"COMBAT CADENCE: THE ULTIMATE MILITARY TRAINING EXPERIENCE"

PARTHIBANRAJ A/L NAGARAJAH

BACHELOR'S DEGREE IN INFORMATION AND TECHNOLOGY (GAME TECHNOLOGY) WITH HONS.

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Faculty of Information, Communications And Technology

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PARTHIBANRAJ A/L NAGARAJAH

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2024

DECLARATION

I declare that this thesis entitled "COMBAT CADENCE: THE ULTIMATE MILITARY TRAINING EXPERIENCE" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : *RAJ*
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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of BACHELOR'S DEGREE IN INFORMATION AND TECHNOLOGY (GAME TECHNOLOGY) WITH HONS.

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ABSTRACT

This research investigates the integration of immersive and interactive learning experiences in military education, specifically focusing on enhancing weapon handling training. Traditional methods such as lectures and simulations often struggle to engage today's digital-native cadets and adequately prepare them for the complexities of modern combat scenarios. The study aims to evaluate the effectiveness of game-based learning approaches, utilizing Unreal Engine 5.0, to bridge the gap between theoretical knowledge and practical application in military training. The primary objective is to assess how immersive and interactive learning experiences can enhance the training outcomes for military students, particularly in weapon handling proficiency. To achieve this, the research will conduct a comprehensive review of existing literature and practices related to game-based learning in military contexts, specifically examining its application to weapon training. Additionally, the study will develop and implement educational modules within a gaming environment to educate military students on various types of weaponry, including pistols, shotguns, sniper rifles, and assault rifles, tailored for different combat scenarios. The effectiveness of the developed game will be evaluated through qualitative assessments of combat skills, tactical decision-making abilities, and overall readiness, supplemented by quantitative analyses to measure specific improvements. By advancing military education methodologies with these objectives, the research aims to better equip cadets with the skills and knowledge necessary for effective performance in contemporary warfare environments.

ABSTRAK

Penyelidikan ini menyiasat integrasi pengalaman pembelajaran yang mendalam dan interaktif dalam pendidikan ketenteraan, khususnya menumpukan pada meningkatkan latihan pengendalian senjata. Kaedah tradisional seperti kuliah dan simulasi sering bergelut untuk melibatkan kadet asli digital masa kini dan menyediakan mereka dengan secukupnya untuk menghadapi kerumitan senario pertempuran moden. Kajian ini bertujuan untuk menilai keberkesanan pendekatan pembelajaran berasaskan permainan, menggunakan Unreal Engine 5.0, untuk merapatkan jurang antara pengetahuan teori dan aplikasi praktikal dalam latihan ketenteraan. Objektif utama adalah untuk menilai bagaimana pengalaman pembelajaran yang mendalam dan interaktif boleh meningkatkan hasil latihan untuk pelajar tentera, terutamanya dalam kecekapan pengendalian senjata. Untuk mencapai matlamat ini, penyelidikan akan menjalankan semakan komprehensif kesusasteraan dan amalan sedia ada yang berkaitan dengan pembelajaran berasaskan permainan dalam konteks ketenteraan, khususnya mengkaji aplikasinya untuk latihan senjata. Selain itu, kajian itu akan membangunkan dan melaksanakan modul pendidikan dalam persekitaran permainan untuk mendidik pelajar tentera tentang pelbagai jenis persenjataan, termasuk pistol, senapang patah, senapang penembak tepat dan senapang serangan, disesuaikan untuk senario pertempuran yang berbeza. Keberkesanan permainan yang dibangunkan akan dinilai melalui penilaian kualitatif kemahiran tempur, kebolehan membuat keputusan taktikal, dan kesediaan keseluruhan, ditambah dengan analisis kuantitatif untuk mengukur peningkatan tertentu. Dengan memajukan metodologi pendidikan ketenteraan dengan objektif ini, penyelidikan bertujuan untuk melengkapkan kadet dengan lebih baik dengan kemahiran dan pengetahuan yang diperlukan untuk prestasi yang berkesan dalam persekitaran peperangan kontemporari.

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Next, my appreciation and gratitude to parents for their continuous support, strength and prayers. Thank You.

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LIST OF ABBREVIATIONS

$UTeM$	-	Universiti Teknikal Malaysia Melaka
UPNM	-	Universiti Pertahanan Nasional Malaysia

LIST OF SYMBOLS

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CHAPTER 1

INTRODUCTION

1.1 Problem Background

Military education is a fluid environment where technology, strategy, and tactics change and evolve continuously to meet the needs of a world in constant flux. Since early years, in the world of military training, the strategies which emphasized instructor-based training styles followed by numerous exercises, drills, and simulations to impart the required information and skills are commonly known as traditional teaching methods (RAND Research,2023).

While these traditional methods have their rigourousness, the fact remains that there are still questions about how to effectively cultivate cadets in a manner that allow them to handle the modern battlefield. Though traditional means have been found useful, they often do nothing to engage or generate the interest and creativity of today's digital native cadets. That non owner may become one that is bored and unengaged, and unable to use their memory recall, effecting overall an untrained force (Johnson, 2022).

Military education is seen to have reached the end of the road and there is a clamor for alternatives that exploit technology to deliver more bang for the buck in terms of learning outcomes. One effective strategy for capturing the imagination, and providing the

practice necessary to develop expertise and mastery, comes in the form of game-based learning - the use of immersive, interactive video games to create dynamic and engaging learning environments.

Key recent studies show discovery benefits to learning in the military - how games can provide higher levels of learning through simulated combat exposure, and contribute to better critical thinking, decision-making and collaboration among cadets. This provides cadets an outstanding opportunity to apply such theory to a practical world setting by blending educational content with game mechanisms, collapsing the divide between classroom knowledge and practical use (Smith, 2023).

1.2 Problem Statement

This is hard to do through lessons learned in traditional military education schools that have struggled to reach cadets or prepare them to meet the demands of modern conflict. In general, these methods such as lectures, exercises, and simulations, remain in traditional forms of learning, and are outdated for today's generation of tech-savvy cadets. As a result, a clear gap exists between the theoretical knowledge that is taught in the classrooms and the practical skills that are required in real time combat. Thus, there is a critical requirement for creative solutions to address this problem and herald in a new era of immersive and experiential learning opportunities (Army University Press,2017).

Though many have endured the standard package of lectures, and drills or simulations that characterize traditional military education experience, these methods rarely capture our attention, or reflect the skills necessary for modern conflict. This difference between teaching approaches, and cadet learning styles (which are primarily digital natives), necessitates innovative solutions. The application of gaming technology to military education can lead to dynamic and interactive learning environments aligned with the tenets of contemporary military training (NDU Press,2016).

The way educate the cadets now has failed in substantially readying those young officers to with their junior enlistedmen and NCOs wage land combat in the era in which they live. Traditional teaching methods rely on lectures and simulations that fail to connect meaningfully with the digital natives that are cadets consequently, the retention and transfer of critical skills suffers. Technology-based learning solutions are a source of immersion that are increasingly required to fill the need. Using the virtual technology of gaming for Reform

in Military Education provides Cadets with the preparation for the unpredictable global-warfare environment of the 21st century (NDU Press,2016).

1.3 Research Aim

This research aims to evaluate the effectiveness of immersive and interactive learning experiences in military training by focusing on weapon handling.

1.4 Project Objectives

The main goal of this research is to evaluate the effectiveness of immersive and interactive learning experiences in military training, specifically focusing on weapon handling. To achieve this goal, the following objectives must be completed:

i. To study immersive and interactive learning experiences focusing on weaponry for military students.

ii. To develop and conduct accuracy testing for various weapons to users about their functionalities and effectiveness.

iii. To evaluate the game's effectiveness in preparing students for weapon handling in real-life simulation scenario.

1.5 Project Scopes

Below are the key project scopes that outline the primary audience, platform, weaponry focus, genre, theme, and hardware requirements for this ambitious project.

i. Target Audience

Military Students: The primary users are cadets and trainees from various military branches. The game is designed to enhance their combat skills and tactical knowledge through immersive, realistic training scenarios.

ii. Platform

Unreal Engine 5.0: The game will be developed using Unreal Engine 5.0, leveraging its advanced graphics, physics, and real-time rendering capabilities to create a highly realistic and engaging training environment.

iii. Focused Weapons

Pistol (Deagle): Quick handling, suitable for short-range engagements. Shotgun (Mossberg flex 500): High impact, ideal for close-quarters combat. Sniper Rifle (M98): Precision weapon for long-range targets.

Assault Rifle (HK 416): Versatile, effective for medium-range combat.

iv. Genre

Simulation and First Person Shooter: The game combines elements of both simulation and action genres. It aims to provide realistic training experiences while maintaining engaging and dynamic gameplay.

v. **Theme**

Military Training: The central theme revolves around military training, focusing on developing practical combat skills and tactical proficiency. The game will include various scenarios that replicate real-world military operations and environments.

vi. **Hardware Requirements**

Windows Platform: The game will be optimized to run on Windows operating systems.

Single Player Only: The focus is on single-player gameplay, allowing for a more personalized training experience.

No Multiplayer: The game will not feature multiplayer modes, maintaining a concentrated focus on individual skill development.

No Cross-Platform Support: Cross-platform compatibility will not be implemented, ensuring a streamlined development process and optimized performance on Windows-based hardware configurations.

1.6 Report Organization

This thesis is divided into six chapters, which are ordered as follows:

Chapter 1 elaborated the introduction of the research project, which covered the problem background, problem statement, research aim, objectives of the research, research scopes and the significance of the research.

Chapter 2 discussed the literature review of the research, which included the analysis of the past research on weapon and First-Person Shooter games.

Chapter 3 explained the research methodology of the research. This chapter presented the research methodology framework that consists of several vital phases which acted as the research guideline to sort the implementation process to achieve the research aim and objectives.

Chapter 4 presented the implementation and details of each approach are explained succinctly, together with its pseudo code and flowchart.

