Journal Article

on

Augmenting Training Pedagogy: Integrating VR, AR, and MR Concepts into Future NBCD Training in the Sri Lanka Navy

By

KHKM Abeysooriya

General Sir John Kotelawala Defence University

(April 2024)

ABSTRACT

This research explores the integration of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) into future Nuclear, Biological, Chemical, and Damage Control, including Fire-Fighting (NBCD) training in the Sri Lanka Navy (SLN). The traditional methods of training, such as lectures and practical exercises, have limitations in preparing individuals for hazardous situations. The integration of VR, AR, and MR offers several benefits, including providing a safe and realistic training environment, allowing for repetitive training, and simulating complex scenarios. Successful implementations of these technologies in military training in other countries serves as evidence of their potential in enhancing training effectiveness. Therefore, it is recommended that the SLN explores the integration of these technologies into its training pedagogy to enhance its capabilities and preparedness for any potential threats.

On the other hand, in several fields, MR, VR, and AR have already been employed as practical training aids. However, a quantifiable and definitive answer to the question of whether these manipulations are useful for training has not been provided. Extended Realities have been contested as training methods, even though they can frequently be time and money saving training procedures. In this endeavour the researcher will examine utilization of VR, AR and MR in different navies, whether the concept could incorporate for the SLN in a cost-effective manner for the NBCD training and what are the existing difficulties may come across whilst addressing for the topic. Secondly, the researcher will refer existing literatures to collect the secondary data where primary data will be explored through a semi-structured questionnaire. Finally, this paper provides an overview of the advantages and constraints of the competing and complementary technologies as well as the diversity of research in the field of VR, AR and MR.

Key Words: VR, AR, MR, Simulator Training, NBCD, Sri Lanka Navy

TERMS AND DEFINITIONS

Virtual Reality (VR) VR is a technology that completely submerges people in a virtual setting. In most cases, a headset is worn, blocking the user's eyes and ears and providing a fully virtual environment in which they can interact. Users can walk around and communicate with one another while remaining disconnected from the outside world. The following figure illustrates the functioning of VR concepts in a more detailed manner:

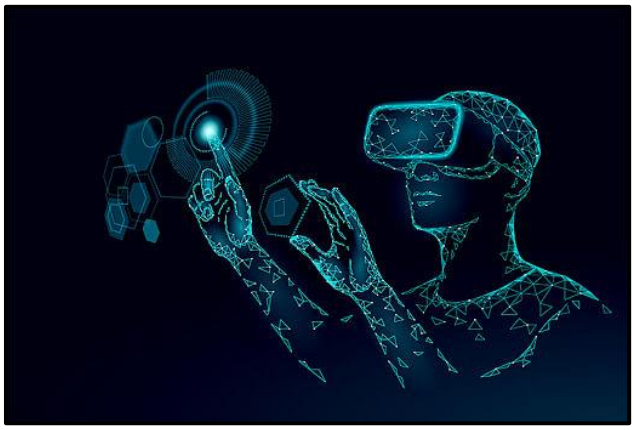

Figure 1: Representation of VR
Source: www.simplilearn.com

Augmented Reality (AR) AR projects digital data over the physical world. It entails using a technology, like an AR headset or a smartphone, to view the real world while incorporating digital aspects into what the user sees, such as images, text, or animations. By incorporating computer-generated components, AR improves perception of the real world. The following figure illustrates the functioning of AR concepts in a more detailed manner:

Figure 2: Representation of AR
Source: www.elearningindustry.com

Mixed Reality (MR) In MR, VR and AR are combined. It combines the virtual and physical worlds and allows digital objects to communicate with the actual world. Unlike AR, where digital parts are only superimposed, MR allows virtual objects to converse with and react to the actual world. When digital and physical aspects are combined, the experience becomes more immersive. The following figure illustrates the functioning of MR concepts in a more detailed manner:

Figure 3: Representation of MR
Source: www.adobe.com

Extended Reality (XR) The idea of VR, AR, and MR can be used as a training tool to improve trainees' practical skills. In addition to these three various simulations are referred to collectively as "Extended Reality" (XR). In other terms, AR, MR, and VR are examples of technologies that fall under the broad category of XR and that modify reality by introducing digital aspects to the physical or real-world environment to whatever degree. The following figure illustrates the functioning of XR concepts in a more detailed manner:

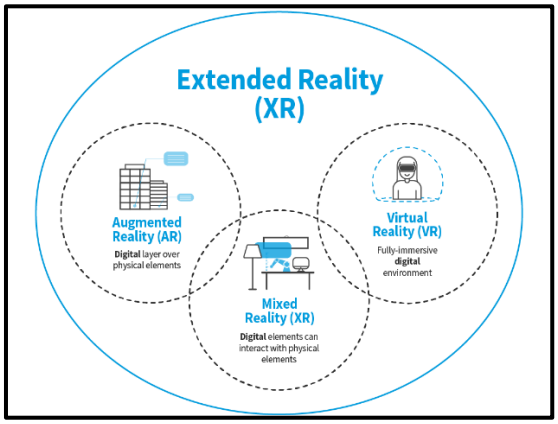

Figure 4: Representation of XR
Source: www.interaction-design.org

INTRODUCTION

In the contemporary world, the practical training is to improve the real-time incident knowledge and boost the decision-making capability of all the tactical and operational level employees when any dire emergency demands. It is fact that, training makes capable and efficient human resource for any organisation. The development of training aids and tools has been made possible by technology advancements in a variety of ways. Training of human resource is a cost-effective factor which will enable any organisation to function smoothly, efficiently and effectively. On the other hand, training of human resources and imparting knowledge-based systems into training aspects have become striking the balance between its return of investment and outcome of training measures in present day context for any organisation.

Given this context, creating training aids for the specialized field of NBCD (Nuclear, Biological, Chemical, and Damage Control, including Fire Fighting) using Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) concepts will need careful selection of simulations for various NBCD scenarios. This concept will be enabling trainers to provide effective and memorable training experience due to being immersive, engaging and simple to understand process. It is notable that, the Sri Lanka Navy (SLN) has been investing significant amount of money in the local and foreign training for the officers and sailors annually. At this point, providing practical training simulators could boost the execution of real-world scenarios and make it feasible to comprehend the potential paths and methods to the best possible resolution. With the support of this endeavour, employees at both the tactical and operational levels will be able to make decisions with the greatest credibility.

On the other hand, the integration of VR, AR and MR into training offers several benefits. Firstly, it provides a safe and controlled environment for trainees to experience hazardous situations without any risk to themselves or others. This is particularly useful for training for nuclear, biological and chemical attacks that involve potentially life-threatening agents. Secondly, it allows for repetitive training without incurring additional costs, as the same scenario can be re-created multiple times. This helps trainees to retain the learning and improve their skills. Thirdly, these technologies can be used to simulate complex and rare scenarios, which may not be possible in real-life training, thus enhancing preparedness for any potential situations.

Considering these aspects, the researcher in a view that SLN also could integrate same concept into NBCD aspect which will be benefitted in the future. A literature search was conducted to locate every peer-reviewed, published article on the topic of training transfer from XR-based instruction. The search terms were combined with a primary keyword (VR, AR, MR, Simulation) explaining numerous XR forms and a secondary group of keywords (Training, Learning) talking about training. Further, the researcher referred Google Scholar to find the data.

The rationale behind this study is to address the limitations of traditional training methods in preparing SLN personnel for hazardous situations. It is fact that, the SLN plays a critical role in safeguarding the nation's maritime interests and protecting its territorial integrity, and as such, it is essential to ensure that they are well-equipped and trained for any potential threats. The integration of VR, AR and MR into training has the potential to enhance the effectiveness and efficiency of training, leading to better preparedness and response in hazardous situations. Hence, exploring and implementing these technologies, the SLN can enhance its capabilities and ensure the safety and security of the nation. This study will also contribute to the existing literature on the use of VR, AR and MR in military training and provide insights and recommendations for the SLN to improve its training pedagogy.

Background of the Study

As the SLN is responsible for safeguarding the nation's maritime interests and protecting its territorial integrity, it is required that the Navy to be prepared for any potential threats, including nuclear, biological and chemical attacks. The Navy personnel also need to be trained in damage control and fire-fighting techniques to mitigate any damages arising from accidents or attacks especially onboard ships and craft.

Further, the traditional training methods used in the SLN include lectures, dry practical, and real practical exercises under limited conditions. While these methods have their advantages, they have limitations in providing an immersive, repetitive and realistic training experience. For example, simulation-based training can be costly and time-consuming to set up, and it may not accurately replicate real-life scenarios. However, lectures may not effectively engage learners and practical exercises may not be feasible for all types of training, such as nuclear, biological or chemical attacks.

Since the simulation-based training has already shown to be beneficial for the military, integrating of these concepts will be a greater advantage in the field of NBCD considering the life cycle cost, return of investment, safety of the employees and skill development of naval personnel in present day context.

Problem Statement

Presently, there is a lack of virtual training simulators integrated for NBCD training in SLN due to lack of awareness and knowledge about the concept. Due to this reason, SLN has been spent huge amount of money for training of personnel annually in locally and abroad. In this back drop, integrating VR, AR and MR technologies into NBCD training will be a feasible and cost-effective solution as a long-term perspective and same could be augment the training efficacy in the field of NBCD.

Research Objectives

The main objective of this research is to study the feasibility of integrating VR, AR and MR concepts into future NBCD training in SLN.

