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Revolutionizing Occupational Health and Safety (OHS) Education: Embracing Immersive Technologies and WebXR

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Abstract

WebXR, a cutting-edge web development application, serves as a platform for hosting 3D objects used in entertainment media, such as game engine simulations, and serves as a powerful tool for virtual practicum in web-based learning. Users can immerse themselves in 3D objects, seamlessly integrated into the real world. This immersive technology, built on web development, enables real-time experiences through VR headsets like Google HeadsetVR, Hololens, and Oculus Quest. Companies can also leverage WebXR for Occupational Health and Safety (OHS) equipment applications. The development of web applications supporting Augmented Reality (AR) and Virtual Reality (VR) using WEBXR API involves utilizing platforms like three.js, which activates Extended Reality (XR) session mode by connecting to XR devices like Oculus Quest 2 or other VR headsets. Unity 3D Engine can also be used by connecting to XR devices. In this study, Collaborative XR using Unity 3D Engine is employed for WebXR applications. The use of 3D objects in interactive OHS learning media is optimized through .fbx and .gITF formats, particularly for 3D object animation, enhancing WebXR file efficiency. Aside from 3D objects, several factors impact the use of WebXR APIs, including the software's SDK development, the expertise of APIs and 3D developers, and user experience. As technology evolves, WebXR opens new possibilities for immersive OHS education and paves the way for safer work environments.

Keywords: *Technology Immersive, Augmented Reality, Virtual Reality, WebXR APIs, Occupational Health and Safety (OHS) Education*.

1. Introduction

Technological developments are growing, we cannot avoid this in life because technology will run in accordance with the advancement of education in the industrial era 4.0. Many innovations have been created and provide many benefits in our lives. By providing a lot of convenience in carrying out daily activities. One of them is in the field of communication technology.

The term Industry 4.0 was born from the idea of the fourth industrial revolution. The European Parliamentary Research Service in [1] said that the industrial revolution occurred four times. The first industrial revolution occurred in England in 1784 where the invention of the steam engine and mechanization began to replace human labor. The second revolution occurred at the end of the 19th century in which production machines powered by electricity were used for mass production activities. The use of computer technology for manufacturing automation starting in the 1970s marked the third industrial revolution. Today, the rapid

development of sensor technology, interconnection, and data analysis has given rise to the idea of integrating all these technologies into various industrial fields.

The internet is one of the media that makes the whole world connected to get the impact as well as many benefits such as a source or collection of knowledge from various countries in the world. The development of information technology has now widely and significantly changed the lifestyle of people who are entering the current industrial 4.0 era. The demand in the world of education for immersive technology is currently very high. But in reality, the application of immersive technology learning packaged in the form of practicum for students in the world of education or for employees in the world of work is very little. Therefore, the introduction of immersive technology needs to be improved and studied, especially in solving existing problems, for example simulating in the form of hybrid learning and online practicum, especially web-based interactions.

However, with immersive technology such as WebXR, in fact the development of information and communication technology in the field of safety and health information in various companies in Indonesia is slightly behind in development compared to the field of shopping or e- commerce media. Referring to the Ministry of Manpower data, throughout 2018 there have been 157,313 work accident cases. In that year, it was higher than 2017 which was 123 thousand cases of work accidents[2]. In Law Number 1 of 1970 concerning work safety it is written that if the management violates or there is an accident at work, the threat of imprisonment for a maximum of 3 (three) months and a maximum fine of Rp. 100,000 (one hundred thousand rupiahs) can be imposed.). Occupational Health and Safety (K3) is an activity that ensures the creation of safe working conditions, protected from physical and mental disorders through coaching and training, direction, and control over the implementation of the duties of employees and the provision of assistance in accordance with applicable regulations, both from institutions government and the company where they work [3].

Every year 2.78 million workers die due to workplace accidents or work-related illnesses. And more than 374 million people are injured or injured or fall ill each year as a result of work-related accidents. The impact on the world economy due to lost workdays is close to 4% of global GDP. (ILO, 2018)[2]. In addition, research by [4] states that the cause of work accidents is 88% due to unsafe behavior, 10% due to dangerous conditions while 2% other causes are not yet known. The same thing by [5], shows that the biggest cause of work accidents is caused by unsafe behavior with a percentage of 80-95%.

