



Legal considerations for implementing Extended Reality (XR) technology in the shipbuilding industry: Perspectives on devices and software

DongHyup Youn¹ · JaeWook Jang[†]

(Received June 14, 2023 ; Revised June 23, 2023 ; Accepted October 15, 2023)

Abstract: This study explores the implementation of Extended Reality (XR) technology, which encompasses virtual, augmented, and mixed reality elements, in the shipbuilding industry to provide immersive and interactive experiences. The XR technology has shown great potential in the shipbuilding industry, offering benefits such as design visualization, virtual prototyping, and training simulations. This study analyzes the legal issues surrounding using XR technology in the industry from both device and software perspectives. It examines the implications of the relevant laws, identifies legal challenges, and proposes areas for further research, including intellectual property rights, software distribution, user management, and policy development.

Keywords: Extended reality, Shipbuilding industry, Legal issue, Devices, Software

1. Introduction

Extended Reality (XR) is a comprehensive term that encompasses various technologies that merge the physical and digital worlds to create immersive and interactive experiences. Virtual Reality (VR) completely replaces users' sensory perception, allowing them to immerse themselves in digital environments. Augmented Reality (AR) enhances the real-world experience by adding digital information and virtual objects to the environment. Mixed Reality (MR) provides an experience where users can interact with virtual objects while perceiving the real world. XR combines the VR, AR, and MR elements to provide users with a more comprehensive and engaging sensory experience. The essence of XR lies in going beyond traditional computer interfaces to immerse users in simulated environments and enhance their perception of the real world. By leveraging the XR technology, users can interact more intuitively and immersively with digital content, objects, and information.

The Korean shipbuilding industry has a long history of utilizing innovative technologies to improve the efficiency and safety of its shipbuilding processes. From the development of CAD/CAM systems in the 1970s to the utilization of robotics and automation in modern shipyards, the industry has continuously embraced new technologies to streamline operations and enhance

product quality. In recent years, the XR technology has emerged as a promising tool for shipbuilding companies. XR technology can be used in shipbuilding for various purposes, including design visualization, virtual prototyping, and training simulations. Seok and Hur conducted a study on practical training for ship engine repair using VR [1]. Seo et al. demonstrated that shipyards have created virtual environments using XR technology, allowing designers and engineers to visualize ship designs in 3D and make real-time modifications. This enables the identification of potential issues in the early stages of the design process, thereby leading to improved accuracy and efficiency in ship design. XR technology can also be used for training [2]. Reed and Dunaway demonstrated the creation of immersive training simulations in a safe and controlled environment where shipyard workers could perform complex tasks [3]. This can help reduce the risk of accidents and enhance workers' proficiency and confidence.

Barfield *et al.* and Wassom raised new issues related to safety and liability despite the numerous potential benefits offered by the XR technology [4][5]. Bevilacqua *et al.* indicated that XR technology can pose safety risks to users, such as motion sickness, accidents, injuries, and vision problems. If XR technology is defective or causes harm to users, manufacturers can be held liable under product liability laws [6]. Turdialiev also highlighted

[†] Corresponding Author (ORCID: <http://orcid.org/0000-0003-0892-2870>): Senior Researcher, Marine Leisure & Safety Center, Research Institute of Medium & Small Shipbuilding, 38-6, Noksansandan 232-ro, Gangseo-gu, Busan 46757, Korea, E-mail: jwjang@rims.re.kr, Tel: +82-51-974-5586

¹ Senior Researcher, Marine Leisure & Safety Center, Research Institute of Medium & Small Shipbuilding, E-mail: dhyoun@rims.re.kr, Tel: +82-51-974-5569

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

the intellectual property issues related to creating and distributing XR-related content, including copyrights, trademarks, and patent rights. Furthermore, privacy and data protection concerns may arise because XR devices and applications collect and process user data [7]. Qamar, Anwar, and Afzal suggested the introduction of new regulatory requirements and certification procedures may need to be introduced [8].