The other objectives of the research are as follows:

a. Evaluate awareness of training by integrating VR, AR and MR concepts.

b. Study the suitability of integrating VR, AR and MR concepts into NBCD training.

c. Determine cost effectiveness of integrating VR, AR and MR concepts into NBCD training.

d. Evaluate user friendliness of integrating VR, AR and MR concepts into NBCD training.

e. Identify integrating VR, AR and MR concepts into NBCD training and ability to enhance risk reduction efforts.

Research Questions

The researcher has formulated following research questions pertaining to research objectives as depicted below:

a. Can we increase the awareness of NBCD training by integrating VR, AR and MR concepts and enhance efficacy of training pedagogy?

b. What would be the suitability of integrating VR, AR and MR concepts into NBCD training?

c. Is it cost-effective way of integrating VR, AR and MR concepts into NBCD training?

d. Can we enhance user-friendliness by integrating VR, AR and MR concepts into NBCD training leading to augmenting the efficacy of training?

e. Does it possible to enhance risk reduction effort by integrating VR, AR and MR concepts into NBCD training?

Scope of the Research

The scope of the study will focus on the SLN and its training methods for NBCD and examine the limitations of traditional training methods and explore how VR, AR and MR technologies can overcome these limitations. Further, it will also study the potential benefits of integrating these technologies into training for hazardous situations and analyse case studies from other countries to understand the successful implementation of VR AR, and MR in military training.

On the other hand, the study will also consider the availability and feasibility of adopting these technologies in the context of the SLN and explore the potential challenges and limitations in the implementation of these technologies in the SLN. The research will also consider the training needs and objectives of the SLN and how the integration of VR, AR and MR can align with them. In particular, the study will focus on the potential cost implications and benefits of incorporating these technologies into training.

Finally, the study will provide recommendations for the integration of VR, AR and MR into training for NBCD field in the SLN and explore potential future developments and advancements in these technologies and their impact on training in the SLN since these concepts are already proven in the present-day context.

LITERATURE REVIEW

In order to accomplish the objectives of this research, it is necessary to get a complete understanding of existing research conducted in the context of relevant field. Hence, this chapter is vital in obtaining more reflective knowledge of the subject and providing the understanding required to build a comprehensive conceptual framework. Further, this chapter reviews the literature theoretically relevant to the study. Theoretically, the literature reviewed by referring to the previous studies relevant to the virtual simulator training.

According to Kaplan et al., (2021), human needs training to acquire the requisite performance skills. The process of learning protocols can be time and money consuming. Therefore, a wide range of people, organizations and industries will find tremendous value in any development in technology or approach that could minimize the cost, either in terms of money or of time. In this backdrop, simulation-based training has shown potential and is becoming more popular to improve training effectiveness. Hence, it is important to consider how the safety of individuals could affect organizational behaviour. As a result, the simulator concept has become a crucial consideration when discussing how to give trainees a feelable practical exposure. Notably, the safety and security of the personnel and equipment in the naval fleet is vital aspect whilst responding against fire, damage or NBC (Nuclear, Biological, Chemical) attack. Further, Kaplan et al., (2021) also in an agreement that by placing participants into simulation rather than in a risky setting at the real situation, XR training can help to reduce some of the hazards associated with high-level of training. Therefore, protecting personnel from NBC hazards, fire, and damage risks is a top responsibility at present. Further it is fact that, effective training could be accomplished by increasing number of practical experiences through virtual simulators avoiding personnel risk.

Feasibility of Incorporate the Concept

The researcher has studied the integration of VR, AR and MR concepts in different navies, which would help to enhance personnel training in effective manner. According to Kim et al., (2017), for the purpose of achieving seamless transitions between the virtual and real worlds, AR has been widely used in the range of sectors. The examples include the military, where augmented reality is used to train soldiers on how to repair or use field equipment. In the game industry, it is expanding outside with AR and other wearable technology to accept real-

world actions. Further, in the medical field, where AR is used to train medical students or assist surgeons on different aspects of practical nature. Hence, it is understood that, the incorporation of the concept is much feasible.

Integration of VR, AR & MR Concepts for Fire Fighting Scenarios

As far as the firefighting scenarios are concerned, the most crucial aspect of the practical training is mastering the methods and skills needed to act in a fire, approach to the fire and finally combat the fire. To achieve those expectations, extensive practical training with a huge amount of material needs to be used and spared for continuous training of personnel. Apparently, same will be a costly endeavour to train huge number of trainees annually. According to Heirman et al., (2020), in order to get personnel ready for a real set up, an XR firefighting simulator can be employed. In this way, personnel are already acquainted with the scenario and are prepared when the practical training starts. Further, another advantage of virtual instruction is that it provides instructors more creative and freedom to present personnel with multiple situations that are more challenging and complex.

Occasionally, they might create simulations that would be difficult or expensive to recreate. In general, to create real time fire onboard ship may be difficult or rather impossible due to certain constraints. In addition, giving actual feeling about the intense of fire for the firefighters cannot be achieved despite fire happens in real. In this way personnel cannot be trained to switch for the real fire situations without having hot fire training. On the other hand, when it comes to real situation, same cannot be predicted which people will get panic with the intensity of the situation and fail to extinguish the fire. However, using XR concept, people who are about to embark onboard can obtain a better understanding of their ship environment by using customized simulators that simulate ship-specific fire scenarios.

On the other hand, actual hot fire trainings may involve financial and environmental issues. Particularly, creating a real hot fire encompasses certain number of materials such as different types of fire extinguishers, fire protective suits, hoses, various types of nozzles, breathing apparatus and mainly combustible materials including huge amount of fuel. In addition, one of the most promising variables that must be controlled in the current situation is environmental pollution. The combustion of gasoline, fuel or propane produces Carbon Dioxide (CO_2) as a byproduct, much of which may be released during actual fire procedures.

Since virtual training sessions do not require the initiation of a fire, an XR simulator can reduce the quantity of pollutants produced every training session. Additionally, it can lower the quantity of materials required to conduct an equivalent number of trainings, lowering the price per training (Heirman et al., 2020). Hence, the researcher has identified the integrating VR, AR and MR concepts into NBCD training would be greatly benefitted for the future applications in terms of financially and environmentally.

Incorporation with NBC Defense Scenarios

In the actual world, setting up the appropriate infrastructure, people and tools for the intended training scenario takes financial value and effort due to resource requirement. Further, it is imperative to prevent environmental contamination due to minor hazardous materials may be utilized during training. Therefore, employing VR suggests a huge potential to reduce expenses and time, train on a wide range of hazardous materials and deliver instruction on a regular basis (Göllner et al., 2019). The Austrian Armed Forces has been used VR based simulator training module with the more emphasis on three types of skill bundles with high degree of training capsule. This includes, NBC defense recce, urban search and rescue and skill for aircraft rescue. Further, they have used NBC defense recce under three major mission tasks such as observation, detection and decontamination. In addition, it has been customized necessary hazardous materials in various physical states, weather conditions of the day, virtual infrastructures, relevant field maps, communication equipment and radio sets for various dismounted operations.

Having such virtual platform, the operators could wear their actual defense protection suits and enter to the relevant contaminated area. At the final outcome they have experienced following benefits (Göllner et al., 2019):

a. The scenario can be utilized for individual user training and education as well as team, group and platoon training.

b. Leaders at all levels can receive decision-making process training as often as needed.

c. On request, the ability to view various regions, seasons and precipitation levels is available. It is also possible to virtually recreate the instruments and tools that are required.

Identify the Gap in the Knowledge

The literature review identified many factors and examples which could be benefitted by integrating VR, AR and MR concepts into training pedagogy of NBCD aspects. However, literature also identified that awareness of technological advancement of those concepts among SLN personnel is minimal. Apart from that, suitability, cost effectiveness, user friendliness and risk reduction effort also found inevitable whilst integrating said concepts. However, there is no any feasibility research has been conducted to evaluate those indicators so far in this field of study. Therefore, the literature review highlighted that there is a research gap in identifying the most significant factors that would be beneficial for SLN as identified in the research objectives.

METHODOLOGY

This research aims to explore the feasibility of integration of VR, AR and MR concepts into future NBCD training in SLN. In order to accomplish the said aim, the research was conducted by implementing a quantitative approach. This chapter describes how this study was designed using a quantitative research approach to satisfy the derived objectives. The chapter further explains how to proceed with data collection methods and tools, development of the questionnaire, data analysis, sampling method and population.

Research Design

According to Saunders, Lewis, and Thornhill (2019), the research has been designed using the Research Onion, as shown in Figure 3.1. Using prior research from many scholars that adhered to the positivism philosophy, the study has been carried out to validate the idea behind it. Additionally, by determining the Independent Variable (IV) and Dependent Variable (DV) a conceptual framework has been created. Consequently, the deductive method has been used. The research has been conducted using the quantitative approach as the research choice. In order to collect primary data, a structured questionnaire has been

distributed online using Google Form as part of the survey technique research approach. The research had a cross-sectional time horizon because the primary data has been acquired throughout a particular period of time.

Formulation of Conceptual Framework

This study suggests a conceptual framework, depicted in Figure 3.2, based on the comprehensive literature evaluation described in Chapter Two of the study.