Chapter 5 displayed the results of the evaluation that had been done to evaluate the performance of the results. There are two types of evaluation, which are qualitative analysis and quantitative analysis.

Chapter 6 discusses the contributions of the research and the limitations of current research progress. In addition, future work is proposed to address these limitations.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents an analysis of the literature review regarding weapons used in the military. The chapter begins with an overview of the various weapons employed in military contexts. Following this, it focuses on selected weapons, examining their recoil and firing patterns in detail. A comparison between different weapons is then conducted to highlight their unique characteristics and effectiveness. The chapter continues by exploring different types of games, including first-person shooters (FPS), third-person shooters (TPS), and virtual reality (VR) games, emphasizing the implementation of these weapons within each genre. Additionally, it discusses FPS games that incorporate the same weapons as those covered in this review, offering comparative insights between these games. Finally, the chapter concludes with a summary of the key findings from the literature review.

2.2 Weapon used in military

Military forces utilize a diverse range of weapons to address various combat scenarios, each designed to maximize effectiveness in different operational contexts. These weapons can be broadly categorized into Small Arm and light weight weapons, Heavy Weapons, Missiles, and Naval Weapons. Each category serves a distinct role in achieving strategic and tactical objectives, ensuring that military units can effectively engage and neutralize threats across land, air, and sea.

2.2.1. Small Arm and Light Weight

Small arms and light weapons (SALW) has shown in figure 2.1 are the two primary categories of portable weapons. Small arms generally refer to handguns and firearms that are compact and can be operated by a single person. This category includes handguns, muskets, shotguns, rifles, submachine guns, personal defense weapons, squad automatic weapons, and light machine guns (United Nations Office for Disarmament Affairs, 2015).

On the other hand, light weapons are crew-served firearms, incendiary devices, or explosive ordnance that require a team to operate effectively. Examples of light weapons include man-portable anti-tank missiles, man-portable air-defense systems (MANPADS), anti-materiel rifles, anti-tank rifles, general-purpose machine guns, medium machine guns, unmounted heavy machine guns, portable flamethrowers, grenades, rifle grenades, underslung grenade launchers, automatic grenade launchers, recoilless rifles, rocket- propelled grenades (RPGs), and mortars under 100 millimeters in caliber (United Nations

Office for Disarmament Affairs, 2015).

These distinctions are crucial in military and security contexts, where understanding the capabilities and classifications of SALW helps in strategic planning, arms control initiatives, and operational deployment. The United Nations Office for Disarmament Affairs provides comprehensive categorizations and guidelines that inform international efforts to regulate and manage the proliferation and use of small arms and light weapons globally (United Nations Office for Disarmament Affairs, 2015). This framework ensures that these weapons are used responsibly and effectively in accordance with international humanitarian law and security protocols.

Figure 2.1 shows the image of SALW (United Nations Office for Disarmament Affairs (UNODA),2015)

2.2.2 Heavy Weapon

Large-caliber explosive weapons, known as "heavy weapons," possess significant destructive potential, making them particularly hazardous in densely populated areas. These weapons are integral to infantry weapons companies, supporting rifle companies with long-range and close-quarters firepower. Examples include the TOW ITAS, MK-19 40mm Grenade Machine Gun, M2 .50 caliber Machine Gun as shown in figure 2.2, and Javelin Close Combat Missile System, enabling mission-specific customization crucial for maintaining stability, civil support operations, and countering enemy attacks (U.S. Army, 2024).

Figure 2.2 shows the image of Machine Gun(U.S. Army, n.d)

The U.S. Army is actively modernizing to enhance its operational capabilities across multiple domains and leverage technological advantages against adversaries. The modernization efforts encompass a wide array of weapon systems and equipment programs, from tanks and artillery to aviation and missile systems, emphasizing timely equipment delivery through collaboration with industrial partners (U.S. Army, 2023). Coordination efforts are facilitated by the U.S. Army Futures Command and its Cross-Functional Teams, aiming to sustain superiority in heavy weapons and equipment through continuous enterprise-wide cooperation.

Despite their firepower and adaptability, heavy weapons companies within infantry battalions often find themselves underutilized, relegated to static security missions. These units are uniquely structured with an "arms-room concept," a high leader-to-trooper ratio, and operational independence, enabling them to deploy various weapon systems such as the M2, M240B, MK19, and ITAS (U.S. Army, 2023). Effective utilization of these companies enhances combined arms operations, providing commanders with flexible tactical options and enhancing overall battlefield adaptability. However, their complex operational requirements demand proficiency in mounted, dismounted, and individual skills across organizational levels.

2.2.3 Missiles

Missiles as shown in figure 2.3 are rocket-powered weapon systems that are used to deliver high explosive warheads with precise accuracy and at great speeds that makes them important in the current tactically plans of attack. The technology of the rocket system started from Chinese rocket missiles in 1232 A. D. However, over the centuries' important advancements were done as German V-2 during the Second World War (Encyclopedia Britannica, 1987). These improvements resulted in the establishment of different guidance systems such as the beam-riding, pre-set, command, and homing technologicalities, which improved the abilities and effectiveness of missiles.

In the case of weapons, other than guns, one can distinguish between tactical and strategic missiles. Tactical missile are faster than the strategic one, and go at twice the speed of sound and are used in the direct theatre of battle while the strategic missiles include the ballistic missiles and cruise missiles are aimed at different war zones farther away from the conflict region (GlobalSecurity. org, 1999). These missiles employ few significant parts like the sensors, control systems for the alteration of the path of the missile, and real time updated operating data to make sure that these missiles cover precise range.

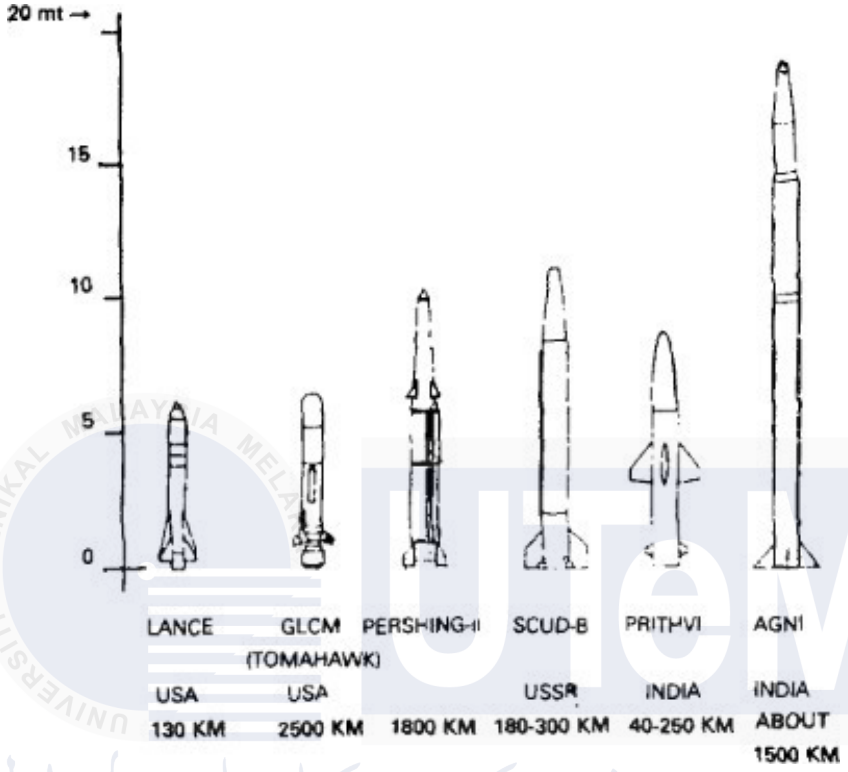


Figure 2.3 shows the image of missiles (Smith, 1979)

Modern missile systems are not only equipped with traditional gunpowder but can also be fitted with chemical, biological, or even nuclear warheads, further increasing the range of applications and power of such weapons (n. d. as cited in GlobalSecurity. org). Since Lisbon summit in 2010, NATO has pursued salient activities towards the development of ballistic missile defence (BMD) and in 2012 it announced an Interim Capability (NATO, 2012). This defensive endeavour involves threat identification, monitoring, reporting and intercepting, besides deciding on the consequences in case of an attempted missile attack on European Allies. Current member nations have not only been supplying information and seeking to contribute technologically but also, financially; the US, Turkey, Romania, Germany, Poland, Spain, the Netherlands, Denmark and the UK augment NATO's BMD by

offering a variety of radars, interceptors and command centres (NATO, 2012)

2.2.4 Naval Weapon

Naval weapon systems are integral to a nation's maritime strategy, serving purposes ranging from defence and deterrence to offensive operations and sovereignty enforcement. These systems encompass torpedoes, guns, missiles, and specialized weapons, such as the 5-inch/62 cannons on cruisers and destroyers and the 20-mm/76 Phalanx Close-In Weapon System (CIWS) (Naval Technology, 2023). Key examples include the Mk 14 and Mk 15 torpedoes, the RGM-84 Harpoon Naval Strike Missile, and the BGM-109 Tomahawk Cruise Missile, which collectively contribute to naval firepower capabilities (Naval Technology, 2023).

`` Figure 2.4 shows the image of missiles (N.R.P, 2016)

Automated centralized command-and-control (C2) systems like the AEGIS Weapon

System streamline weapon deployment processes, enhancing efficiency from target recognition to elimination (Raytheon, 2022). Naval guns, positioned prominently on various naval vessels like cruisers, destroyers, and frigates, offer cost-effective versatility and adaptability in naval operations (GlobalSecurity.org, 2021). Meanwhile, advanced missile systems such as the Harpoon and Tomahawk missiles provide crucial offensive capabilities, essential for engaging targets at extended ranges (GlobalSecurity.org, 2021).