This study examines the legal factors that would arise when XR technology is introduced into the shipbuilding industry. It investigates safety concerns, intellectual property rights, personal information and data protection, and regulations and certifications from the perspectives of devices and software. By analyzing the legal issues and implications of the relevant laws, this study seeks to provide appropriate response strategies and guidelines for implementing XR technology in the shipbuilding industry.

2. Application Approaches of XR Technology in the Shipbuilding Industry

2.1 Legal definition

Currently, it is difficult to find specific regulations dedicated to VR, AR, and MR in South Korea, and there is no legal definition that specifically addresses VR/AR/MR. According to this, there is a need to establish a comprehensive and independent legal concept of virtual reality to define and pursue policies. Khan provided the first active definition of VR/AR from a normative perspective. The definitions of VR, AR, MR, and HMD (Head Mounted Display) reflect the current general understanding [9]. However, distinguishing between them becomes challenging as the boundaries between VR, AR, and MR become increasingly blurred. A schematic of this concept is shown in **Figure 1**.

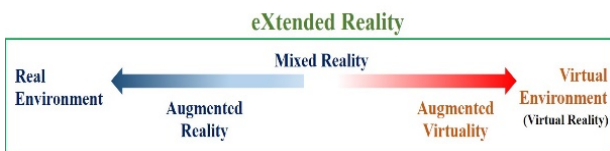


Figure 1: Conceptual diagram of VR, AR, MR, and XR

2.1.1 Virtual Reality, VR

This technology aims to create a virtual, fictional environment or situation that closely resembles reality and allows users to perceive and interact with visual, auditory, tactile, and other sensations as if they were in a real environment.

2.1.2 Augmented Reality, AR

This technology combines virtual visuals or meaningful information with reality to enhance the user experience.

2.1.3 Mixed Reality, MR

It is a technology that combines the real and virtual worlds, adding virtual information to the real environment or adding real-world information to the virtual environment, allowing users to interact with it.

2.1.4 Extended Reality, XR

It combines real and virtual worlds to provide new experiences. XR is an umbrella term that encompasses Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR).

2.2 Applications of XR in the Shipbuilding Industry

According to the Industrial Accident Compensation Insurance Act, the shipbuilding industry falls under the shipbuilding and repair industry. It is much larger in scale and more complex than general buildings and involves assembling numerous members and equipment to create a single movable product.

The shipbuilding industry manufactures ships and marine structures. First, as a large-scale industry, shipbuilding requires facilities and equipment at a significant scale, including large cranes and other massive infrastructure. This necessitates highly specialized manufacturing facilities and technologies in the shipbuilding industry. Second, the shipbuilding industry demands continuous technological innovation to satisfy requirements such as safety, improved vessel speed, and environmental friendliness. Creative technologies and innovations are required in various fields including ship design, automation systems, and marine engineering. Third, the shipbuilding industry requires advanced production systems to maximize productivity and efficiency. The production process can be optimized by utilizing CAD/CAM systems, robotics, and automated production facilities while enhancing production capabilities.

Applications of XR in the shipbuilding industry can be classified into manufacturing, distribution, and content. Manufacturing applications include design and simulation using virtual reality, maintenance and repair operations using mixed reality, sensor fusion technology that integrates real sensor data with virtual objects, and 3D modeling and visualization techniques. From the distribution perspective, there are activities, such as product design and demonstration using virtual reality, product

visualization and interaction using augmented reality, establishing virtual stores and e-commerce platforms, and developing platforms for virtual experiences and demonstrations. Regarding immersive content, 3D simulations, and experiences use virtual and augmented reality; interactive experiences use augmented reality; and immersive experiences use high-quality videos, audio, and haptic technologies for sensory feedback. Various legal issues can be identified by considering these aspects collectively.

3. Legal Issues regarding the Integration of XR Technology into the Shipbuilding Industry

3.1 General issue

Critical legal issues must be considered when integrating XR technology into the shipbuilding industry.

