at the same time
  - ❑ How simple would it be to replicate the research results outside the project partners' institutions
  - ❑ Is the tool appropriate to teach Health and Safety related topics
  - ❑ What hazards/scenarios are available in the tool
  - ❑ Does the tool support the import of user generated BIM models
  - ❑ Does the tool support creating additional scenarios
  - ❑ Does the tool have open source, enabling modifications to suit the user's needs

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  - **Is the tool available for use**
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NEEDS ANALYSIS

	The tool is available	The tool is suitable to teach H&S topics	Ability to create and customize scenarios	Possibility to have multiple users in VR	Has open source	Supports various HMD's	Has mobile and desktop versions	Possible to use and to replicate in outside the project partners' institutions
1. 3M	YES	YES	NO	NO[1]	NO	YES	NO	YES[2]
2. CAT	YES	YES	NO	NO[1]	NO	NO	NO	YES[2]
3. SRI	YES	NO	NO	NO[1]	NO	NO	NO	YES[2]
4. Safety Compass	YES	NO	NO	YES	NO	NO	YES	YES[2]
5. LandMark VR	YES	YES	NO	YES	NO	YES	NO	YES[2]
6. FULmax cube	YES	YES	YES	YES	NO	N/A	NO	YES[2]
7. Visualization Technologies in Safety Planning and Management	YES	YES	YES	NO[1]	NO	YES	NO	YES[2]
8. SMVS	YES	YES	YES	NO[1]	NO	YES	NO	YES[2]
9. OSHA PIXO	YES	YES	NO	NO[1]	NO	YES	NO	YES[2]
10. LIRKIS G-CVE	YES	YES	YES	YES	YES	YES	YES	YES

[1] Only one user in VR, however others can watch on a separate screen

[2] Possible, but the intended user needs to buy the software and/or special hardware

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DISCUSSION

- Goals of the observed tools

- Prevalent modeling tools

- Gamification software used

- Hardware requirements

- Applicability to CSETIR project goals

CONCLUSION

- Future of safety training in AR/VR

- Role of CSETIR in future safety training

- Limitations

- Future research

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Thank you for your attention

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