Technological advancements, including the development of directed energy weapons like the US Navy's High Energy Laser and Integrated Optical dazzler with Surveillance (HELIOS) system, exemplify efforts to innovate naval warfare capabilities (U.S. Navy, 2021). These advancements underscore the ongoing evolution of naval weaponry to meet contemporary operational demands, ensuring nations can effectively maintain maritime dominance, deter adversaries, and safeguard national interests.

2.3 Assault Rifles

Lightweight, self-loading assault rifles as shown in figure 2.5 chambered in intermediate-caliber rounds like 5.56 × 45 mm or 7.62 × 39 mm have become ubiquitous in modern military and police forces, offering versatility in engaging targets up to 400 meters. Developed in response to the close combat needs of World War II, assault rifles combine automatic fire capability for assaults with precise single-shot accuracy when required (Encyclopedia Britannica, 2017). Since their introduction in the 1950s, assault rifles have remained the cornerstone of infantry weapons worldwide, with extensive global production by numerous manufacturers making exact production estimates challenging. Variants of the

AK-47 alone are estimated to number over 100 million, produced across more than 13 countries, with adaptations like the Israeli Galil and Finnish Valmet expanding the platform's versatility (Encyclopedia Britannica, 2017).

Figure 2.5 shows the image of assault rifle (Encyclopedia Britannica, 2024)

Common calibers include the NATO-standard 5.56 × 45 mm and Warsaw Pact cartridges like the 5.45 × 39 mm and 7.62 × 39 mm. Innovations like caseless ammunition and the Chinese 5.8 × 42 mm seek to enhance penetration and performance against body armor, yet widespread adoption is hindered by the entrenched use of existing ammunition types and interoperability concerns among allies (Encyclopedia Britannica, 2017). Despite technological advancements, the fundamental design of assault rifles has seen minimal evolution over the past half-century. The enduring M16 series and Kalashnikov-pattern rifles like the AK-74 exemplify this continuity, benefiting from periodic updates rather than wholesale redesigns (Encyclopedia Britannica, 2017). Many militaries opt for enhancing

existing rifles with aftermarket components such as optics and ergonomic upgrades, preserving the simplicity and reliability of proven designs adapted to modern combat environments.

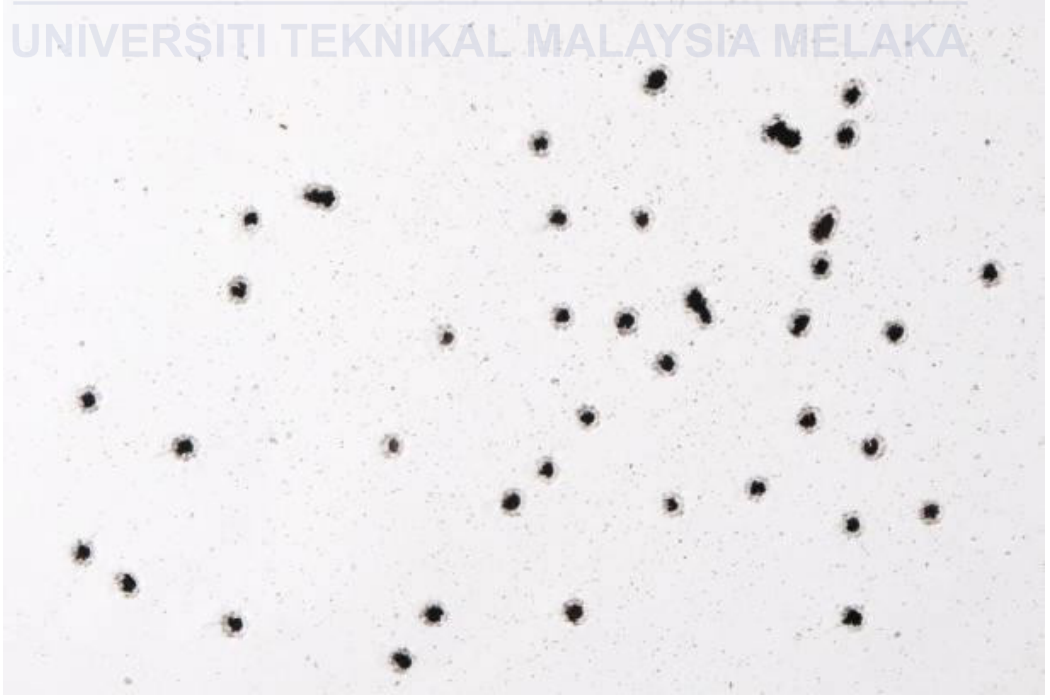
2.3.1 Recoil

The recoil of assault rifles, a critical aspect in their design and operation, is rooted in the principles of physics governing projectile firing. Typically chambered for intermediate-caliber cartridges such as 5.56 × 45 mm or 7.62 × 39 mm, assault rifles are engineered to balance power with controllability (Glock, 2020). Upon firing, the ignited propellant generates expanding gases that propel the bullet forward, simultaneously exerting an equal and opposite force backward onto the rifle. This backward force, known as recoil, manifests as a noticeable jolt or kickback felt by the shooter. The intensity of recoil can vary based on factors such as cartridge caliber, rifle weight and design, and the selected firing mode.

While recoil from assault rifles is generally manageable for trained shooters, it can impact shooting accuracy and control, especially during rapid-fire sequences. To mitigate recoil effects, shooters employ proper shooting techniques, including maintaining a firm grip, adopting stable shooting stances, and using controlled breathing and trigger control (USCCA, 2020). Additionally, firearm accessories like recoil pads, muzzle brakes, and adjustable stocks are utilized to reduce recoil and improve shooter comfort and control during firing. Understanding and effectively managing recoil are crucial for achieving accurate and effective shooting with assault rifles in diverse combat scenarios, enhancing overall operational effectiveness and mission success.

2.3.2 Pattern

An assault rifle's recoil pattern, critical to understanding its handling characteristics, is influenced by factors such as its design, caliber, and firing mode. In semi-automatic or single-shot modes, the rifle typically exhibits a rearward movement along the shooter's shoulder axis, followed by a slight upward movement due to muzzle climb (NRA Family, 2020). Shooters can anticipate and manage this predictable pattern by adjusting their grip and stance to counteract recoil forces, thereby maintaining control and shooting accuracy. In contrast, firing in fully automatic mode introduces more complexity to the recoil pattern. Rapid and successive shots can cause the rifle to move erratically, combining both upward and backward movements. This phenomenon, commonly referred to as "muzzle climb" or "muzzle rise," poses challenges for shooters aiming to sustain precision and control during extended bursts of fire (NRA Family, 2020).



2.6 shows the pattern of assault rifle

The specific recoil pattern as figure 2.6 of an assault rifle can vary significantly based on factors such as cartridge caliber, weapon weight and design, and the effectiveness of recoil mitigation systems. To effectively manage recoil and optimize control, shooters must familiarize themselves with their rifle's unique recoil tendencies and employ correct shooting techniques (USCCA, 2020). Additionally, accessories like adjustable stocks, muzzle brakes, and recoil pads can be utilized to mitigate recoil effects and enhance shooter comfort and control. By mastering their assault rifle's recoil pattern through practice and adaptation, shooters can enhance their proficiency and effectiveness across diverse combat scenarios, ensuring consistent and accurate performance.

2.4 Sniper Rifles

Sniper rifles as shown in figure 2.7 are meticulously engineered to achieve unparalleled precision at extreme distances, representing the pinnacle of firearms technology. Every component, from the choice of materials to the design of the barrel, is meticulously optimized to ensure accuracy and reliability (Popular Mechanics, 2021). The heavy barrel construction plays a crucial role in minimizing vibrations, thereby ensuring that each shot lands precisely on target, even after multiple firings.

Figure 2.7 shows the image of sniper rifle (Eugene, April 2000)

While bolt-action systems are slower compared to their semi-automatic counterparts, they offer unmatched consistency and durability, which are essential qualities for operations in challenging environments (American Rifleman, 2020). The selection of caliber is a critical consideration, balancing factors such as stopping power, effective range, and ammunition availability. Smaller calibers like the .308 Winchester are preferred for their accuracy and manageable recoil, while larger calibers such as the .50 BMG offer extended range and increased lethality, albeit requiring heavier firearms and specialized ammunition (The National Interest, 2021).

Optics play a pivotal role in sniper rifles, with advanced telescopic sights featuring technologies like bullet drop compensation and illuminated reticles that significantly enhance accuracy, particularly in adverse weather and lighting conditions (Guns & Ammo, 2020). Achieving proficiency with sniper rifles necessitates extensive training in marksmanship, fieldcraft, observation, and camouflage techniques. Snipers must possess a deep understanding of ballistics, wind patterns, and precise range estimation to consistently deliver accurate shots under varying conditions (Military Times, 2021).

2.4.1 Recoil

Recoil, or "kickback," in sniper rifles refers to the backward force experienced by the shooter when the rifle is fired, significantly impacting accuracy and consistency (Guns & Ammo, 2020). When the trigger is pulled, the firing pin ignites the primer, propelling the bullet forward while simultaneously pushing the rifle backward into the shooter's shoulder with an equal and opposite force. Several factors influence recoil in sniper rifles, including the size of the caliber, the weight of the rifle, and the length of the barrel. Smaller calibers such as the .308 Winchester produce less recoil, enabling faster follow-up shots, whereas larger calibers like the .50 BMG generate substantial recoil due to their higher propellant charge. Heavier sniper rifles absorb more recoil but are less portable, while longer and heavier barrels help dampen recoil effects. Muzzle devices like muzzle brakes and suppressors can mitigate recoil by redirecting gases or slowing their exit from the barrel (Guns & Ammo, 2020).

Effective management of recoil is crucial for maintaining accuracy and precision in sniper operations. Excessive recoil can disrupt the shooter's aim, reducing the accuracy of subsequent shots. Proper recoil management techniques allow snipers to maintain their sight picture and stay on target consistently, which is essential for achieving high precision in their shots (Military Times, 2021). Recoil management also plays a role in reducing shooter fatigue during prolonged engagements, highlighting its importance in maintaining stamina and focus. Additionally, recoil places stress on the rifle and its components, including optics, necessitating robust design and regular maintenance to ensure durability (Guns & Ammo, 2020).