First, compliance with safety regulations within shipyards is critical to ensure the safe use of XR technology. XR technology can affect worker safety and may be related to the working environment and the use of safety equipment. This may require meeting certification, verification, and compliance requirements.

Second, the collection and processing of users' personal information may occur while using XR technology. This includes obtaining user consent, implementing data collection and protection policies, and ensuring data security.

Third, intellectual property issues such as copyrights, trademarks, and patents may arise when developing or using new XR content. These legal considerations can be categorized from both hardware and software perspectives, with safety regulations falling under the hardware perspective and personal data protection and intellectual property rights falling under the software perspective.

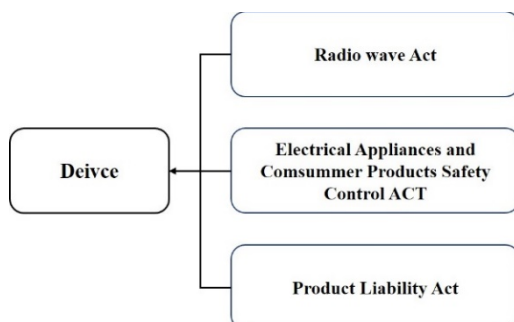


Figure 2: Device-related laws

3.2 From a Device Perspective

The term “device” refers to mechanical or electronic devices

that can be encountered from both the manufacturing and distribution/sales perspectives for those involved in selling devices. However, if public platforms (e.g., Android and iOS) are used, as long as they do not violate the platform market, there are no sanctions on the device side. The relevant laws are shown in **Figure 2**.

3.2.1 Legal issue

The “Radio Waves Act” aims to promote the efficient and safe use and management of radio waves and the development of technologies related to radio waves, thereby contributing to the advancement of radio wave-related fields and public welfare [10]. In terms of quality certification, there are concerns about devices that may cause harm to the radio wave environment or that may be susceptible to interference from electromagnetic waves. This is referred to as a suitability evaluation for broadcasting and communication equipment. Devices that have obtained radio wave certification are relatively safe from the influence of surrounding electromagnetic waves, meet the output power and frequency criteria, and operate stably. On the other hand, uncertified devices may react sensitively to surrounding electromagnetic waves or have excessively high output power or frequencies that encroach upon adjacent unauthorized bands.

The “Electrical Appliances and Consumer Products Safety Control Act” aims to regulate the management of safety related to electrical appliances and consumer products to protect citizens' lives, bodies, and property and promote the interests and safety of consumers [11]. Accidents caused by improper design, manufacturing, use, and management pose serious issues; therefore, the law encompasses various provisions. Compliance with specific safety standards and specifications is required, and companies must evaluate and test the safety of their products to obtain safety certification. The manufacturer, model name, manufacturing date, and safety certification mark must be included, and recalls must be conducted if any issues arise with the product.

“Product Liability Act” is a law that governs the legal liability of manufacturers for damages caused by the products they have manufactured [12]. This law aims to protect consumers and ensure product safety by holding manufacturers accountable for maintaining the quality and safety of their products and preventing harm. The Product Liability Act includes key provisions related to manufacturers' liabilities, product defects, and consumer rights. Manufacturers are legally responsible for their products, including all design stages, manufacturing, sales, and supply.

They are required to ensure the safety and quality of their products and minimize the risks to consumers' lives, bodies, and property. Manufacturers are held liable for damages caused to consumers owing to product defects. They are expected to minimize their weaknesses through proper design, manufacturing, testing, and quality control processes. If a defect is discovered, manufacturers must take appropriate measures to rectify it and prevent consumer harm. The Product Liability Act protects consumer rights. Consumers can report the damage caused by product defects and seek manufacturer compensation. They have rights over the manufacturer's liabilities and procedures for claiming compensation. Under the Product Liability Act, manufacturers are responsible for consumer protection and safety. This ensures that consumers affected by product-related damages receive payments and establishes legal regulations to foster a fair market environment and ensure safe product availability.