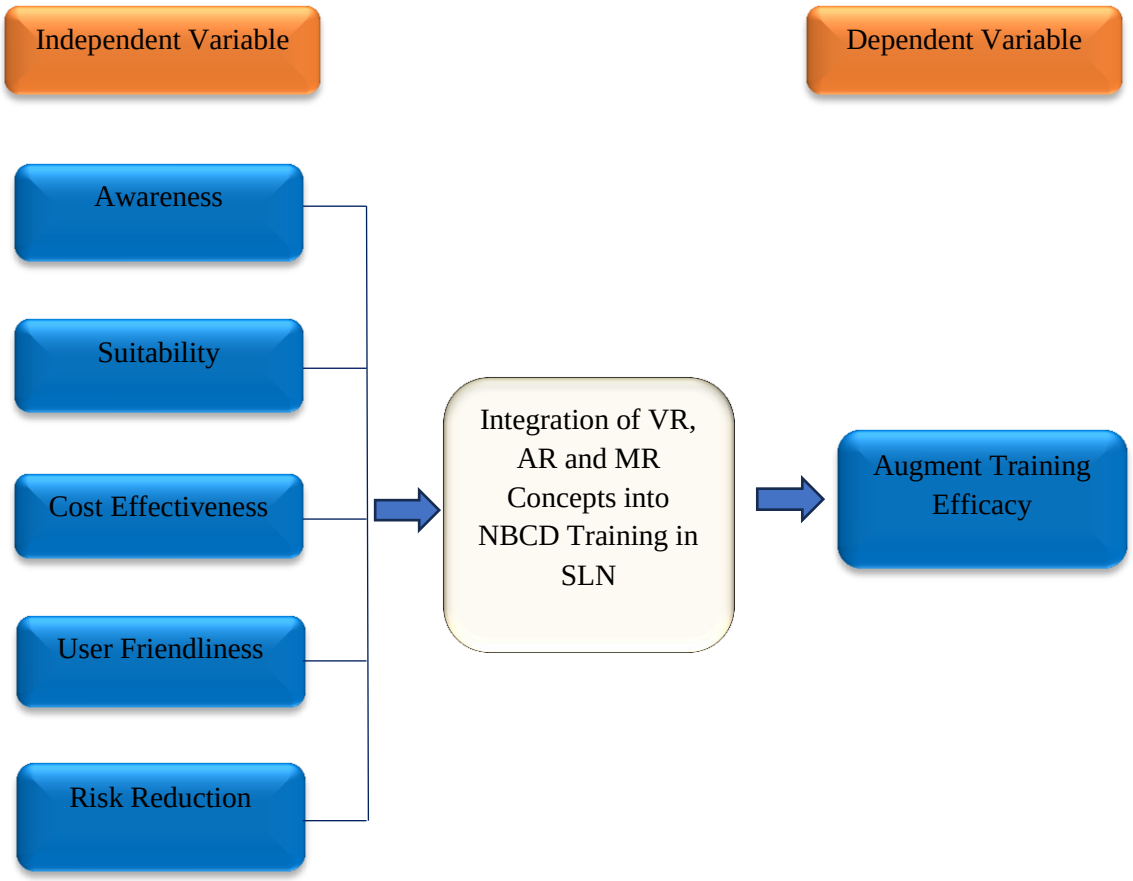

Figure 3.1: Conceptual Framework
Source: Formulated by the Researcher (2024)

The above conceptual framework has been developed to determine the correlation between the IV and DV. In the present research study, the researcher has identified five IVs namely, awareness, suitability, cost-effectiveness, user-friendliness, and risk reduction. In the meantime, the identified DV includes augment training efficacy.

Hypothesis Statement

The following Hypothesis statements have been derived from the above conceptual framework to determine the correlation between the IV and DV.

Table 3.1: Depiction of Research Hypothesis
Source: Formulated by the Researcher (2024)

Sr. No.	Hypothesis	Definition
1.	**H1**	Awareness invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy of training
	H0	Awareness invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training
2.	**H2**	Suitability invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy of training
	H0	Suitability invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training
3.	**H3**	Cost - Effectiveness invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy of training
	H0	Cost - Effectiveness invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training
4.	**H4**	User - Friendliness invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy of training
	H0	User - Friendliness invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training
5.	**H5**	Risk Reduction invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy training
	H0	Risk Reduction invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training

Population

The researcher has been taken population as officers and sailors of the engineering branch of SLN those who have specialized in NBCD background and sample was selected according to purposive sampling method.

Sampling

A hundred (100) participant from both sailors (50 No's) and officers (50 No's) have been selected for the survey those who have undergone the NBCD specialisation in locally at Naval & Maritime Academy (NMA) and INS Shivaji in India. In addition, the sailors who

have done local long NBCD course at NMA has distributed questionnaire of translated in Sinhala medium. According to Campbell et al., (2020), purposive sampling improves the rigour of the study and the reliability of data and outcomes by better matching the sample to the researcher's goals and objectives.

Data Collection Method.

The questionnaire was developed based on the literature review showed at the chapter two of this research. The questions have been asked as formulated in a Likert scale which are intended to explore the objective of the research.

Data Analysis.

The primary data has been analysed using SPSS V 28.0.1 software package and MS Excel. The researcher has been used descriptive statistics and inferential statistical tools to analyse data during the data analysis process. Under the descriptive statistics, standard deviation and variance values were presented. Under the inferential statistical data analysis, validity test, reliability, normality, correlation, and regression analysis has been conducted. Further, the researcher has been analysed significant data through MS Excel sheet by generating pie charts for more elaboration of research objectives.

Ethical Consideration

This study has been implemented all the procedures to encourage moral behaviour in all activities. Above all, the researcher entrusted that there was no bias in the process of choosing participants. In this sense, the outcomes kept both very dependable and unpredictable. In addition, the participants were well-protected. The researcher has been well protected the participants' privacy at every stage of the procedure. The questionnaires were made anonymous, the replies have been kept under confidential, and the research has been conducted solely to accomplish the requirements for the Post Graduate Diploma in Defense Management. Further, all the information has been retained throughout the study and destroyed thereafter.

FINDINGS

The focus of this chapter is to discuss the main findings and present the most important sections of the data analysis which is derived through the analysis and the primary data which have been collected through structured questionnaires and the secondary data collected through the previous research literature, online journal articles and web articles which expressed in the analysis. The main objective of this research is to study the feasibility of integrating VR, AR and MR concepts into future NBCD training in SLN. In order to achieve the desired objective, the collected data were analyzed and represented through statistical tool by generating pie charts and tables. Hence, this chapter will be enabled to give some recommendations while addressing the research objectives.

Analysis of Survey Responses

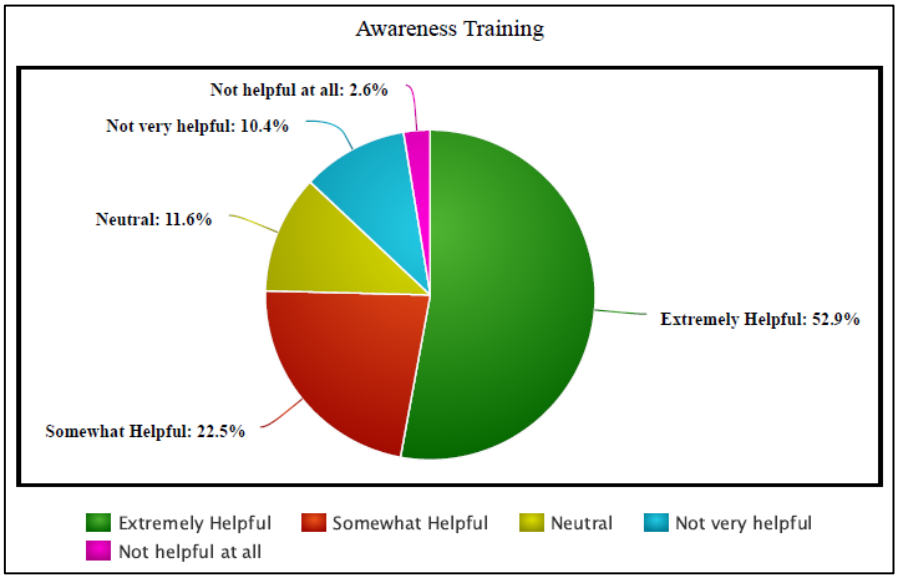

Figure 4.1: Depiction of Enhancing Awareness of Training
Source: Survey Data, (2024)

The above chart depicts that a large percentage of the survey participants [**52.9%**] agree that integrating VR, AR and MR technologies are **Extremely Helpful** in enhancing awareness training for NBCD incidents. In addition, **22.5%** of the survey participants agree that integrating VR, AR and MR technologies are **Somewhat Helpful** in enhancing awareness training for NBCD incidents. On the other hand, the rest of the survey participants have contrasting opinions on the above perspective.