Snipers employ various techniques to manage recoil effectively, such as adopting stable shooting positions like lying prone to distribute recoil forces across the body and ensuring a firm shoulder placement of the rifle buttstock. Support equipment such as bipods, tripods, and sandbags provide stability and help absorb recoil impact. Recoil pads added to the rifle's buttstock further cushion the impact on the shooter's shoulder, contributing to improved comfort and control during firing (Military Times, 2021). Through extensive training and experience, snipers develop the skills necessary to handle recoil effectively, enabling them to maintain precision and consistency in diverse operational environments.

2.4.2 Pattern

Pattern holes in sniper rifles as shown in figure 2.7, often referred to as porting or fluting, serve multiple purposes that significantly enhance the rifle's performance and handling. Barrel fluting involves machining grooves along the barrel's length to reduce

weight, improve heat dissipation, and increase stiffness, thereby enhancing accuracy (PrecisionRifleBlog, 2024). By removing material, the barrel becomes lighter without compromising its structural integrity, allowing for better balance and easier handling. The increased surface area also helps in dissipating heat more effectively, maintaining the barrel's accuracy during prolonged shooting sessions.

Muzzle porting consists of small holes drilled into the barrel's end, redirecting gases to counteract the backward and upward forces generated during firing. This reduction in recoil and muzzle rise allows the shooter to maintain a steadier aim and execute quicker follow-up shots, crucial for tactical scenarios where precision and rapid response are required (Shooting Illustrated, 2024). Vent holes in handguards are designed to allow air circulation around the barrel, aiding in cooling and preventing overheating, which can negatively affect accuracy and barrel life (The Truth About Guns, 2024). These vents also contribute to weight reduction, making the rifle more manageable during extended operations.

Figure 2.7 shows the pattern of sniper rifle

Lightening cuts involve strategic material removal from various parts of the rifle, such as the receiver and stock. These cuts reduce the overall weight and improve the rifle's balance, enhancing the shooter's ability to maneuver and stabilize the weapon in diverse environments (The Truth About Guns, 2024). This is particularly important for snipers who may need to carry their rifles over long distances or maintain a stable position for extended periods.

These design features collectively enhance the sniper rifle's accuracy, handling, and durability, making it a more effective tool for long-range precision shooting. Precision rifles like the Remington 700 and tactical models such as the Sako TRG often incorporate these elements to optimize their performance in various operational conditions. The use of pattern holes exemplifies the meticulous blend of engineering and tactical design aimed at meeting

the demanding needs of snipers. By reducing weight, managing recoil, and improving heat dissipation, these features ensure that sniper rifles maintain their reliability and precision, even under the most challenging circumstances.

2.5 Shotgun

Military shotguns shows in figure 2.9, have a rich history of service and innovation, with their utility spanning a wide range of military operations and environments. From the early conflicts of the Philippine-American War to the modern battlefields of the 21st century, these versatile firearms have proven their worth in a variety of roles. In urban warfare, shotguns offer unparalleled effectiveness in close-quarters engagements, where their devastating firepower and ability to clear rooms make them invaluable tools for clearing buildings and conducting room-to-room combat. Moreover, in dense forest and jungle environments, where visibility is limited and engagements often occur at short ranges, shotguns excel in delivering lethal force with precision and stopping power, making them well-suited for ambushes and patrols (Military.com, 2024).

Figure 2.9 shows the image of shotgun (Thompson,2013)

The usage of military shotguns extends beyond traditional combat roles into specialized tasks such as trench warfare, where their ability to deliver concentrated firepower in confined spaces has been historically decisive. Additionally, shotguns have found utility in guard duties, providing security personnel with a formidable deterrent against potential threats while minimizing collateral damage in sensitive areas. Furthermore, their adaptability for riot control and crowd dispersal, thanks to the availability of specialized less-lethal ammunition, underscores their versatility in maintaining law and order in volatile situations (The National Interest, 2024).

In recent years, military shotguns have also seen adoption in counterterrorism and counterinsurgency operations, where their ability to deliver precise, lethal force in urban environments has proven instrumental in neutralizing high-value targets and clearing entrenched enemy positions. Additionally, their effectiveness in breaching doors and barriers makes them indispensable tools for special operations forces conducting raids and hostage rescues (American Rifleman, 2024).

As technology continues to advance, the role of military shotguns in modern warfare is likely to evolve further, with ongoing innovations in ammunition, materials, and design ensuring that these firearms remain relevant and effective tools for the armed forces around the world. Whether in conventional combat, asymmetric warfare, or peacekeeping missions, military shotguns continue to play a vital role in the arsenal of modern military forces, embodying a legacy of reliability, versatility, and combat effectiveness.

2.5.1 Recoil

Recoil in military shotgun weapons refers to the backward force experienced by the shooter upon firing a round. It is a result of Newton's third law of motion, which states that for every action, there is an equal and opposite reaction. When a shotgun is fired, the expanding gases from the ignited gunpowder propel the projectile down the barrel and out of the muzzle. Simultaneously, an equal and opposite force is exerted backward onto the shooter, causing the firearm to recoil (The Physics Classroom, n.d.).

The magnitude of recoil experienced by the shooter depends on several factors, including the weight of the firearm, the power of the ammunition, and the design features of the shotgun. Heavier firearms typically absorb more recoil due to their mass, resulting in less felt recoil for the shooter. Additionally, shotguns firing more powerful loads, such as Magnum cartridges or specialized anti-vehicle rounds, will produce greater recoil compared to lighter loads like birdshot or less-lethal ammunition.

Design features of the shotgun can also influence recoil. Firearms with features such as padded buttstocks, recoil-absorbing mechanisms, and muzzle brakes are designed to mitigate the effects of recoil on the shooter, making them more comfortable to fire, especially during prolonged shooting sessions. Furthermore, the action type of the shotgun, whether pump-action, semiautomatic, or manual, can impact recoil characteristics. For example, semiautomatic shotguns typically absorb some of the recoil energy through their cycling mechanism, resulting in less felt recoil compared to pump-action or manual shotguns.

Managing recoil is essential for maintaining accuracy and control while shooting a shotgun, especially in military scenarios where rapid follow-up shots may be necessary. Proper shooting technique, including a firm grip, proper stance, and shouldering the firearm correctly, can help mitigate the effects of recoil and allow the shooter to maintain accuracy and effectiveness in combat situations. Additionally, training and practice are crucial for developing proficiency in managing recoil and effectively employing military shotgun weapons in a variety of operational environments (National Shooting Sports Foundation, 2017.)

2.5.2 Pattern

In military shotguns, the pattern and distribution of pellets, often referred to as "shot spread," play a crucial role in determining their effectiveness on the battlefield. When a shotgun is fired, the pellets contained within the shell spread out as they travel down the barrel and exit the muzzle, forming a pattern that impacts the target area. The pattern density and size of the spread influence the shotgun's effectiveness at various distances and against different types of targets.

Figure 2.10 shows the pattern of shotgun

The pattern of pellets as shown as figure 2.10 can be affected by several factors, including the type of ammunition used, the choke of the shotgun barrel, and the distance to the target. Ammunition types such as buckshot, which contain multiple large pellets, tend to produce denser patterns with a shorter spread, making them effective at shorter ranges and against larger targets (Hogg, 2008). On the other hand, birdshot, which contains numerous smaller pellets, produces wider patterns with less penetration, making it suitable for smaller game or aerial targets (Brown, 2013).

The choke of the shotgun barrel also plays a significant role in shaping the pattern of pellets. Chokes are devices installed at the muzzle of the shotgun that constrict or tighten

the spread of pellets as they exit the barrel. Different choke designs, such as cylinder, improved cylinder, modified, and full choke, control the dispersion of pellets to varying degrees (Wilson, 2017). A tighter choke will produce a denser pattern with less spread, while a more open choke will result in a wider pattern with more spread.

In military shotguns, the pattern of pellets is carefully considered to ensure optimal effectiveness in combat situations. For close-quarters engagements, such as room clearing or urban combat, shotguns may be equipped with cylinder or improved cylinder chokes to produce wide patterns suitable for engaging multiple targets at short ranges (Miller, 2015). In contrast, for longer-range engagements or precision shooting, shotguns may be equipped with modified or full chokes to tighten the pattern and increase the effective range of the firearm.Understanding the pattern and distribution of pellets is essential for military personnel using shotguns in combat. Proper training and familiarization with the characteristics of their shotgun's pattern can help soldiers effectively engage targets with accuracy and precision, maximizing the weapon's effectiveness on the battlefield (Hogg, 2008). Additionally, knowledge of shot spread allows military personnel to make informed decisions about ammunition selection and engagement distances, ensuring optimal performance in various operational environments.

2.6 Pistol

The pistol, a compact and versatile firearm designed for one-handed use, has undergone significant evolution throughout history. Early pistols such as matchlocks and flintlocks paved the way for more sophisticated designs like the revolver and semi-automatic pistols. According to firearms historian Ian V. Hogg, pistols progressed dramatically with the introduction of the revolver in the mid-19th century, which enabled repeated firing without the need to reload after each shot (Hogg, 2004). This innovation was followed by semi- automatic pistols, which utilize the recoil or gas pressure from fired cartridges to automatically chamber a new round, enhancing their rate of fire and usability.

Figure 2.11 shows the image of pistol (Skennerton, Ian, 1997)

Pistols shows in figure 2.11, play crucial roles in various aspects of modern life. They are widely employed in self-defense due to their compact size and ease of handling, essential

attributes noted by experts in firearms technology (Ezell, 2001). Law enforcement agencies worldwide rely on pistols as standard-issue sidearms for officers, offering both deterrence and capability in critical situations. In military contexts, pistols serve as secondary weapons for personnel, particularly officers and specialized units requiring lightweight and easily maneuverable firearms. Beyond practical applications, pistols have a profound cultural impact. They feature prominently in literature, film, and video games as symbols of power, danger, and sophistication. Iconic models like the Colt M1911 and Glock series have become legendary in popular culture, perpetuating their mystique and allure.