KC (Korea Certification) is a certification process in Korea that ensures that certain products, such as electronic and information communication devices, broadcasting and communication devices, and others, comply with relevant regulations for safe use [13]. It aims to fulfill the requirements of the Radio Waves Act by ensuring compliance with radio frequency standards and preventing interference. Additionally, the Electrical Appliances and Consumer Products Safety Act prohibits the manufacturing, importing, and selling electrical and consumer products without KC certification. Obtaining KC certification for their products allows manufacturers to ensure compliance with safety standards and facilitates adherence to the Product Liability Act. This signifies that the products have undergone testing and evaluation to meet the specified safety requirements, thus contributing to consumer protection and promoting the safe use of such products in the Korean market. Manufacturers demonstrate their commitment to producing safe and reliable products that comply with Korean safety regulations by obtaining KC certifications. This ensures that consumer products meet the necessary safety standards and requirements. Additionally, KC certification simplifies the process by which manufacturers fulfill their legal obligations under the Product Liability Act, as they can demonstrate compliance with safety regulations through certification.

3.2.2 Issues in the Shipbuilding Industry from the device point of view

A wide array of equipment is utilized in shipyards, leading to numerous radio wave-related issues. Unlike specific industries, such as aviation and space, shipyards do not offer an environment

where radio waves can be easily segregated and allocated within confined spaces. Consequently, challenges arise concerning the provision and utilization of frequency bands for individual pieces of equipment. Introducing XR devices in this context necessitates strict adherence to the regulations outlined in the Radio Act, including the acquisition of the requisite certifications and permits. One option is to obtain KC, which assumes responsibility for the manufactured products and ensures their safety.

However, a notable challenge arises owing to the absence of an explicit definition of XR devices in Annex 5 of the Enforcement Rules of the Electrical Appliances and Consumer Products Safety Act. As a result, XR devices may fall under categories similar to those listed under "Information, Communication, and Office Equipment" in items subject to the Supplier's Declaration of Conformity (Article 3, Paragraphs 5 and 6, and related provisions). Manufacturers and importers of XR devices can apply for certification and undergo product evaluation and testing through designated government-certified bodies. This might lead to excessive testing requirements, prompting the inclusion of XR device-specific categories in Annex 5, contingent on market viability. Therefore, XR devices used in shipyards are additionally in the area of special equipment, and if a legal basis is established to use other frequency bands, XR equipment that can only be used in shipyards is created.

Additionally, when using XR devices within a shipyard, they should not be available to anyone, even if the aforementioned legal issues are resolved and introduced. The shipbuilding industry is inherently susceptible to severe accidents [14]. Therefore, new regulations mandating mandatory training for employees who wish to use XR equipment must be established.

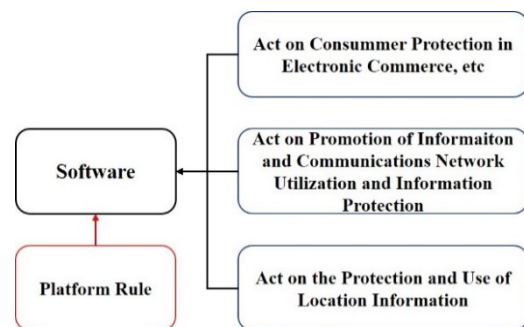


Figure 3: Software-related laws and rule

3.3 From a Software Perspective

"Software" refers to the platform (e.g., Android, iOS, etc.) built and installed on the device. These must satisfy the requirements of each platform provider. However, because the laws vary

in each country and platform providers are multinational corporations, the laws of each country take precedence, and compliance with these laws allows for registration. The relevant laws and rules are shown in **Figure 3**.