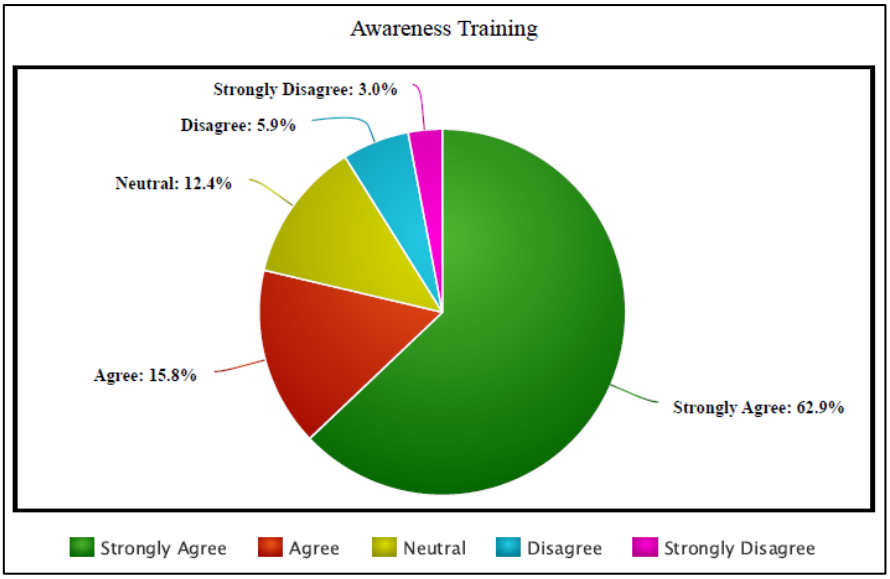

Figure 4.2: Depiction of Enhancing Awareness of Training
Source: Survey Data, (2024)

Furthermore, from the above chart it is evident that a large percentage of the survey participants [**62.9%**] strongly agree with the following statement:

"VR, AR or MR integration in NBCD awareness training could benefit such as enhanced situational awareness, realistic simulations, increased safety, skill acquisition, decision-making abilities and teamwork and cost-effectiveness".

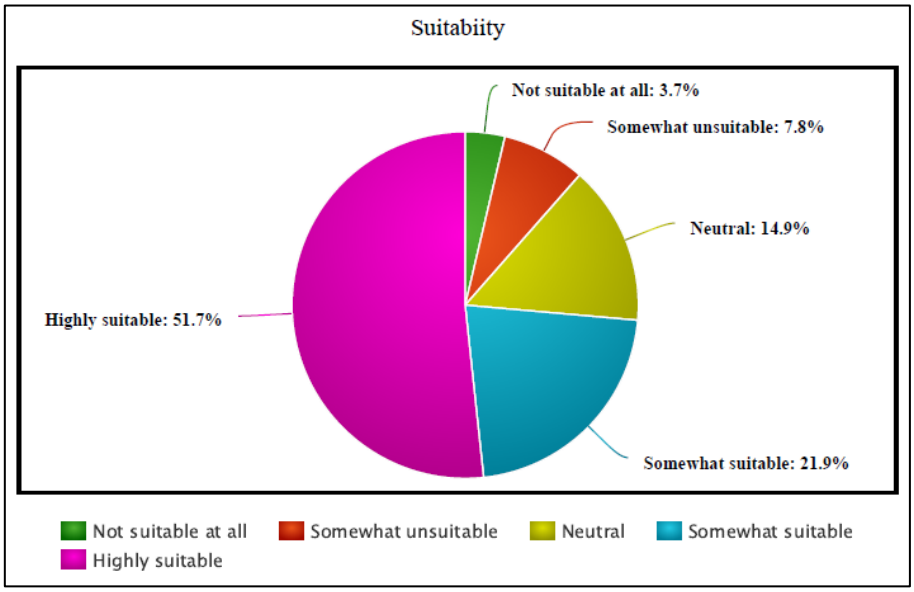

Figure 4.3: Depiction of Suitability of Integrating VR, AR and MR Concepts
Source: Survey Data, (2024)

The above chart depicts that a large percentage of the survey participants [**51.7%**] agree that integrating VR, AR and MR technologies are **Highly Suitable** in enhancing training for NBCD incidents.

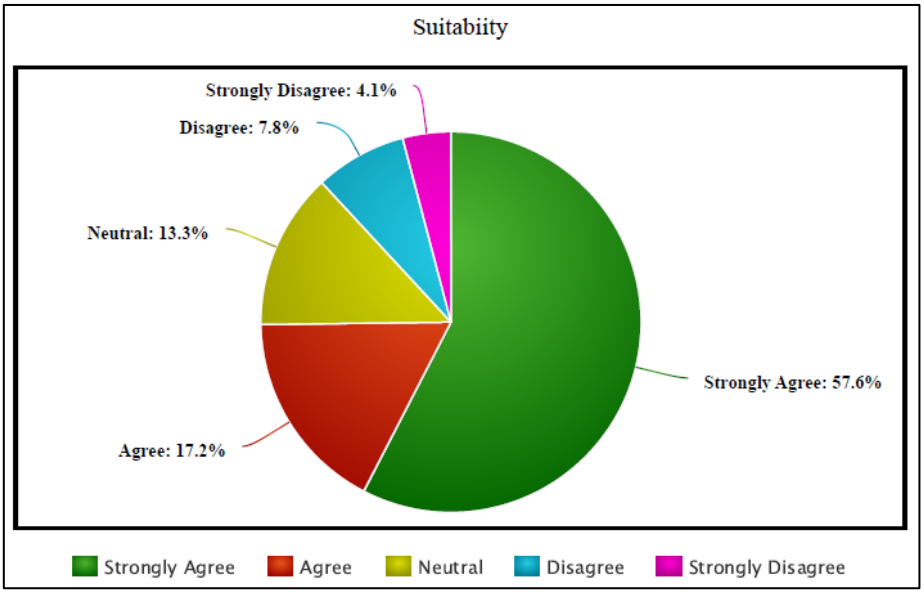

Figure 4.4: Depiction of Suitability of Integrating VR, AR and MR Concepts
Source: Survey Data, (2024)

Furthermore, from the above chart it is evident that a large percentage of the survey participants [**57.6%**] strongly agree with the following statement:

"The use of VR, AR or MR technologies for training purposes in the NBCD context has numerous strengths and limited limitations".

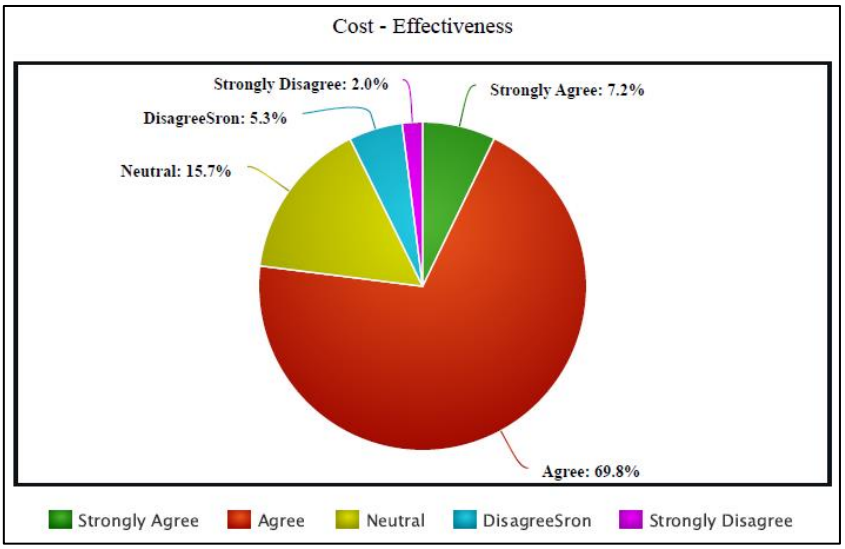

Figure 4.5: Depiction of Cost Effectiveness by Integrating VR, AR and MR
Source: Survey Data, (2024)

The above chart depicts that a large percentage of the survey participants [**69.8%**] agree that integrating VR, AR and MR technologies in enhancing training for NBCD incidents, incurs moderate costs. In contrast, **15.7%** of the survey participants agree that integrating VR, AR and MR technologies in enhancing training for NBCD incidents, incurs significant costs. However, it is imperative that initial cost for simulator would be significantly higher than the expected due to system software cost. On the other hand, the rest of the survey participants have contrasting opinions on the above perspective.

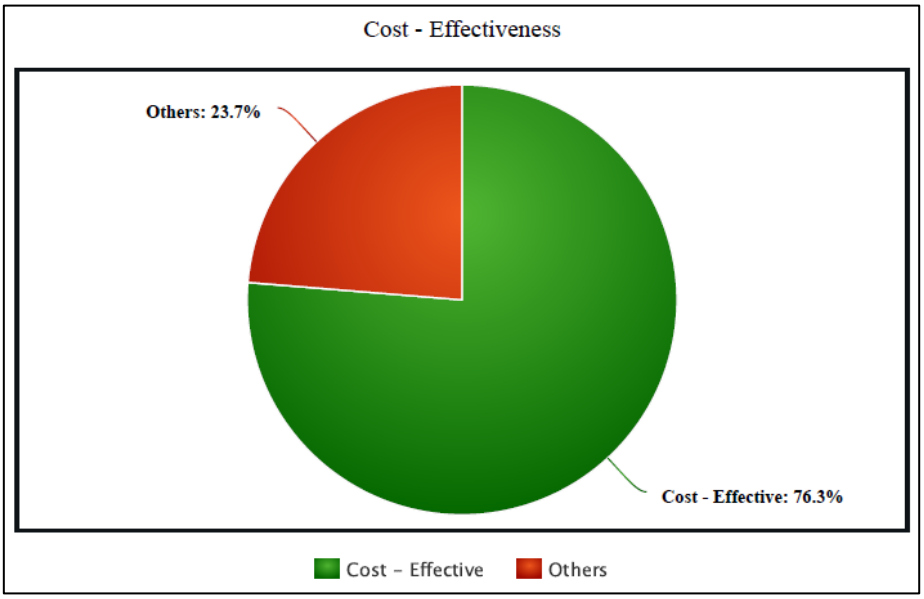

Figure 4.6: Depiction of Cost Effectiveness
Source: Survey Data, (2024)

Furthermore, from the above chart it is evident that **76.3%** of the survey participants agree that the above technologies (VR, AR and MR) have the potential to be cost-effective as a long-term training and can optimize training to some extent.