The legal and ethical implications of pistol ownership are significant and vary widely across jurisdictions. Debates surrounding gun control, safety measures, and the ethics of self-defense continue to shape legislation and public discourse. These considerations underscore the dual role of pistols as both functional tools and potent cultural artifacts, influencing perceptions and policies worldwide. In conclusion, the evolution of pistols reflects advancements in firearm technology and their multifaceted roles in contemporary society. Detailed studies and historical analyses by scholars like Ian V. Hogg and Edward Clinton Ezell provide valuable insights into their development and impact on law, culture, and technology.

2.6..1 Recoil

Recoil in pistols is a fundamental aspect influenced by various factors such as caliber, design, and firing mechanism. When a pistol is fired, the expanding gases from the ignited cartridge propel the bullet down the barrel. Simultaneously, these gases exert an equal and opposite force backward onto the pistol, resulting in recoil. According to firearms experts and studies, the magnitude of recoil depends significantly on the caliber and design of the pistol. For instance, pistols chambered in larger calibers generally produce stronger recoil due to the greater number of propellant gases generated upon firing. This is evident in firearms literature and technical manuals that detail the mechanics of firearm operation and the physics of recoil management (Hatcher, 1947).

Manufacturers often employ various design features to mitigate recoil and improve shooter comfort and accuracy. These include recoil-reducing mechanisms such as recoil springs, muzzle brakes, and ergonomic grips, which help to absorb and distribute recoil forces more effectively.In practical terms, understanding and managing recoil is crucial for shooters to maintain control over their firearm, ensure accurate shot placement, and reduce fatigue during prolonged shooting sessions. Training and experience play significant roles in developing effective recoil management techniques, allowing shooters to maximize their proficiency with pistols across various shooting disciplines and applications.

In conclusion, recoil in pistols is a physical phenomenon influenced by caliber, design, and shooter technique. Research and practical experience contribute to ongoing advancements in recoil management strategies aimed at enhancing firearm performance and

user comfort.

2.6.2 Pattern

Pattern holes, often referred to as shot patterns, describe the dispersion of projectiles (bullets or pellets) fired from a pistol. This dispersion is influenced by several factors including barrel length, ammunition type, and shooting distance. When a pistol is fired, the bullets exit the barrel in a grouping that can vary in spread depending on these factors.According to firearms experts and studies, the pattern holes or shot patterns from pistols can be affected by barrel rifling, which imparts spin to the bullet to stabilize its flight. Rifling helps to improve accuracy by reducing tumbling and dispersion of the projectile, resulting in tighter shot groups at greater distances (Ezell, 2001).

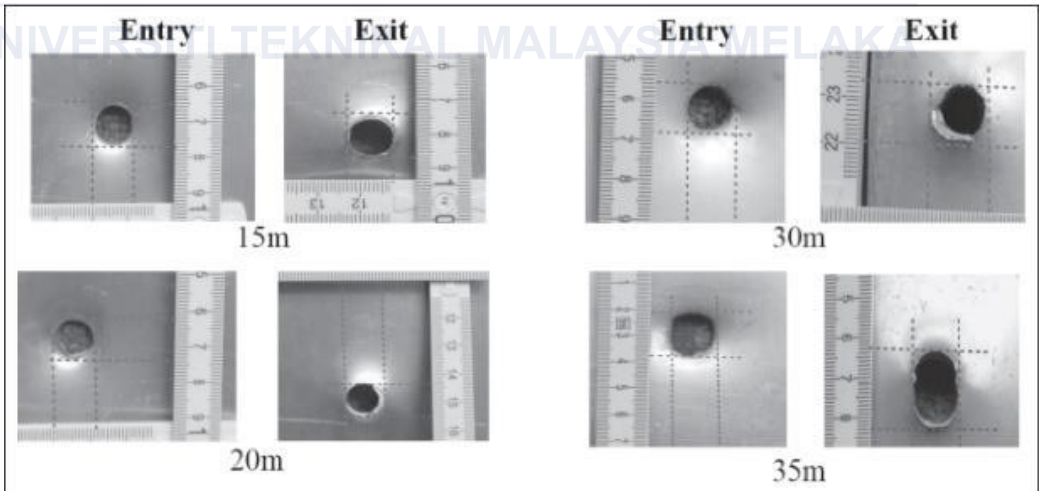


Figure 2.12 shows the pattern of pistol

Additionally, ammunition choice plays a crucial role in determining shot patterns. Different bullet weights, shapes, and compositions can affect how consistently bullets group together when fired from a pistol. Hollow point bullets, for example, are designed to expand upon impact and may exhibit different shot patterns compared to full metal jacket bullets.The distance at which the pistol is fired also influences shot patterns. At shorter distances, shot patterns are typically tighter, with bullets closely grouped together. As the distance increases, factors such as bullet drop and wind drift can cause shot patterns to spread out more, affecting accuracy.

In practical terms, understanding shot patterns shows in figure 2.12 is essential for shooters to gauge the effectiveness and consistency of their pistol's performance. This knowledge helps in selecting appropriate ammunition and optimizing shooting techniques for different applications, whether it's target shooting, self-defense, or competitive shooting. In conclusion, shot patterns from pistols are influenced by barrel characteristics, ammunition selection, and shooting distance. Research and practical experience contribute to improving understanding and optimizing shot patterns to enhance accuracy and performance in various shooting scenarios.

2.7 Comparison between weapons

Table 2.1 The comparison between weapons.

Characteristic	Shotgun	Assault Rifle	Sniper Rifle	Pistol
Primary Purpose	Shotguns are versatile firearms designed for various roles including close-quarters combat, breaching, riot control, and hunting. They excel in situations where stopping power and spread are important. (National Shooting Sports Foundation, 2019)	Assault rifles are the primary infantry weapons used for engaging targets at medium ranges. They offer a balance of firepower, accuracy, and maneuverability for combat scenarios. (U.S. Army, 2018)	Sniper rifles are precision firearms designed for long-range engagements, typically used by trained marksmen to engage targets with high accuracy and lethality at extended distances. (British Army, 2018)	Pistols are sidearms carried by military personnel for self-defense, close-quarters combat, and as a backup weapon. They are compact and lightweight, suitable for use in confined spaces or as a last resort. (Smith & Wesson, 2017)
Action Type	Shotguns can have various action types including	Assault rifles are typically semiautomatic or selective fire,	Sniper rifles are commonly bolt-action for precision	Pistols can be semiautomatic, single-action, double-action,

	pump-action, semiautomatic, or mixed (selectable between manual and semiautomatic). (Remington Arms Company, 2022)	allowing for both single-shot and automatic firing modes. (Heckler & Koch, 2019)	shooting, although some models may be semiautomatic for rapid follow-up shots. (Accuracy International, 2014)	or a combination of these depending on the design and model. (Glock, 2022)
Caliber	Shotguns are typically chambered in 12 gauge or 20 gauge, with variations in shot size and shell length. (Federal Premium Ammunition, 2002)	Assault rifles commonly use intermediate rifle cartridges such as 5.56mm NATO or 7.62mm NATO, offering a balance of power and controllability. (Federal Ammunition, 2009)	Sniper rifles are often chambered in larger calibers like 7.62mm NATO, .338 Lapua Magnum, or .50 BMG for long-range precision shooting. (Barrett Firearms Manufacturing, 2022)	Pistols are available in various calibers including 9mm, .45 ACP, .40 S&W, and others, chosen based on factors like stopping power and recoil control. (SIG Sauer, 2009)
Effective Range	Shotguns are effective at short to medium ranges,	Assault rifles have a medium effective range of up to 500	Sniper rifles are capable of engaging targets at long	Pistols are effective at short to medium

	typically up to 50 meters, depending on the ammunition and choke configuration.	meters, although engagement distances may vary based on the specific rifle and cartridge used.	ranges, often exceeding 1,000 meters or more, with precision and accuracy.	ranges, typically up to 50 meters, although skilled shooters may achieve accurate shots at longer distances.
Ammunition	Shotguns can fire a variety of ammunition types including buckshot, slugs, specialty rounds (e.g., less-lethal, breaching), and birdshot for hunting. (Winchester Ammunition, 2019)	Assault rifles use detachable box magazines to feed intermediate rifle cartridges like 5.56mm or 7.62mm NATO, offering a high ammunition capacity and rapid reloading. (Magpul Industries, 2020)	Sniper rifles use detachable box magazines or internal magazines to feed high-velocity, precision rifle cartridges designed for long-range accuracy and lethality. (Lapua, 2014)	Pistols use detachable box magazines or internal magazines to feed pistol cartridges such as 9mm, .45 ACP, or .40 S&W, chosen based on factors like terminal ballistics and magazine capacity. (Hornady Manufacturing, 2012)
Magazine Capacity	Shotguns typically have	Assault rifles commonly have	Sniper rifles generally have	Pistols typically have

	lower magazine capacities ranging from 5 to 8 rounds, depending on the design and type of shotgun. (Benelli, 2007)	magazine capacities ranging from 20 to 30 rounds, providing sustained firepower in combat situations. (FN America, 2017)	lower magazine capacities ranging from 5 to 10 rounds, although some models may have higher capacities depending on the caliber and design. (Remington Defense, 2012)	magazine capacities ranging from 10 to 20 rounds, although smaller compact models may have lower capacities for improved concealability. (Springfield Armory, 2017)
Optics	Shotguns may be equipped with iron sights as standard, with the option to mount optics such as red dot sights or low-power scopes for improved accuracy and target acquisition. (Bushnell, 2021)	Assault rifles are commonly equipped with optics like red dot sights or magnified scopes for enhanced target identification and engagement at medium ranges. (Aimpoint, 2007)	Sniper rifles are often fitted with high-powered telescopic scopes with variable magnification for precision aiming at long distances, sometimes complemented by additional optics like laser	Pistols may have fixed or adjustable iron sights as standard, with the option to mount optics like reflex sights or laser aiming modules for improved accuracy and target acquisition. (Trijicon,