This behavior can occur because of the perception and belief of workers who feel they are experts in their fields and are supported so far there has never been a work accident during work so that the level of concern for working according to rules and procedures is reduced. Identification of unsafe behavior in workers then directs them to be able to work safely and this can encourage workers to apply Occupational Health and Safety (OHS) culture in the work environment. Because the factors that cause work accidents are mostly caused by unsafe actions [6], so that the formation of a good Occupational Health and Safety (OHS) culture in the company can reduce the number of work accidents experienced inside or outside the workplace [7].

The current state of development is inseparable from the industrial sector which has achieved rapid progress, including progress in the field of Occupational Health and Safety (OHS). The implementation of Occupational Health and Safety (OHS) in all aspects is very important for human life [8], [9], [10]. The development of Start Ups in the Occupational Health and Safety (OHS) sector is still minimal, although several companies that have implemented Occupational Health and Safety (OHS) very well have made progress in this regard. These companies must have realized how important Occupational Health and Safety (OHS) is in its application in the workplace. The use of a WEBXR-based website application can provide understanding in the form of pre-employment practicum so that it can convey or inform matters related to Occupational Health and Safety (OHS) to the community in the industrial era 4.0.

The use of WEBXR can be used as an initial simulation and training for workers and is expected to be able to assist Occupational Health and Safety (OHS) practitioners in the company in disseminating

Occupational Health and Safety (OHS) such as procedures for using PPE in sequence or installing scaffolding to minimize work accidents in the field.

It is hoped that the use of WEBXR simulation can provide information and understanding of occupational safety and health without meeting face to face and if new employees are expected to go directly to the work site, these workers can master the area and terrain in the field.

2. Materials and methods

2.1 Materials

A. Literature Study

There are several studies that have been carried out in immersive technology in building Virtual Reality (VR), Augmented Reality (AR), and Extended Reality (XR) applications where these applications rely heavily on 3D objects that depict objects in the real world. In this paper, the author tries to describe it, in research related to WebXR, the use of web development that uses extended reality (XR) in the form of Virtual (VR), Augmented (AR), or Extended Reality (XR). Use of Virtual Reality (VR) in terms of usability parameters in the higher education application submitted by research [11], [12], [13], [14], [15]while the use of Augmented Reality (AR) can be divided into two, in terms of the use of markers, standard Augmented Reality supported by the use of libraries on the vuforia engine described in articles [16], [17], [18], [19], [20] while the use of markerless for example in the use of ARCore and ARKit has been carried out in maintaining the relativeity of 3D objects to the real world where the rate of each frame is tested on mobile devices and the use of APIs [21], [22] In addition to the use of immersive technology above, the use of Extended Reality (XR) in industry also carried out [23], [24], [25] Some research related to XR is the use of collaborative Extended Reality (XR) that presented in studies [26], [27], [28].

B. 3D Visualization for WEBXR

WebXR as a web development application, which is used in immersive technologies such as Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) where the use of interactive applications is more used in games than interactive learning media. This is because WebXR supporting tools are mostly expensive. WebXR is usually designed in a web application in main.ts when using a three.js file integrated with WEBGL that uses XR mode and is connected to an XR device such as the oculus quest 2 or other VR headset. Usually the program code used uses HTML and the content is set to be responsive to its users, generally in the WEBXR approach to learning or game learning, the learning materials used include 3D object design, scenario design effectiveness, visualization simulations, and design rules (boundaries) that given by the developer as the flow and design of application development which is usually presented on game-engines but more on learning media simulations. The initial implementation usually contains information related to general functions that make it easier for the user and the provision of buttons that are usually used in learning to use WebXR.

In WebXR page content, it is almost similar to WEBGL where the application that is displayed is a display of the scene, rendering 3D objects, and the camera. However, the WEBXR application can display information to the user if an error occurs such as WebXR cannot be used because the browser does not support WebXR.

WebXR API, basically there is no feature to identify objects such as in machine learning, but developers (WebXR programmers) can sequence the scenarios designed in WebXR media so that objects can appear to be read or identified by image recognition from the image identity of 3D objects even though done manually programming. WebXR applications can use 3D object dimensions at coordinates (X,Y,Z) as a reference for the identity of the 3D object image.

In addition to the above methods, the use of immersive technology can be done by integrating WebXR APIs by developing VR Apps using Animation plus 3D Objects, Physics Engine, 3D Engine, XR Scene, Camera and VR APIs combined with Collaborative Extended Reality (Collaborative XR) and Web programs and Services. Where in each service in the WebXR APIs can support developers and users to perform computations such as object recognition and computer graphics design as in WebGL.