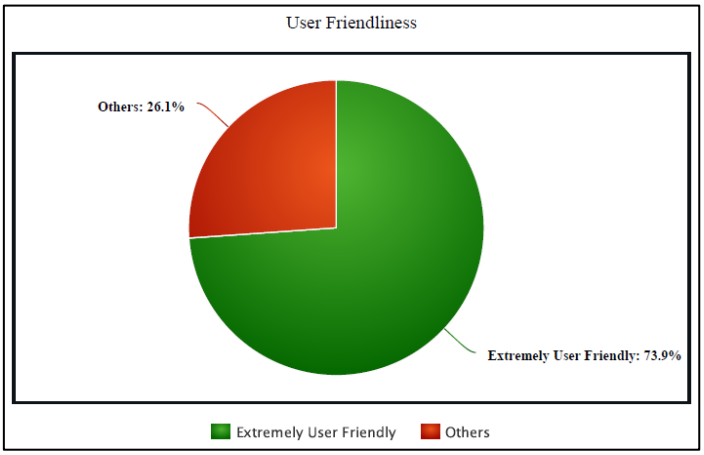

Figure 4.7: Depiction of User Friendliness by Integrating VR, AR and MR
Source: Survey Data, (2024)

The above chart depicts that a large percentage of the survey participants [**73.9%**] agree that integrating VR, AR, and MR technologies in enhancing training for NBCD are extremely user-friendly.

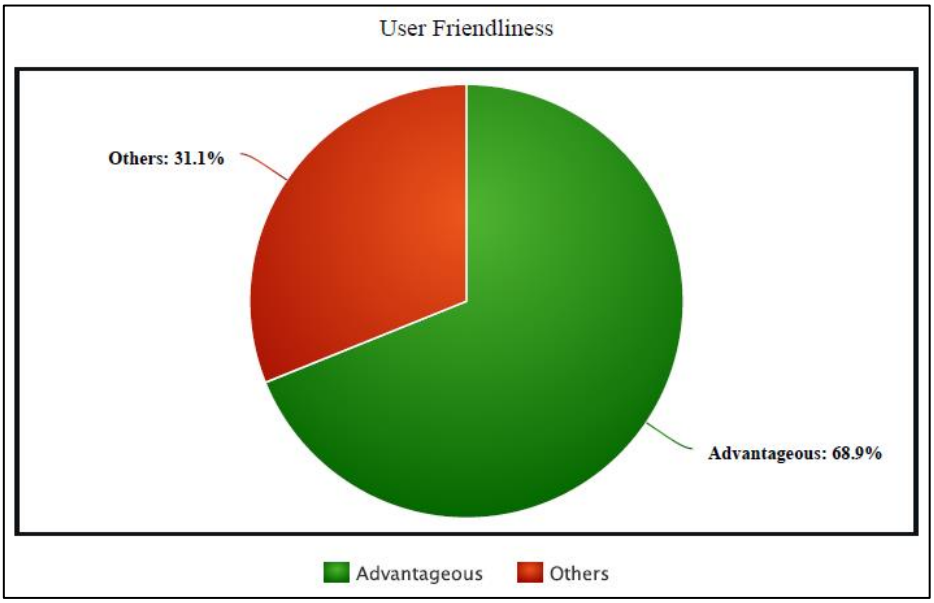

Figure 4.8: Depiction of User-Friendliness
Source: Survey Data, (2024)

Furthermore around **68.9%** of the survey participants indicate that integrating VR, AR, or MR concepts into NBCD training in terms of user-friendliness are advantageous.

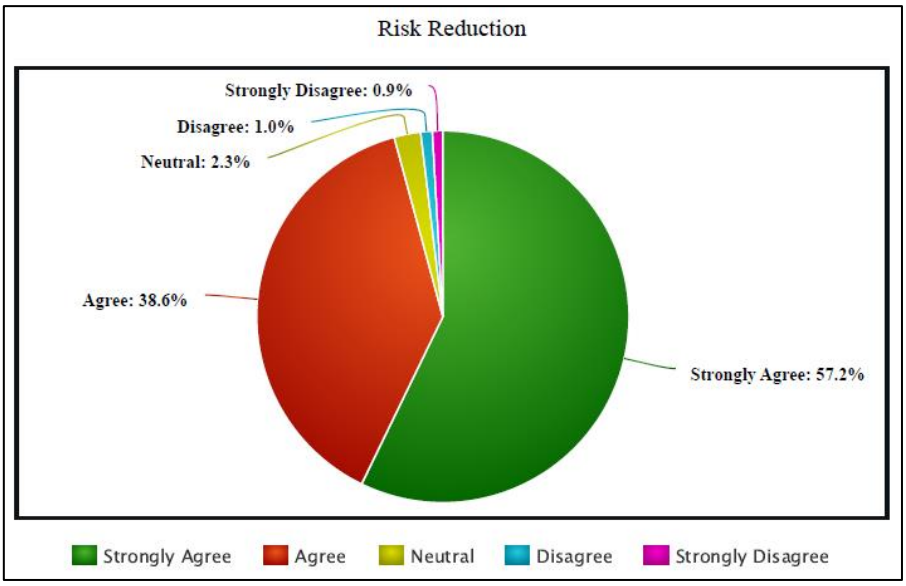

Figure 4.9: Depiction of Risk Reduction by Integrating VR, AR and MR
Source: Survey Data, (2024)

The above chart depicts that a large percentage of the survey participants [**57.2%**] strongly agree that integrating VR, AR and MR technologies in enhancing training for NBCD incidents tend to help mitigating potential risks.

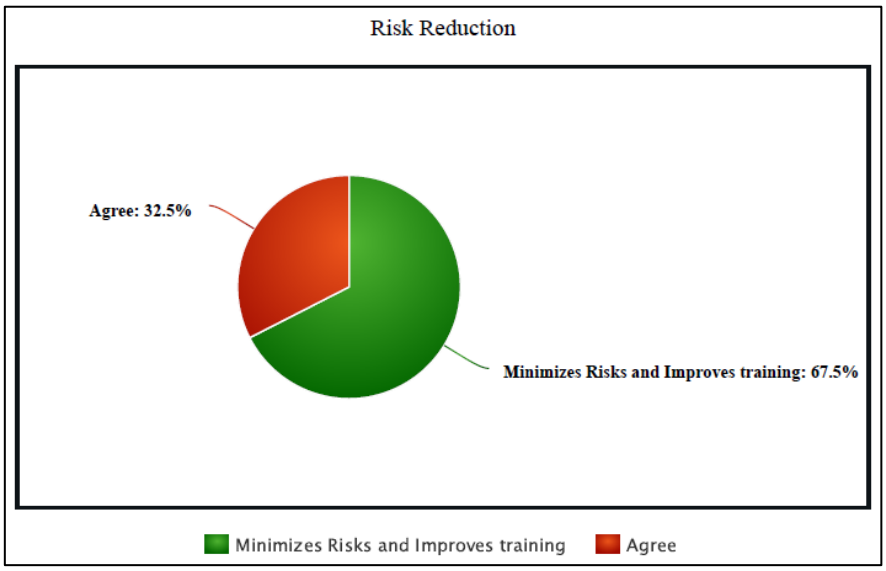

Figure 4.10: Depiction of Risk Reduction
Source: Survey Data, (2024)

Furthermore, from the above chart it is evident that a large percentage of the survey participants [**67.5%**] strongly agree with the following statement:

"The successful implementation and integration of VR, AR and MR technologies into existing NBCD training programs effectively minimizes risks and improves overall training outcomes".

Descriptive Statistics

The descriptive statistics analysis provides key insights on the responses obtained with regards to the IVs, which includes significant features of VR, AR and MR concepts.