3.3.1 Legal Issue

The Act on Consumer Protection in Electronic Commerce applies to e-commerce and other related fields, including software embedded in XR devices, to strengthen user rights and protect consumers [15]. This law clearly defines the responsibility for the safety of XR software, implying that the software must be designed without inappropriate functions or defects that could harm user security. Legal obligations may be imposed if these requirements are not satisfied. Additionally, this law protects users' personal information collected and processed using XR software. XR software often collects sensitive data, such as user movements, voice, and gaze, which must be adequately protected and used. Legal requirements must be met in all data collection and processing, with top priority given to user privacy. Software sellers must provide accurate and precise information about a product's functions, usage conditions, license terms, price, etc. This information is crucial for consumers in making informed decisions when purchasing and using a product. The provision of incorrect information that may mislead consumers is prohibited. Strong measures against illegal software usage and infringement are important. This includes preventing illegal copying, hacking, malware, and other threats to software, as well as responding appropriately when such threats occur. By doing so, XR software providers can establish a fair and secure trading environment, ensuring consumers receive trusted products and services.

“Act on Promotion of Information and Communications Network Utilization and Information Protection” (commonly referred to as the “Information and Communications Network Act” or “ICNA”) plays a significant role in the development and operation of Extended Reality (XR) software [16]. Personal information protection is a critical consideration in XR software, as it often involves collecting sensitive data such as user location, movements, and gaze. This law requires that such information be securely handled and not shared without user consent and that software developers find ways to meet these legal requirements. The XR software often provides users with various forms of content, which makes online content management an important consideration. Adequate content filtering and monitoring systems are necessary to prevent illegal content distribution and provide users with a safe and wholly XR environment. Data protection and

security are also integral to XR software, ensuring the safety of user data through security protocols and encryption technologies and ensuring that information transmission through XR software is protected. Finally, because the XR software is often used for online transactions, it must provide accurate and transparent transaction information, guarantee user rights, and take appropriate measures for consumer protection.

The “Act on the Protection and Use of Location Information” is a necessary legal consideration for developing and operating Extended Reality (XR) software [17]. XR software often collects and utilizes user location data, which significantly enhances user experience. However, these location data are sensitive information that can infringe upon an individual's privacy, making it important to protect and use them appropriately. This law sets standards for collecting, using, and providing location information, and provides a robust means to protect personal location information. First, XR software developers and service providers cannot collect, use, or provide personal location information without users' explicit consent. Consent must be obtained in a specific manner and is required after a certain period. In addition, appropriate security measures must be implemented when collecting or using location information. This prevents the unauthorized access, alteration, destruction, or leakage of location information. Users must be notified immediately in the event of a leak, theft, or loss of location information. Additionally, XR software should respect and protect user privacy while providing services based on user location information. Unnecessary location information should not be collected or shared without the user's consent, and the user must be able to revoke access rights to location information at any time.

3.3.2 Platform Issue

“Platform” refers to the environment of hardware or software required to run a specific software application. This environment includes the operating system, hardware type, and network infrastructure. Android refers to the underlying technological environment necessary for developing applications that can run on the Android operating system. This platform provides APIs (Application Programming Interfaces) that allow developers to implement specific functionalities, including file system management, network access, and graphics rendering. Therefore, a platform provides a foundational environment for developers to create software and for users to utilize the software.

When distributing new XR-related software applications on platforms, various issues arise, such as store policies, user

consent and privacy, content filtering and monitoring, copyright protection, and regulations specific to countries and regions. The store policies include rules to maintain user privacy and ensure content safety. Sensitive aspects, such as personal data processing, content policies, payment systems, and advertising policies, are typically addressed. Apps must not collect or share personal information without the user's consent, and distributing violent, sexual, hammable, or discriminatory content is prohibited. Moreover, the reliability of transactions through payment systems, advertising transparency, and user experience's importance are emphasized, and inappropriate or false advertisements must not be provided. These policies were designed to prioritize user safety and personal data protection.

3.3.3 Issues in the Shipbuilding Industry from the Software Point of View

Implementing software integrated into XR devices in the shipbuilding industry poses distinct challenges, particularly regarding communication and confidentiality between staff, officers, and orderers. These exceptional circumstances require rigorous security protocols and robust data management practices tailored to the industry's specific requirements.