			rangefinders or night vision devices. (Leupold & Stevens, 2019)	2021)
Weight	Shotguns can vary in weight depending on factors like barrel length, action type, and materials used, typically ranging from moderate to heavy. (Beretta, 2021)	Assault rifles generally have moderate weights, balancing durability, firepower, and maneuverability for combat operations, with variations based on the design and materials used. (Colt's Manufacturing Company, 2008)	Sniper rifles tend to be heavier than other firearms due to their long barrels, precision components, and specialized optics, often requiring additional support or bipods for stability during long-range shooting. (Barrett Firearms Manufacturing, 2008)	Pistols are lightweight and compact for easy carry and handling, with variations in weight depending on factors like size, frame material, and magazine capacity. (Smith & Wesson, 2017)
Special Features	Shotguns may feature specialized attachments or accessories for	Assault rifles often include features like folding or collapsible	Sniper rifles may have adjustable stocks, heavy barrels for	Pistols may include features like ambidextrous controls,

	breaching, less-lethal capabilities (e.g., rubber pellets, bean bags), or mounting options for lights, lasers, or foregrips depending on the intended use.	stocks, rails for mounting accessories like lights or foregrips, and muzzle devices for recoil control or flash suppression.	improved accuracy, and threaded muzzles for mounting suppressors or muzzle brakes to reduce recoil and muzzle rise.	accessory rails for mounting lights or lasers, and ergonomic grips for improved handling and control, with some models offering options for suppressor compatibility or optic mounting.

2.8 Types of games

In gaming, the term "types of games" encompasses a wide array of genres that categorize video games based on their distinctive gameplay mechanics, themes, and objectives. Action games, known for their fast-paced challenges and emphasis on physical prowess, often involve combat, platforming, and exploration, exemplified by titles like Super Mario Bros. and Call of Duty shows in figure 2.13 (Nintendo, 1985; Infinity Ward, 2003). Adventure games prioritize narrative-driven experiences, encouraging players to interact with characters and environments to progress through a story or solve puzzles, as seen in classics like The Secret of Monkey Island and modern masterpieces like The Last of Us

(Lucasfilm Games, 1990; Naughty Dog, 2013). Role-playing games (RPGs) offer immersive worlds where players control customizable characters, engage in quests, and develop skills and abilities, evident in series like Final Fantasy and The Witcher (Square Enix, 1987; CD Projekt Red, 2007).

Figure 2.13 shows the example of games

Strategy games demand careful planning and tactical execution to achieve victory, whether in real-time strategy epics like StarCraft or turn-based classics like Civilization (Blizzard Entertainment, 1998; Firaxis Games, 1991). Simulation games replicate real-world activities or scenarios, from life simulations like The Sims to vehicle simulators like Microsoft Flight Simulator (Maxis, 2000; Microsoft Game Studios, 2020). Sports games bring the excitement of real and fictional sports to players, featuring realistic physics and team management, while puzzle games challenge players with brain-teasing conundrums and logic puzzles, such as Tetris and Portal (Nintendo, 1984; Valve Corporation, 2007). Horror games aim to instill fear and suspense through atmospheric storytelling and encounters with terrifying enemies, as seen in franchises like Resident Evil and Silent Hill (Capcom, 1996;

Konami, 1999).

2.8.1 First Person Shooter

A first-person shooter (FPS) example shows in figure 2.14 is a type of video game where the player sees the action through the eyes of the protagonist and is mostly focused on gun and other weapon-based combat (Valve Corporation, 1998). Action gameplay is the focus of FPS games, where players engage in fast-paced, intense battles using a variety of weaponry that significantly influences their strategy (Infinity Ward, 2003). These games often feature accurate and realistic representations of genuine weapons, including factors like accuracy, magazine size, and rate of fire (Activision, 2007). Some FPS games incorporate creative weaponry with a variety of projectiles such as crossbows, laser, energy, plasma, rocket, and grenade launchers to diversify gameplay mechanics (Blizzard Entertainment, 2016). According to recent surveys, FPS games are highly popular among gamers, especially those with military themes that depict scenarios like World War II, anti- terrorism operations, and other military campaigns (Electronic Arts, 2013).

Figure 2.14 shows the example of first-person shooter games(medium,2024)

Classic FPS games like the DOOM and Quake series have played a significant role in shaping the genre, emphasizing flight simulation, arcade shooting, and console gun games (id Software, 1993; Bethesda Softworks, 1996). Modern FPS titles, inspired by the success of games like Call of Duty 4: Modern Warfare, often focus on military-themed narratives and multiplayer gameplay (Infinity Ward, 2007).Games such as Rainbow Six, Counter- Strike, Sudden Attack, Point Blank, and Alliance of Valiant Arms (AVA) exemplify the military-themed FPS genre, where players engage in team-based matches involving objectives like occupation, escape, rescue, and demolition (Ubisoft, 1998; Valve Corporation, 1999; Nexon, 2008). Team-based modes such as those found in the Team Fortress series allow players to select different character classes and compete in various game styles like king of the hill and capture the flag (Valve Corporation, 2007). FPS games commonly feature multiple modes including team deathmatch, elimination, free-for-all solo

play, and last-man-standing, each with distinct rules and objectives (Activision, 2019). These

diverse gameplay modes contribute to the genre's appeal and longevity among gamers worldwide.

2.8.2 Third Person Shooter

Video games that use the third-person shooter (TPS) example shows in figure 2.15 perspective let the player see their character from above and behind, giving them a full perspective of both the character and the surroundings. Because it improves situational awareness, this viewpoint is essential for players to maneuver through complex areas and engage in strategic battle. TPS games usually include a strong cover system that lets players hide behind objects to avoid enemy fire and then fire tactically from behind cover. A notable example of this mechanic may be found in the "Gears of War" series, which is praised for having a tactical and dynamic battle system (IGN, 2023).

Figure 2.15 shows the example of third person shooter games(Argentics,2024)

Furthermore, compelling storylines and fully realized characters are frequently attributes of third-person shooters. For example, the "Uncharted" series creates a deep and engaging storyline experience by skillfully fusing shooting mechanics with platforming and puzzle-solving aspects (GameSpot, 2024). Comparably, the "Tomb Raider" series follows archaeologist Lara Croft's exploits as she solves riddles and faces off against enemies while fusing exploration, combat, and puzzle-solving (Polygon, 2023). The emotional bond that the third-person perspective creates between players and their characters is one of its main benefits. The game increases the emotional effect of the narrative and makes the plot more interesting by letting players watch the actions and emotions of their characters (Kotaku, 2023). But creating a smooth cover system and user-friendly camera controls can be difficult. The cover mechanics must seem natural and not interfere with the game's flow, and the camera must move smoothly to offer clear views without interfering with gameplay. Third-person shooters are still well-liked because of their unique combination of immersive storytelling, strategy, and action.

2.8.3 Virtual Reality Shooting game

Virtual Reality (VR) shooting games are an immersive video game genre that utilizes VR technology's potential to produce an extremely captivating and participatory experience. Virtual reality (VR) shooting games example game shown in figure 2.16, in contrast to traditional shooting games, immerse the player in the game environment and offer a first-person viewpoint that closely resembles motions and actions in real life. This is accomplished by using motion controllers and virtual reality headsets, which follow the player's hand and head movements, respectively. This enables natural aiming, firing, and

environment interaction.

Figure 2.16 shows the example of VR shooting games

"Half-Life: Alyx," one of the most well-liked VR shooting games, has raised the bar for the genre. The game offers a highly immersive experience with realistic physics, complex settings, and an engrossing story thanks to Valve's cutting-edge VR technology. VR controllers give players the ability to manipulate items, solve riddles, and participate in fierce combat—a sensation of presence that is unmatched by traditional gaming (PC Gamer, 2020). The popularity of the game has shown how VR, with its unmatched immersion and involvement, has the potential to revolutionize the first-person shooter (FPS) genre.

"Beat Saber," a well-liked virtual reality shooting game, blends rhythm-based gameplay with shooting elements. Players create a dynamic and physically engaging experience by slashing through blocks that represent musical rhythms using VR motion controllers. The popularity of the game demonstrates how VR technology can be used to create creative gameplay experiences that go beyond conventional shooting mechanics (The

Verge, 2018).Virtual reality shooting games present unique considerations and obstacles because of their immersive nature. For example, creators need to consider player safety and comfort because extended VR use can cause motion sickness or other physical discomfort. Furthermore, the physical aspect of virtual reality gaming necessitates meticulous planning to avoid player fatigue and guarantee inclusivity for a diverse spectrum of participants (Ars Technica, 2019).

To sum up, virtual reality shooting games are a big step forward for the gaming industry since they provide unmatched immersion and engagement. These games raise the bar for the genre by offering a first-person experience that closely resembles real-life actions thanks to the use of VR technology. The popularity of titles like "Beat Saber" and "Half- Life: Alyx" shows how VR has the ability to completely change how shooting games are played, but creators must overcome certain special difficulties brought on by this technology.