Table 4.1: Descriptive Statistics

Variables	N	Min	Max	Mean	Std. Deviation	Variance
Significance of Awareness in Enhancing Efficacy of Augment Training	100	1.75	4.50	3.2703	0.62684	0.393

Significance of Suitability in Enhancing Efficacy of Augment Training	100	1.75	5.00	3.4224	0.51438	0.265
Significance of Cost - Effectiveness in Enhancing Efficacy of Augment Training	100	2.25	5.00	3.7311	0.46829	0.219
Significance of User - Friendliness in Enhancing Efficacy of Augment Training	100	2.25	4.75	3.5206	0.47808	0.229
Significance of Risk Reduction in Enhancing Efficacy of Augment Training	100	2.25	5.00	3.6425	0.45721	0.208

Variables	**Interpretation**
Significance of Awareness in Enhancing Efficacy of Augment Training	The Mean value for the perceptions of respondents on the **Awareness** offered by the Integration of VR, AR and MR concepts into NBCD training in SLN in order to increase the efficacy of augment training, is approximately **3.27**. In addition, the scores range from a minimum value of [**1.75**] to a maximum value of [**4.50**]. The Standard Deviation value is **0.63**, which indicates a ***"moderate level of dispersion"*** in responses. Furthermore, the Variance value is **0.39**, which indicates a moderate level of variability in the opinions of the respondents on the above perspective.
Significance of Suitability	The Mean value for the perceptions of respondents on the **Suitability** of Integrating VR, AR and MR concepts into NBCD

in Enhancing Efficacy of Augment Training	training in SLN in order to increase the efficacy of augment training, is approximately **3.42**. In addition, the scores range from a minimum value of [**1.75**] to a maximum value of [**5.00**]. The Standard Deviation value is **0.51**, which indicates a ***"moderate level of dispersion"*** in responses. Furthermore, the Variance value is **0.26**, which indicates a moderate level of variability in the opinions of the respondents on the above perspective.
Significance of Cost Effectiveness in Enhancing Efficacy of Augment Training	The Mean value for the perceptions of respondents on the **Cost – Effectiveness** features offered by the Integration of VR, AR and MR concepts into NBCD training in SLN in order to increase the efficacy of augment training, is approximately **3.73**. In addition, the scores range from a minimum value of [**2.25**] to a maximum value of [**5.00**]. The Standard Deviation value is **0.47**, which indicates a ***"moderate level of dispersion"*** in responses. Furthermore, the Variance value is **0.22**, which indicates a moderate level of variability in the opinions of the respondents on the above perspective.
Significance of User Friendliness in Enhancing Efficacy of Augment Training	The Mean value for the perceptions of respondents on the **User - Friendliness** features offered by the Integration of VR, AR and MR concepts into NBCD training in SLN in order to increase the efficacy of augment training, is approximately **3.52**. In addition, the scores range from a minimum value of [**2.25**] to a maximum value of [**4.75**]. The Standard Deviation value is **0.48**, which indicates a ***"moderate level of dispersion"*** in responses. Furthermore, the Variance value is **0.23**, which indicates a moderate level of variability in the opinions of the respondents on the above perspective.
Significance of Risk Reduction in Enhancing Efficacy of	The Mean value for the perceptions of respondents on the **Risk Reduction Effort** offered by the Integration of VR, AR and MR concepts into NBCD training in SLN in order to increase the efficacy of augment training, is approximately **3.64**. In addition, the scores range from a minimum value of [**2.25**] to a maximum value

Augment Training	of [**5.00**]. The Standard Deviation value is **0.46**, which indicates a ***"moderate level of dispersion"*** in responses. Furthermore, the Variance value is **0.21**, which indicates a moderate level of variability in the opinions of the respondents on the above perspective.

Source: Extracted from SPSS (2024)

Inferential Analysis

Table 4.2: Validity Testing

Variable	No of Items	KMO	Bartlett's Test		CR	AVE
			Chi Square Value	Sig (p)		
Significance of Awareness in Enhancing Efficacy of Augment Training	2	0.697	7.233	0.000	0.837	0.722
Significance of Suitability in Enhancing Efficacy of Augment Training	2	0.794	45.411	0.000	0.995	0.862
Significance of Cost - Effectiveness in Enhancing Efficacy of Augment Training	2	0.787	43.244	0.000	0.983	0.823
Significance of User - Friendliness in Enhancing Efficacy of Augment Training	2	0.740	18.452	0.000	0.933	0.767

Significance of Risk Reduction in Enhancing Efficacy of Augment Training	2	0.718	12.253	0.000	0.914	0.748

Variables	**Interpretation**
Significance of Awareness in Enhancing Efficacy of Augment Training	The results presented in the above table states that the KMO value being 0.697 denotes that the sample is suitable for Factor Analysis. This is further supported by the values contributed by Bartlett's Test
Significance of Suitability in Enhancing Efficacy of Augment Training	The results presented in the above table states that the KMO value being 0.794 denotes that the sample is suitable for Factor Analysis. This is further supported by the values contributed by Bartlett's Test
Significance of Cost Effectiveness in Enhancing Efficacy of Augment Training	The results presented in the above table states that the KMO value being 0.787 denotes that the sample is suitable for Factor Analysis. This is further supported by the values contributed by Bartlett's Test
Significance of User Friendliness in Enhancing Efficacy of Augment	The results presented in the above table states that the KMO value being 0.740 denotes that the sample is suitable for Factor Analysis. This is further supported by the values contributed by Bartlett's Test

Training	
Significance of Risk Reduction in Enhancing Efficacy of Augment Training	The results presented in the above table states that the KMO value being 0.718 denotes that the sample is suitable for Factor Analysis. This is further supported by the values contributed by Bartlett's Test

Source: Extracted from SPSS (2024)

Reliability Analysis

Cronbach's Alpha has a value which ranges between 0 and 1.

Table 4.3: Reliability Analysis

Variable	**Cronbach's Alpha**	**Number of Items**
Significance of Awareness in Enhancing Efficacy of Augment Training	0.923	2
Significance of Suitability in Enhancing Efficacy of Augment Training	0.737	2
Significance of Cost - Effectiveness in Enhancing Efficacy of Augment Training	0.708	2
Significance of User - Friendliness in Enhancing Efficacy of Augment Training	0.895	2
Significance of Risk Reduction in Enhancing Efficacy of Augment Training	0.757	2

Significance of Awareness, Suitability, Cost – Effectiveness, User – Friendliness, and Risk Reduction in enhancing Efficacy of Augment Training	0.945	2

Variables	**Interpretation**
Significance of Awareness in Enhancing Efficacy of Augment Training	Cronbach's value is **0.923** which indicates high degree of reliability and internal consistency between the Awareness offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.
Significance of Suitability in Enhancing Efficacy of Augment Training	Cronbach's value is **0.737** which indicates moderate degree of reliability and internal consistency between the Suitability of Integrating VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.
Significance of Cost Effectiveness in Enhancing Efficacy of Augment Training	Cronbach's value is **0.708** which indicates moderate degree of reliability and internal consistency between the Cost – Effectiveness feature offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.
Significance of User Friendliness in Enhancing Efficacy of Augment Training	Cronbach's value is **0.895** which indicates high degree of reliability and internal consistency between the User – Friendliness features offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.

Significance of Risk Reduction in Enhancing Efficacy of Augment Training	Cronbach's value is **0.757** which indicates moderate degree of reliability and internal consistency between the Risk Reduction features offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.
Significance of Awareness, Suitability, Cost Effectiveness, User Friendliness, and Risk Reduction in enhancing Efficacy of Augment Training	Cronbach's value is **0.945** which indicates high degree of reliability and internal consistency between Awareness, Suitability, Cost – Effectiveness, User – Friendliness, and Risk Reduction offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.

Source: Extracted from SPSS (2024)

Correlation Analysis

A correlation that is positive between the variables is shown by a positive ρ. Significant correlation between the variables is shown by a p-value of less than 0.05.

Table 4.4: Correlation Analysis

Variable	**ρ**	**p – value**
Significance of Awareness in Enhancing Efficacy of Augment Training	0.511	0.019
Significance of Suitability in Enhancing Efficacy of Augment Training	0.355	0.027
Significance of Cost - Effectiveness in Enhancing Efficacy of	0.308	0.032

Augment Training		
Significance of User - Friendliness in Enhancing Efficacy of Augment Training	0.452	0.021
Significance of Risk Reduction in Enhancing Efficacy of Augment Training	0.322	0.028

Variables	Interpretation
Significance of Awareness in Enhancing Efficacy of Augment Training	**Positive ρ value and [p < 0.05]** Therefore, a strong positive relationship exists between the Awareness offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.
Significance of Suitability in Enhancing Efficacy of Augment Training	**Positive ρ value and [p < 0.05]** Therefore, a strong positive relationship exists between the Suitability of Integrating VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.
Significance of Cost Effectiveness in Enhancing Efficacy of Augment Training	**Positive ρ value and [p < 0.05]** Therefore, a strong positive relationship exists between the Cost – Effectiveness feature offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.
Significance of User Friendliness in Enhancing Efficacy of Augment Training	**Positive ρ value and [p < 0.05]** Therefore, a strong positive relationship exists between the User Friendliness features offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment

	Training.
Significance of Risk Reduction in Enhancing Efficacy of Augment Training	**Positive ρ value and [p < 0.05]** Therefore, a strong positive relationship exists between the Risk Reduction Effort features offered by Integration of VR, AR and MR concepts into NBCD training in SLN and the resulting increased Efficacy of Augment Training.

Source: Extracted from SPSS (2024)

Regression Analysis (Hypothesis Testing)

a. **Hypothesis 1 (H1)**

Data obtained from Regression Analysis offers a comprehensive statistical analysis of the Hypothesis Statement 1, which interprets the correlation between Awareness invoked by Integration of AR, VR, and MR concepts into NBCD Training and Efficacy of Augment Training.

Table 4.5: Model Summary of H1

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.511	0.261	0.260	0.675

Source: Extracted from SPSS (2024)

Model Summary presents an R value of .511, indicating a strong positive relationship between the IV and the DV. R Square value of .261 suggests approximately 26.1% of variance in Efficacy of Augment Training can be explained by Awareness invoked, within this model.

Table 4.6: ANOVA Table 1

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	204.233	1	204.233	3704.376	.000
	Residual	21.064	199	0.105		
	Total	225.297	200			

Source: Extracted from SPSS (2024)

The ANOVA table supports the regression model's validity, with an F statistic of 3704.376, which is highly significant ($p < .001$). This indicates the model is a robust fit for the data.

b. **Hypothesis 2**

Data obtained from Regression Analysis offers a comprehensive statistical analysis of the Hypothesis Statement 2, which interprets the correlation between Suitability invoked by Integration of AR, VR, and MR concepts into NBCD Training and Efficacy of Augment Training.