From a software perspective, it is essential to emphasize the prioritization of laws related to information protection and handling of user location information within the shipbuilding sector. The unique operational environment of a shipyard, with its specific communication and data requirements, requires specialized considerations.

Furthermore, adherence to app store policies remains critical, underscoring the need to safeguard personal data and content stability within shipyards. Even if software distribution is confined within shipyard boundaries, strict compliance with the security protocols stipulated by app stores remains indispensable. These protocols are engineered to uphold the application's integrity and safeguard users' personal information, and they must be followed diligently, regardless of the distribution scope.

Security regulations tailored to the shipbuilding industry encompass a comprehensive array of prerequisites, including data protection, encryption, authentication, secure communication, and other critical aspects that traverse the entire app development and distribution lifecycle within this specialized domain. Compliance with industry-specific regulations demands a steadfast commitment to app security and user privacy protection.

Compliance with app store regulations does not necessarily imply complete legal satisfaction when information and

communication networks are used in shipyards. The complexity of shipyard operations requires a customized approach to legal compliance.

Therefore, in the process of app development and distribution within the shipbuilding industry, it is imperative to adhere strictly to regulations governing the collection, utilization, storage, provision, and disposal of personal information within the specific confines of shipyard operations. Additionally, implementing robust encryption and security protocols for safeguarding data within an app, specifically tailored to the unique demands of the shipbuilding environment, is of paramount importance.

Moreover, in light of the absence of standardized guidelines concerning data collection limitations and the protection of trade secrets related to collected videos or data within the shipyard setting, it becomes evident that specific criteria, such as infringement standards for trade secret violations, must be established within the framework of legal regulations pertinent to the shipbuilding industry. As data ownership is often governed by contractual arrangements rather than strict rules within shipyards, developing guidelines for averting trade secret infringement has become increasingly important. These guidelines may encompass the implementation of non-disclosure agreements and the cultivation of specialized personnel who are well-versed in security practices tailored to the specific needs of the shipbuilding sector.

Hence, there is a requirement to establish and oversee specific legal provisions related to business contract performance tailored to the advancement of the shipbuilding industry. This legislation may have diverse software implications. A bill that safeguards the shipbuilding sector should be passed, and if the suggested laws are incorporated into the associated laws, it could protect trade secrets held by shipyards.

4. Conclusion

In conclusion, the integration of Reality (XR) technology into the shipbuilding industry presents a series of unique legal challenges that require careful consideration and adaptation.

First, the complex and diverse array of equipment within shipyards raises radio-wave-related issues that require compliance with the strict regulations outlined in the Radio Act. The absence of a specific definition of XR devices within existing regulations adds complexity, potentially leading to excessive testing requirements and the need for dedicated XR device categories. Specialized legal frameworks may need to be established to address

these challenges effectively.

Secondly, despite resolving legal concerns regarding XR equipment in the shipbuilding industry, unrestricted usage should be avoided because of the industry's susceptibility to severe accidents. Therefore, there is a need for new regulations mandating the training of employees who intend to use XR equipment.

Third, the deployment of software integrated with XR devices in shipyards presents distinct challenges. Stringent security measures tailored to the unique environment of a shipyard are essential. Prioritizing laws related to information protection, user location information, and adherence to app store policies are critical. Compliance with industry-specific security regulations encompassing data protection and encryption is imperative. Ensuring strict adherence to regulations governing data collection, utilization, and disposal within shipyard operations is essential for protecting user privacy. Establishing trade-secret protection and confidentiality criteria, particularly within contractual arrangements, has become increasingly important.

Finally, there is an evident need to enact and manage specific laws related to the performance of business contracts tailored to the unique needs of the shipbuilding industry. This legal framework provides essential safeguards for the protection of trade secrets and the overall advancement of the shipbuilding sector.