2.9 First Person Shooter that used same weapon

Table 2.2 The table of First Person Shooter that used same weapon

Game	Assault Rifle	Pistol	Shotgun	Sniper Rifle	Explanation	Citation
Call of Duty: Modern Warfare	M4A1	M1911	Model 680	AX-50	Features realistic and diverse weaponry, customizable for tactical gameplay.	PC Gamer (2019)
Battlefield V	STG 44	P38	M30 Drilling	Lee-Enfield No. 4 Mk I	Set in World War II, with historically accurate weapons, offering an immersive experience.	Polygon (2018)
Destiny 2	Suros Regime	The Last Word	The Chaperone	Whisper of the Worm	Blends FPS mechanics with RPG elements, featuring unique and powerful customizable weapons.	IGN (2017)
Rainbow	R4-C	P226 Mk	M870	OTs-03	Emphasizes	GameSpot

Six Siege		25			strategic planning and teamwork, with specialized weapons for various operators.	(2015)
Counter-Strike: Global Offensive	AK-47	Desert Eagle	Nova	AWP	Known for competitive gameplay, offers a balanced arsenal contributing to deep tactical layers.	Eurogamer (2012)

The 2019 video game Call of Duty: Modern Warfare is well known for its realistic and varied armament, which includes a variety of interchangeable weapons that improve tactical gaming. The diverse weapon options in the game include the M4A1 assault rifle, M1911 handgun, Model 680 shotgun, and AX-50 sniper rifle (PC Gamer, 2019). With its World War II setting and historically accurate weaponry, Battlefield V (2018) offers a realistic and comprehensive gunplay experience. Key weaponry in the game (Polygon, 2018) include the STG 44 assault rifle, P38 handgun, M30 Drilling shotgun, and Lee-Enfield No. 4 Mk I sniper rifle. FPS gameplay and role-playing game aspects are combined in Destiny 2 (2017), which features a wide range of powerful and distinctive weaponry that may be

enhanced and modified. The Chaperone shotgun, The Last Word handgun, The Suros Regime assault weapon, and The Whisper of the Worm sniper rifle are a few examples (IGN, 2017). The 2015 game Rainbow Six Siege, which offers a large variety of specialized weaponry deployed by different operators, places a strong emphasis on strategic planning and cooperation. A few examples of the intricate weapon design in the game are the R4-C assault rifle, P226 Mk 25 pistol, M870 shotgun, and OTs-03 sniper rifle(GameSpot, 2015). Counter-Strike: Global Offensive (2012), a game well-known for its competitive action, has a well-balanced variety of weaponry, each with unique strengths and weaknesses that add to the game's intricate tactical levels. The AWP sniper rifle, Desert Eagle pistol, Nova shotgun, and AK-47 assault rifle are important weaponry (Eurogamer, 2012).

2.10 Comparison between game and Disadvantages in Real-Life Military Use

Table 2.3 The Comparison between game and Disadvantages in Real-Life Military Use

Game Weapon	Real-Life Counterpart	Disadvantages in Real-Life Military Use	Weather system	Pattern	Citation
Call of Duty: Modern Warfare			No	No	
M4A1 (Assault Rifle)	M4 Carbine	The rifle's restricted range in comparison to larger models, need on maintenance, overheating and degradation from continuous firing			Military.com (2019)
M1911 (Pistol)	M1911	Compared to modern duty handguns, these weapons have a smaller magazine capacity, are heavier, and have a shorter effective range.			Firearm News (2018)
Model 680 (Shotgun)	Mossberg 500	Reduced magazine capacity, longer			Pew Pew Tactical

		reload times, longer range, and increased recoil			(2020)
AX-50 (Sniper Rifle)	Accuracy International AX50	Heavy and unwieldy, expensive to create and maintain, and requiring extensive training for proper usage			Task & Purpose (2019)
Battlefield V			No	No	
STG 44 (Assault Rifle)	STG 44	The rifle's intricate construction, heavy weight, and unreliability in harsh conditions make it archaic in comparison to modern guns.			HistoryNet (2018)
P38 (Pistol)	Walther P38	Reliability in harsh environments, intricate mechanism, and reduced magazine capacity in comparison to contemporary designs			American Rifleman (2019)

M30 Drilling (Shotgun)	M30 Luftwaffe Drilling	Extremely small magazine capacity, intricate mechanism, and more of a survival weapon than a weapon for fighting			NRA Museums (2018)
Lee-Enfield No. 4 Mk I (Sniper)	Lee-Enfield No. 4 Mk I	Compared to modern sniper rifles, it is heavier, bulkier, has a slower rate of fire, is restricted by outdated technology, and has less accuracy.			British Army (2017)
Destiny 2			No	No	
Suros Regime (Assault Rifle)	FN SCAR-L	Real-world counterparts might be large and unwieldy, delicate to the environment, and require a lot of upkeep.			SOFREP (2019)
The Last Word (Pistol)	Colt Single Action Army	Single-action mechanism, slower reload speed, less amount of ammo,			Guns.com (2018)

		impractical for use in contemporary warfare			
The Chaperone (Shotgun)	Winchester Model 1887	Lever-action mechanisms have a limited magazine capacity and moderate fire rates, making them more appropriate for historical recreations than modern warfare.			Forgotten Weapons (2017)
Whisper of the Worm (Sniper)	Barrett M82	Incredibly heavy, challenging to handle, noisy, considerable recoil, and requiring a team to work well			Military Today (2019)
Rainbow Six Siege			No	No	
R4-C (Assault Rifle)	Remington R4	Frequent upkeep and cleaning are necessary due to the high fire rate, which can cause overheating and sensitivity to dust			Police1 (2018)

		and sand.			
P226 Mk 25 (Pistol)	SIG Sauer P226	Larger and heavier than many contemporary handguns, more expensive, complicated mechanism that needs constant upkeep			The Truth About Guns (2017)
M870 (Shotgun)	Remington 870	Restricted firing range, reduced magazine capacity, strong recoil, and delayed reloading during combat			Tactical Life (2019)
OTs-03 (Sniper Rifle)	Dragunov SVD	Compared to bolt-action sniper rifles, it is heavier, bulkier, less accurate at long range, and has a higher recoil.			War History Online (2018)
Counter-Strike: Global Offensive			No	No	
AK-47	AK-47	Heavy compared to			Military

(Assault Rifle)		other modern rifles, with a high recoil, poor long-range accuracy, and a noise level that can interfere with stealth operations			Factory (2019)
Desert Eagle (Pistol)	Desert Eagle	Incredibly heavy, has a strong recoil, a smaller magazine capacity, and is not suitable for prolonged combat use.			The National Interest (2018)
Nova (Shotgun)	Benelli Nova	Restricted magazine capacity, severe recoil, reduced firing tempo, and limited range			Gun Digest (2017)
AWP (Sniper Rifle)	Accuracy International AWM	Extremely heavy, slow to spread, expensive to maintain and repair, and requiring extensive training			The Firearm Blog (2019)

2.11 Summary

These games were created clearly to address shortcomings found in existing military training simulations. One significant issue in many current games is the lack of a thorough weather component, which is critical in real-world military operations because environmental conditions dramatically influence tactical decisions and outcomes. These new games, which include a complex weather engine, aim to present realistic scenarios that test military students to adapt and strategize successfully under different weather circumstances.

In these games, particular attention has been given to simulate realistic recoil patterns and accuracy adjustments that occur after firing a weapon. This includes the behavior of firearms where each shot affects subsequent shots, influencing accuracy and requiring players to adjust their aim accordingly. By accurately modeling these "recoil patterns," the games aim to provide a more immersive and challenging experience, crucial for military training. This realistic depiction helps to train students in handling firearms effectively under varying conditions, enhancing their skills in marksmanship and tactical decision-making.

In essence, these new games are designed to offer a more immersive and realistic training environment that addresses the specific needs and challenges faced by military students. By integrating advanced features like a dynamic weather system and after effect recoil pattern, the games aim to foster critical skills such as decision-making,

adaptability, and strategic thinking, ultimately preparing students more effectively for the dynamic nature of contemporary military operations.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter discusses the methodology of the research. Acting as a guide to make sure all the specific tasks can be performed correctly and completed in a specific range of time, a set of phases are used to interpret and analyze different problems within the scope of a particular discipline.

3.2 Methodology

Figure 3.1 illustrates the research methodology framework to achieve the objectives stated in Chapter 1. The research methodology framework is based on the Game Development Life Cycle (GDLC) consists of three main phases that are preproduction, production and testing. This chapter will discuss the general idea of every phase and being further explained in Chapter 4.