Table 4.7: Model Summary of H2

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.355	0.126	0.125	0.768

Source: Extracted from SPSS (2024)

Model Summary presents an R value of .355, indicating a strong positive relationship between the IV and the DV. R Square value of .126 suggests approximately 12.6% of variance in Efficacy of Augment Training can be explained by Suitability invoked, within this model.

Table 4.8: ANOVA Table 2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	99.907	1	99.907	304.368	.000
	Residual	125.390	199	0.630		
	Total	225.297	200			

Source: Extracted from SPSS (2024)

The ANOVA table supports the regression model's validity, with an F statistic of 304.368, which is highly significant ($p < .001$). This indicates the model is a robust fit for the data.

c. **Hypothesis 3**

Data obtained from Regression Analysis offers a comprehensive statistical analysis of the Hypothesis Statement 3, which interprets the correlation between Cost-Effectiveness invoked by Integration of AR, VR, and MR concepts into NBCD Training and Efficacy of Augment Training.

Table 4.9: Model Summary of H3

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.308	0.094	0.095	0.835

Source: Extracted from SPSS (2024)

Model Summary presents an R value of .308, indicating a strong positive relationship between the IV and the DV. R Square value of .094 suggests approximately 9.4% of variance in Efficacy of Augment Training can be explained by Cost-Effectiveness invoked, within this model.

Table 4.10: ANOVA Table 3

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	52.633	1	52.633	4.467	.000
	Residual	172.664	199	0.867		
	Total	225.297	200			

Source: Extracted from SPSS (2024)

The ANOVA table supports the regression model's validity, with an F statistic of 4.467, which is highly significant ($p < .001$). This indicates the model is a robust fit for the data.

d. **Hypothesis 4**

Data obtained from Regression Analysis offers a comprehensive statistical analysis of the Hypothesis Statement 4, which interprets the correlation between User-Friendliness invoked by Integration of AR, VR, and MR concepts into NBCD Training and Efficacy of Augment Training.

Table 4.11: Model Summary of H4

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.452	0.204	0.203	0.721

Source: Extracted from SPSS (2024)

Model Summary presents an R value of .452, indicating a strong positive relationship between the IV and the DV. R Square value of .204 suggests approximately 20.4% of variance in Efficacy of Augment Training can be explained by User-Friendliness invoked, within this model.

Table 4.12: ANOVA Table 4

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	129.502	1	129.502	516.414	.000
	Residual	95.795	199	0.481		
	Total	225.297	200			

Source: Extracted from SPSS (2024)

The ANOVA table supports the regression model's validity, with an F statistic of 516.414, which is highly significant ($p < .001$). This indicates the model is a robust fit for the data.

e. **Hypothesis 5**

Data obtained from Regression Analysis offers a comprehensive statistical analysis of the Hypothesis Statement 5, which interprets the correlation between Risk Reduction invoked by Integration of AR, VR, and MR concepts into NBCD Training and Efficacy of Augment Training.

Table 4.13: Model Summary of H5

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.322	0.103	0.104	0.801

Source: Extracted from SPSS (2024)

Model Summary presents an R value of .322, indicating a strong positive relationship between the IV and the DV. R Square value of .103 suggests approximately 10.3% of variance in Efficacy of Augment Training can be explained by Risk Reduction invoked, within this model.

Table 4.14: ANOVA Table 5

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	76.346	1	76.346	51.489	.000
	Residual	148.951	199	0.748		
	Total	225.297	200			

Source: Extracted from SPSS (2024)

The ANOVA table supports the regression model's validity, with an F statistic of 51.489, which is highly significant ($p < .001$). This indicates the model is a robust fit for the data.

Normality Testing.

The study mainly involved testing to identify a relationship between IVs and the DV. Therefore, it relies on the normal distribution of the data. Correspondingly, Figure 4.11 depicts the normality curves.

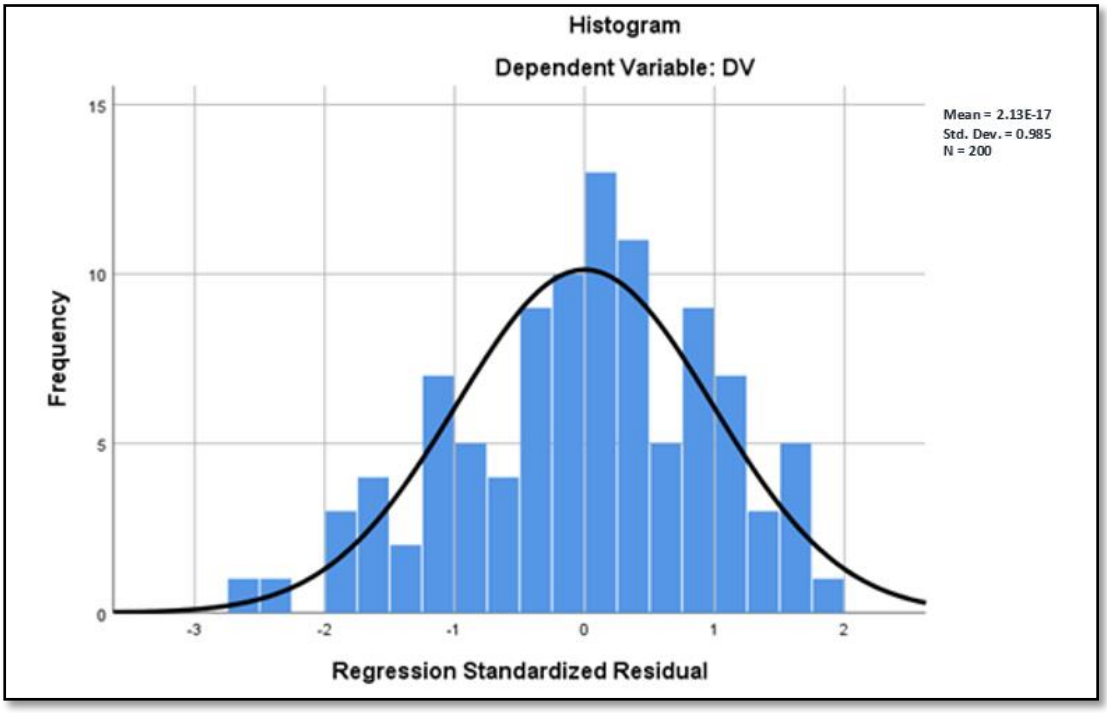

Figure 4.11: Normality Curve
Source: Survey Data (2024)

The data set had a normal distribution, which could be seen from the histogram and the normal curve on the histogram. The researcher then tested the normality of variables using skewness and kurtosis. In general, all variables' coefficients of skewness should be between -1 and +1 to be approximately normally distributed, whereas all variables were within the accepted range of normal distribution.

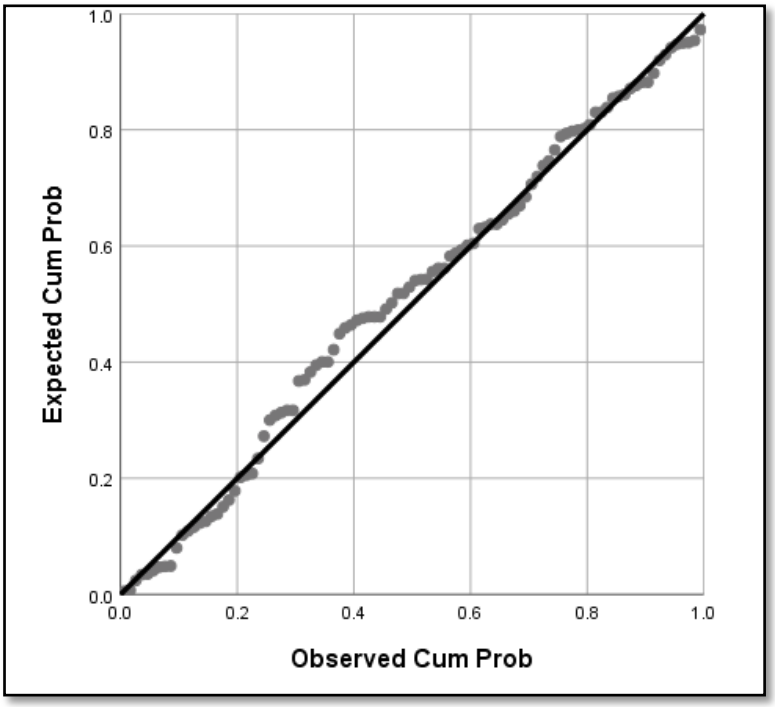

Figure 4.12: Normal P-P Plot of Regression Standardized Residual
Source: Survey Data (2024)

Discussion

In the present research study, the SPSS Data Analysis Software was adopted to analyze the responses obtained from the surveys. Accordingly, the results from the Validity Testing or Inferential Analysis indicated that the variables were highly suitable for the Factor Analysis. Additionally, the results obtained from the Reliability Analysis and Correlation Analysis further indicate a strong, positive, and linear reliability, correlation, and internal consistency, between the identified independent and dependent variables. Hence, all the research hypothesis statement were accepted, and the null hypothesis statements were rejected.