In summary, the successful integration of XR technology into shipyards requires a comprehensive understanding of the legal challenges and a proactive approach to address these challenges effectively. Tailored legal frameworks and regulations are crucial for ensuring the compliance, safety, and protection of vital industrial interests.

Acknowledgements

This research was a part of the project titled 'XR-based shipbuilding, marine design and process systems,' funded by Ministry of Science and ICT.

Author Contributions

Introduction, D. H. Youn and J. W. Jang; Application approach, D. H. Youn; Legal issue investigation, D. H. Youn; Legal issue analysis, D. H. Youn and J. W. Jang; Conclusion, D. H. Youn and J. W. Jang; Writing—Original Draft Preparation, D. H. Youn; Writing—Review & Editing, J. W. Jang; Visualization, D. H. Youn; Supervision, J. W. Jang; Project Administration, J. W. Jang; Funding Acquisition, J. W. Jang.

References

- [1] B. S. Roh and J. J. Hur, "Development of VR curriculum for marine engines," *Journal of Advanced Marine Engineering and Technology*, vol. 46, no. 3, pp. 143-149, 2022.
- [2] D. I. Seo, B. H. Yoo, and H. D. Ko, "Webizing collaborative interaction space for cross reality with various human interface devices," *Proceedings of the 23rd International ACM Conference on 3D Web Technology*, pp. 1-8, 2018.
- [3] J. C. Reed and N. Dunaway, "Cyberbiosecurity implications for the laboratory of the future," *Frontiers in bioengineering and biotechnology*, vol. 7, p. 182, 2019.
- [4] W. Barfield and M. J. Blitz, *Research Handbook on the Law of Virtual and Augmented Reality*, Edward Elgar Publishing, 2018.
- [5] B. Wassom, *Augmented Reality Law, Privacy, and Ethics: Law, Society, and Emerging AR Technologies*, Syngress, pp. 43-69, 2015.
- [6] M. Bevilacqua, B. Eleonora, F. E. Ciarapica, F. Costantino, L. D. Donato, A. Ferraro, G. Mazzuto, A. Monteriù, G. Nardini, M. Ortenzi, and M. Paroncini, "Digital Twin Reference Model Development to Prevent Operators' Risk in Process Plants," *Sustainability*, vol. 12, no. 3, p. 1088, 2020.
- [7] M. Turdialiev, *Legal Discussion of Metaverse Law*, *International Journal of Cyber Law*, vol. 1, no. 3, 2023.
- [8] S. Qamar, Z. Anwar, and M. Afzal, "A systematic threat analysis and defense strategies for the metaverse and extended reality systems," *Computers & Security*, vol. 128, 2023.
- [9] S. Khan, "Extended reality: bringing the 3Rs together," *Extended Reality for Healthcare Systems*, pp. 1-13, 2023.
- [10] Korean Law Information Center, "Radio Wave Act," Republic of Korea, No. 18957, 2023.
- [11] Korean Law Information Center, "Electrical Appliances and Consumer Products Safety Control Act," Republic of Korea, No. 19005, 2023.
- [12] Korean Law Information Center, "Product Liability Act," Republic of Korea, No. 14764, 2018.
- [13] Korean Law Information Center, "Notification for Conformity Assessment of Broadcasting and Communication Equipment," National Radio Research Agency, 2013-13, 2023.
- [14] E. H. Lee, *A comparative Analysis of Risk Perception between Safety Managers and Field Workers in Shipbuilding*

Industry, M. S. thesis, School of Safety Engineering, Pukyong National University, Korea, 2019 (in Korean).

- [15] Korean Law Information Center, “Act on the Consumer Protection in Electronic Commerce, etc,” Republic of Korea, No. 15698, 2018.
- [16] Korean Law Information Center, “Act on Promotion of Information and Communications Network Utilization and Information Protection,” Republic of Korea, No. 18871, 2022.
- [17] Korean Law Information Center, “Act on the Protection and Use of Location Information,” Republic of Korea, No. 18517, 2022.