C. XR Mode in Three.js and Unity3D Engine

XR Mode is using while to query the immersive VR- Content. There are two ways to start WebXR, first by using XR Mode in Three.js. Second by XR property or XR object in WebXR using Unity3D Engine.

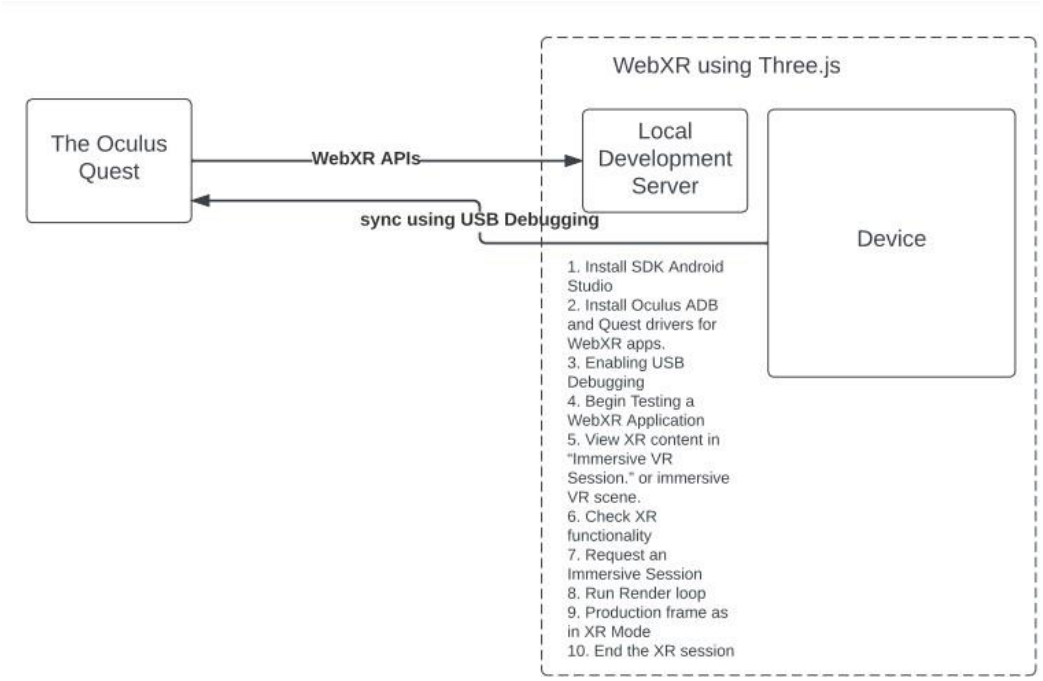

Figure 1. WebXR using Three.js

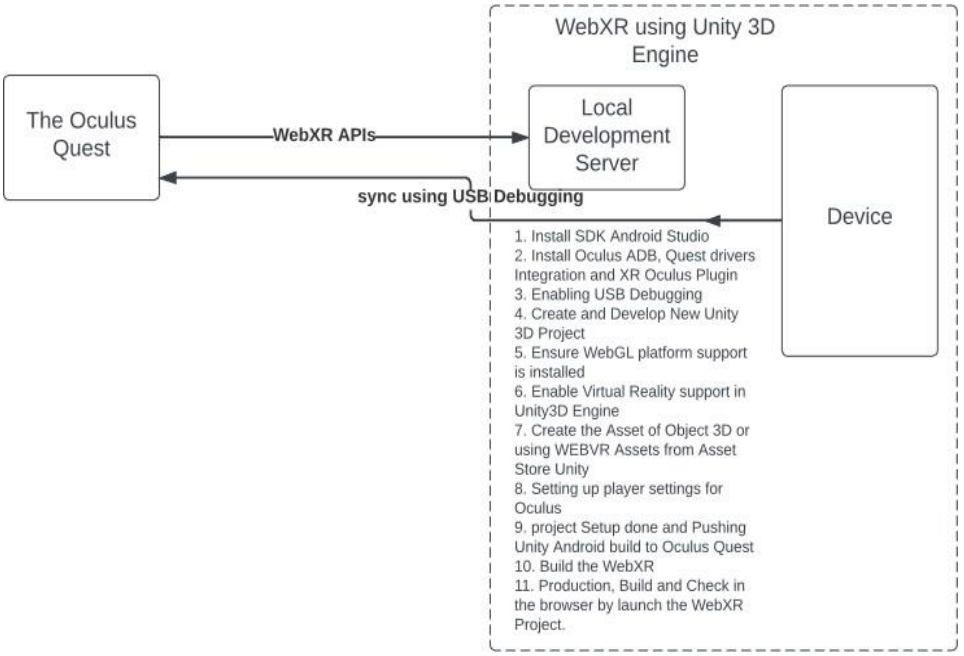

Figure 2. WebXR using Unity 3D Engine.