Table 4.15: Summary of Hypothesis Statements

Sr. No.	Hypothesis	Definition
1.	**H1**	Awareness invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy of training - **ACCEPTED**
	H0	Awareness invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training - **REJECTED**
2.	**H2**	Suitability invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy of training - **ACCEPTED**
	H0	Suitability invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training - **REJECTED**
3.	**H3**	Cost - Effectiveness invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy of training - **ACCEPTED**
	H0	Cost - Effectiveness invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training - **REJECTED**
4.	**H4**	User - Friendliness invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy of training - **ACCEPTED**
	H0	User - Friendliness invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training- **REJECTED**
5.	**H5**	Risk Reduction invoked by integrating of VR, AR, and MR concepts into NBCD training enhances efficacy training - **ACCEPTED**
	H0	Risk Reduction invoked by integrating of VR, AR, and MR concepts into NBCD training does not enhance efficacy of training - **REJECTED**

Source: Formulated from SPSS Data (2024)

CONCLUSION AND RECOMMENDATIONS

From the analysis of the survey responses and interviews, it is evident that integrating VR, AR, and MR technologies would be feasible for NBCD training purposes and SLN can witness a wide range of benefits in terms of Awareness of Training, Suitability, Cost Effectiveness, User Friendliness and Risk Reduction. Further, said technologies tend to enhance situational awareness among the trainees, minimize the potential of risks and furthermore improves the overall efficacy and quality of training. More importantly, through the reliability, validity and normality tests, it is evident that all the identified independent

variables tend to significantly influence the dependent variable. Therefore, by integrating VR, AR, and MR technologies enhancing awareness of training on NBCD scenarios for trainees and SLN can witness improved efficacy and quality of training in future.

However, there are substantial limitations/ challenges also could be involved whilst implementing such technological advancement for the SLN in the field of NBCD training which can be elaborated under following sub paragraphs:

a. **Technological Infrastructure**. It is observed that, establishing requisite technological infrastructure in SLN may involve substantial investment and logistical planning.

b. **Training for Trainers**. Instructors will require training to effectively design and implement VR, AR and MR based training modules. Hence, training of trainers is paramount important through expertise collaboration.

c. **Adaptation and Acceptance**. There might be reluctance to change or adhere to such kind of virtual simulation from traditional method among both trainers and trainees, hence it is required to implement change management strategies to overcome such difficulties.

In addition, these concepts can impart several other benefits. The VR in particular, can simulate complex NBCD scenarios with high realism, providing trainees with experiences closely mirroring real-life situations without the associated risks. Further, AR and MR technologies can offer real-time feedback to trainees, facilitating immediate correction and learning during training process. More importantly, the investment in these technologies could lead to significant savings by reducing the dependence on physical assets and resources currently used in NBCD training.

In conclusion, the integration of VR, AR and MR concepts into NBCD training for the SLN holds considerable promise for enhancing the effectiveness and efficiency of training. Particularly, to achieve successful integration requires careful planning, significant investment and commitment to overcome identified challenges. Finally, with the proper implementation of these technologies would significantly contribute to better preparation and resilience of naval personnel for any complex situation evolve in near future.

Recommendations

The NBCD training is crucial for preparing naval personnel to respond effectively to onboard emergencies and different contingencies occurring during peacetime situations. Particularly, the traditional NBCD training methods, while effective to a degree, face limitations such as risk to the trainees, logistical challenges and high cost. Hence, the integration of VR, AR and MR concepts can potentially overcome these limitations by providing realistic, immersive and interactive training environments. Further, integrating immersive technologies into NBCD training could significantly augment the SLN training capabilities, fostering a more prepared, responsive and technologically advanced force. This study embarks on a comprehensive exploration into the integration of these technologies within the SLN NBCD training framework while implementing following recommendations:

a. **Initiate Pilot Program**. Begin with pilot program to assess the viability and effectiveness of integrating VR, AR and MR into NBCD training, allowing for adjustments based on feedback.

b. **Government and Private Partnerships**. Seek partnerships with government agencies, NGOs and private entities for funding support and cost sharing opportunities. This could also include technology grants or in-kind contributions of hardware and software. Further, collaboration with technology experts will help to stay updated on the latest advancements and application on VR, AR and MR technologies.

c. **Partnership with Tech Companies**. Forge partnerships with technology companies specializing in VR, AR and MR to tailor solutions to the specific needs of SLN.

d. **Incremental Integration**. Gradually introduce these technologies into the training curriculum to allow time for adaptation and to manage the transition effectively.

e. **Comprehensive Trainer Training**. Invest in extensive training programs for trainers to ensure they are well-equipped to leverage these technologies effectively.

f. **Evaluation and Adjustment**. Establish robust mechanisms for ongoing evaluation and feedback to continuously refine and enhance the integration of these technologies into NBCD training.

Contribution to Knowledge

This extended essay aimed to analyse the feasibility to integrate VR, AR and MR concepts into NBCD training in future SLN. Accordingly, this argument contributes to the current literature because it emphasizes significant factors such as awareness of training, suitability of concept for present day context, cost effectiveness in terms of return of investment, user friendliness for trainees involved and comparatively higher risk reduction whilst implementing these technologies for future course curriculums. Consequently, the observations made in this study can also contribute to the list of areas where future academic researchers could add their world of knowledge.

Area for Further Research

Since the subject area was still new to Sri Lankan context, the researcher attempted to understand the feasibility of integrating the novel concept for NBCD training. Hence, there are many pathways been unlocked for future researchers in Sri Lanka to conduct research on designing of suitable immersive platform.

References

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., Walker, K., 2020. Purposive sampling: complex or simple? Research case examples. Journal of Research in Nursing 25, 652–661. https://doi.org/10.1177/1744987120927206

Göllner, J., Peer, A., Meurers, C., Wurzer, G., Schönauer, C., Kaufmann, H., Bösch, C., 2019. Virtual reality cbrn defence, in: Meeting Proceedings of the Simulation and Modelling Group Symposium. pp. 1–25.

Hameed, B.M., Somani, S., Keller, E.X., Balamanigandan, R., Mahapatra, S., Pietropaolo, A., Tonyali, Ş., Juliebø-Jones, P., Naik, N., Mishra, D., 2022. Application of virtual reality, augmented reality, and mixed reality in endourology and urolithiasis: an update by YAU Endourology and Urolithiasis Working Group. Frontiers in Surgery 9, 866946.

Heirman, J., Selleri, S., De Vleeschauwer, T., Hamesse, C., Bellemans, M., Schoofs, E., Haelterman, R., 2020. Exploring the possibilities of Extended Reality in the world of firefighting, in: 2020 IEEE International Conference on Artificial Intelligence and Virtual Reality (AIVR). IEEE, pp. 266–273.

Kaplan, A.D., Cruit, J., Endsley, M., Beers, S.M., Sawyer, B.D., Hancock, P.A., 2021. The effects of virtual reality, augmented reality, and mixed reality as training enhancement methods: A meta-analysis. Human factors 63, 706–726.

Kim, S.K., Kang, S.-J., Choi, Y.-J., Choi, M.-H., Hong, M., 2017. Augmented-Reality Survey: from Concept to Application. KSII Transactions on Internet & Information Systems 11.

Bibliography

Bayer, M.M., Rash, C.E., Brindle, J.H., 2009. Introduction to helmet-mounted displays. Helmet-mounted displays: sensation, perception and cognition Issues 47–108.

Călin, R.-A., 2018. Virtual reality, augmented reality and mixed reality-trends in pedagogy. Social Sciences and Education Research Review 5, 169–179.

Kobayashi, L., Zhang, X.C., Collins, S.A., Karim, N., Merck, D.L., 2018. Exploratory application of augmented reality/mixed reality devices for acute care procedure training. Western Journal of Emergency Medicine 19, 158.

Kwon, Y., 2023. Improving Basic Cadet Training for Changing Environment: Case Study at the Korea Air Force Academy.

Lenuik, T.A., Velazquez, L.E., Murley, S.R., Greiner, N., Willis, R., Quantico, V.A., Dubuque, I.A., Charleston, S.C., 2015. Mixed reality: the new reality in DoD decision making. MODSIM word.

Lungu, A.J., Swinkels, W., Claesen, L., Tu, P., Egger, J., Chen, X., 2021. A review on the applications of virtual reality, augmented reality and mixed reality in surgical simulation: an extension to different kinds of surgery. Expert review of medical devices 18, 47–62.

Morimoto, T., Kobayashi, T., Hirata, H., Otani, K., Sugimoto, M., Tsukamoto, M., Yoshihara, T., Ueno, M., Mawatari, M., 2022. XR (extended reality: virtual reality, augmented reality, mixed reality) technology in spine medicine: status quo and quo vadis. Journal of Clinical Medicine 11, 470.

Regal, G., Pretolesi, D., Schrom-Feiertag, H., Puthenkalam, J., Migliorini, M., De Maio, E., Scarrone, F., Nadalin, M., Guarneri, M., Xerri, G.P., 2023. Challenges in Virtual Reality Training for CBRN Events. Multimodal Technologies and Interaction 7, 88.

Quint, F., Sebastian, K., Gorecky, D., 2015. A mixed-reality learning environment. Procedia Computer Science 75, 43–48.

Rauschnabel, P.A., Babin, B.J., tom Dieck, M.C., Krey, N., Jung, T., 2022. What is augmented reality marketing? Its definition, complexity, and future. Journal of business research.

Volkow, S.W., Howland, A.C., 2018. The case for mixed reality to improve performance. Performance Improvement 57, 29–37.