2.2 Methods

In this section, the method used by researchers aims to develop, test and evaluate WebXR applications for K3 education, with the aim of increasing awareness and understanding of work safety in the workplace. However, at this stage, we will explain in more detail from an educational perspective the preparation of K3 work equipment using the WebXR Unity 3D Engine. The process of apps WebXR for Occupational Health and Safety (OHS) in preparation of K3 Work Equipment as follows:

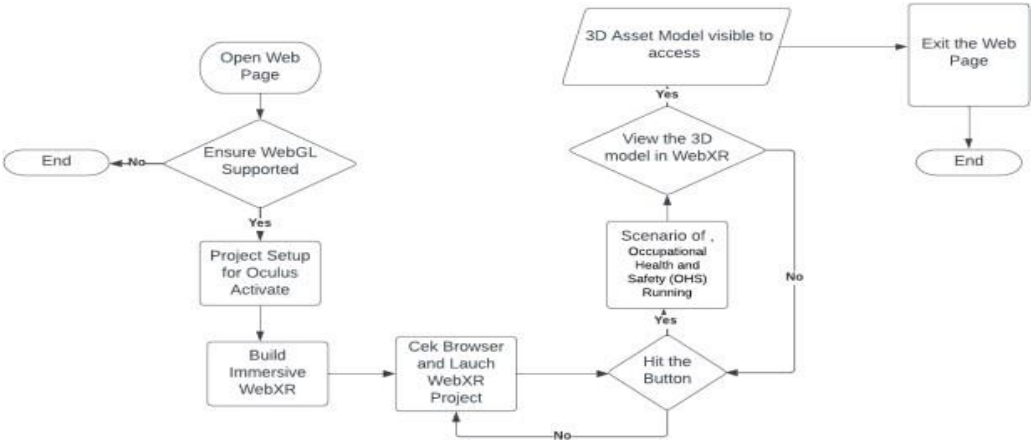

Figure 3. The process of apps WebXR for Occupational Health and Safety (OHS) in Preparation of K3 Work Equipment

3. Results and discussion

3.1 Results and discussion

In this section, the methods that have been used in this paper is WebXR using Unity 3D Engine. As for the experimental environment, we use the web browser to run WebXR, the device using oculus quest 2, 3D Model Assets, and all supported tools for WebXR as Local Development Server and etc. The process of the experimental by using scenario for Occupational Health and Safety (OHS) as follows:

A. Scenario Use of APD Occupational Health and Safety (OHS)

A simulation scenario that will be made on WEBXR Occupational Health and Safety (OHS), which is used as one of the implementations, namely the use of APD Occupational Health and Safety (OHS).

Table 1. Scenario of the use of APD OHS.

No.	Scene Name	Description
1	Preparation of K3 Work Equipment	Players must prepare work equipment and check the completeness of work equipment 1. Wear a Wearpack 2. Using a Full Body Harness 3. Install a Lanyard 4. Using a Safety Helmet 5. Using Safety Shoes 6. Using Safety Gloves 7. Using Safety Goggles 8. Understanding OHS signs 9. Bringing a first aid kit **Enter Scene "Process Scaffolding Installation Simulation" Then Select "Single Player"** **Work Equipment Objects** Occupational Health and Safety (OHS): Choose according to the list of equipment used.

B. 3D Asset Design

There To create 3D images, software is needed that supports the creation of 3D objects for virtual reality. Making 3D objects using an application called blender as the main application, because it is very light and can be more clear in making indentations. In addition, the use of the blender application is also very easy, especially for beginners. Another advantage of the blender application compared to other applications is that the rendering process in the formation of small indentations is only when needed, in contrast to other applications which render the rendering process all the time for the formation of small indentations which are more difficult.

After all objects and spaces are created in the blender, the next step is to create a virtual reality prototype, at this stage the application used is Unity 3D, because Unity is one of the most complete applications for creating virtual reality, animation and games. The minimum specification when creating virtual reality using Unity 3D is 16 GB of RAM.

Figure 4. 3D Objects Design

In the images of 3D objects, above are some descriptions of the Occupational Health and Safety (OHS) devices used, including:

(1)Wearpack
(2)Full Body Harness
(3)Lanyard
(4)Safety Helmet
(5)Safety Shoes
(6)Safety Gloves
(7)Safety Goggles
(8)OHS sign
(9)First aid kit

C. WebXR Supporting Tools

There Minimum requirements for creating 3D objects and virtual reality are not very high, but there are standard specifications used to design hardware without being too burden the performance of the device used.

Table 2. WebXR Supporting Tools

No	Name Hardware	Minimum Specifications
1	Hand Controller	Supported Virtual Reality/ Augmented Reality
2	Glasses	Supported Virtual Reality/
3	Computers/ Laptops	16GB RAM

D. Development of WebXR for Occupational Health and Safety (OHS)

In this stage, the first thing to do is to determine a good software development kit (SDK) and support the development of cross-platform applications for the creation of VR Education APNs according to needs. This development uses a software development kit developed by Unity and downloads the Google VR SDK for Unity plugin. In unity make sure the XR Interaction Toolkit is installed. The XR interaction Toolkit is used to handle the core interactions of Virtual Reality (VR) technology.

The development is carried out on the WebXR scene which will display the WebXR visualization. In the WebXR scene, there is a WebGL engine that functions to render a set of 3D objects on the web. The WebGL engine will develop several services, namely physics engine, mesh, camera view, lighting, GUI, and WebXR API. At this stage, the user will be able to freely interact directly with the virtual model and perform simulations according to the simulation scenario that has been built on the medical scenario stored in the database. This service can be accessed by users through a Web Browser that supports WebXR technology on their respective devices. With the WebXR API feature on the WebGL engine, it is possible to integrate this service with VR / MR devices, such as Oculus, Magic Leap and others.

In this study, the Unity XR SDK is used as a plugin to integrate applications that have been created with VR devices. The Unity XR plugin aims to provide the tools needed to achieve Unity's original principle of "Build once, deploy anywhere" for VR and AR projects so that developers can target a number of different platforms and devices with the same source code. In the past, VR developers have been plagued by incompatible device-only, vendor-specific, and platform-specific SDKs and toolkits. Various other "solutions," both open source and proprietary, have serious flaws and limited support.

E. 3D Object Animation Development for WebXR

As for the animation development on 3D objects, using the Animator Component and Animator Controller. In the animator component, animation on a 3D object in Unity, as for one way, namely the rigging/skeleton method. Rigging is basically a 3D mesh bound digital framework. as for this rigging consists of a joint which is then made a controller to facilitate movement, and the last one is skinning. While in the animator controller where in making the animation state on the animator controller, the animation state that will be played when transferred and transition conditions will be used for the transition from one state to another will be used.

F. The results of the WebXR Project Scene regarding Occupational Health and Safety (OHS).

Figure 5. Dashboard Menu WebXR

Figure 6. WebXR Apps for Occupational Health and Safety (OHS)

In this results, the use of 3D objects on the tools used that are attached to the WebXR application in interactive learning media in the field of Occupational Health and Safety (OHS) where for the use of 3D asset file formats, the author recommends the use of 3D asset files in *.fbx and *.gITF formats, especially for the use of 3D object animation in maintaining texture, material and animator controllers which indirectly provide access which is lighter, especially the size efficiency of WebXR files. As for the use of algorithms in the WEB, if needed, APIs developers can implement them more easily in developing interactive learning media based on WebXR.

4. Conclusion

The use of immersive technology can be used in the production of Occupational Health and Safety (OHS) platform applications, in this case a website-based Extended Reality (XR) application using WebXR APIs. The development of WebXR provides an alternative solution in providing 3D objects that resemble basic Occupational Health and Safety (OHS) equipment that Occupational Health and Safety (OHS) practitioners can use in implementing various scenarios in OHS. The experiments carried out by the author and the implementation of WebXR are still simple and can be further developed as a real-world interpretation after the covid19 pandemic. On the use of 3D objects in WebXR applications in interactive learning media in the field of Occupational Health and Safety (OHS) 3D asset files are better used in *.fbx and *.gITF formats, especially for the use of 3D object animation, this affects the efficiency of WebXR files.In addition to 3D objects, there are several supporting factors, related to the use of WebXR APIs and interactions in them depending on the development of the SDK on the software, the expertise of APIs developers, 3D developers, and user experience in their ability to use hardware, each of which has limitations that affect the user's cognitive level. The Extended Reality (XR) application in the form of WebXR can still be developed on an ongoing basis.

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