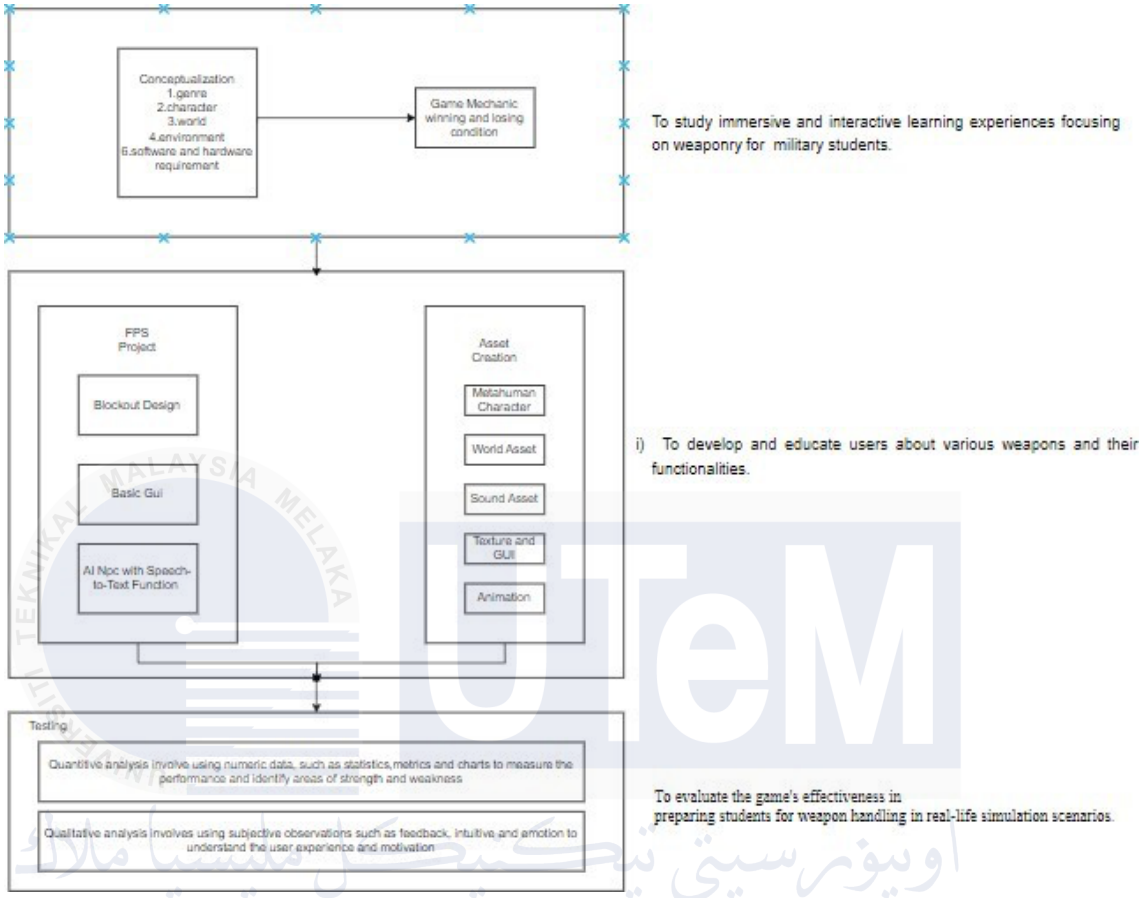


Figure 3.1 The proposed framework for developing this game

It begins with the initialization stage, where the development team brainstorms the game's core idea, assesses its feasibility, identifies the target audience, and outlines the core gameplay mechanics and unique selling points. Following this, the pre-production stage focuses on preparing visual and audio content, defining the art style, creating music and sound effects, and developing game prototypes to test and refine concepts. The production stage is where the bulk of content creation happens, including asset development, coding, and integration of all game elements, alongside continuous testing and optimization to ensure smooth performance. Finally, the application release stage involves final testing and

debugging, followed by marketing, distribution, and post-launch support to address any remaining issues and provide updates. Implementing the GDLC effectively reduces the risk of costly errors and helps achieve a polished final product that meets both the developers' vision and players' expectations, enhancing the overall quality and efficiency of game creation (Rollings & Morris, 2003; Bethke, 2003; Schell, 2008). This study employs the Game Development Life Cycle (GDLC) methodology, which includes the phases of initiation, pre-production, production, testing, launch, and post-launch. Each phase is designed to systematically achieve the study's objectives.

3.3 Phase 1-Pre-Production

The pre-production phase involves detailed planning and preparation before the actual development begins. Key activities include creating a detailed game design document, developing the story, characters, and settings, and prototyping core mechanics. This phase also includes planning the project timeline. The aim is to lay out a clear roadmap for development and ensure all design aspects are well-defined, which helps in minimizing risks and setting realistic expectations.

3.3.1 Conceptualization

In the concept phase, the initial idea and vision for the immersive learning experiences are developed. This involves brainstorming ideas and drawing inspiration from popular games like CS, Destiny 2, and PUBG to create engaging and realistic training scenarios. The key activities include defining the game concept and genre, identifying the target audience (military students), and creating a high-level game design document. This phase sets the foundation for the entire project by establishing the core objectives and the overall direction.

3.3.1.1 Genre

The game falls under the Simulation and First Person Shooter genres, blending realistic training experiences with engaging and dynamic gameplay. This hybrid genre is designed to provide military cadets with a practical and immersive learning environment that

simulates real-world combat scenarios. The simulation aspect focuses on accurate representations of weapon mechanics, tactical decision-making, and combat strategies, while the action component ensures the training remains engaging and interactive, capturing the attention and interest of today's tech-savvy cadets.

3.3.1.2 Character

The character design emulates real military personnel to enhance the authenticity of the military training environment. This realistic portrayal helps immerse cadets in the training scenarios, making the experience more relatable and effective.

Figure 3.2 The sketch of character which was generated using AI

3.3.1.3 World and Environment

The game world is a meticulously crafted representation of diverse military

environments, including weapon exhibition, military base, rural landscapes and training base. Each location is designed with attention to detail to replicate real-world conditions and challenges. The world includes dynamic elements such as weather changes to create a realistic and immersive training experience.

The environment in the game is highly detailed and interactive, designed to mimic real- world military settings accurately. Key elements include:

i) Weapon exhibition: Designed for the player to inspect weapon and figure out the information.

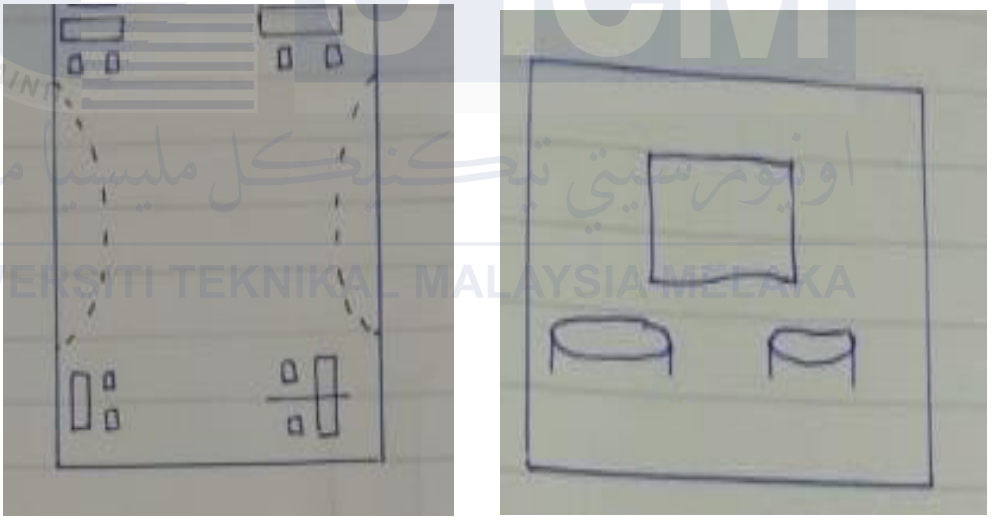


Figure 3.3 The sketch of top down view and side view of Exhibition world

ii) Shooting range: Simulating actual military training grounds with shooting ranges, and weapon testing.

Figure 3.4 The sketch of top down view and side view of shooting range

iii) Military Environments: Featuring buildings, barrel, fuel container and obstacles commonly found in military base combat scenarios.

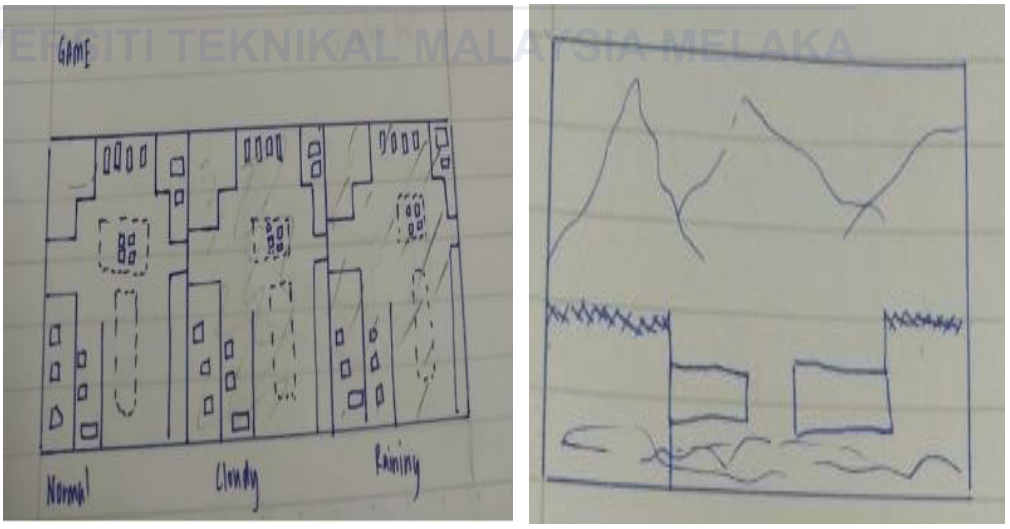


Figure 3.5 The sketch of top down view and side view of military base

3.3.1.4 Software and Hardware requirements

Table 3.1 shows the software and the hardware requirement

Software Requirements:

Game Engine	Unreal Engine 5.0
Operating System	Windows 10/11
Graphics API	DirectX 12, Vulkan, or Metal
Audio	Surround sound support (5.1/7.1)

Hardware Requirements:

Processor	Intel Core i7-9700K / AMD Ryzen 7 3700X or better
Graphics Card	NVIDIA GeForce RTX 2070 / AMD Radeon RX 5700 XT or better
Operating System	Windows 10/11
RAM	16 GB or more
Storage	SSD with at least 50 GB of free space
Display	1080p resolution or higher, 60Hz refresh rate (support for 144Hz or higher recommended for better performance)
Peripherals	Keyboard and mouse (support for

	game controllers optional)
Audio	High-quality headphones or surround sound speakers for immersive audio experience

These requirements ensure that the game runs smoothly and delivers a high-fidelity experience, providing cadets with an effective and engaging training tool.

3.3.2 Game Mechanic

To achieve victory, one must destroy the enemy in challenging environments within the specified time limit. This requires overcoming obstacles and adapting to difficult conditions swiftly. Failure to eliminate the enemy within the allotted time results in defeat, underscoring the need for both rapid and strategic action.

3.4 Phase 2-Production

During the production phase, the main development work takes place. This includes developing game assets such as 3D models of weapons, sound effects, and music. Coding game mechanics and features, designing and developing levels, and conducting regular playtesting and quality assurance (QA) are also crucial activities. This phase is where the immersive learning modules take shape, integrating various multimedia elements to create an engaging and interactive educational experience.

3.4.1 FPS Project

3.4.1.1 Blockout Design

Blockout design involves creating a basic, low-detail version of the game levels to establish the overall layout and flow. This stage focuses on designing the essential structure of training environments, including the placement of key objects, obstacles, and pathways. The goal is to test and refine the level design to ensure it provides a balanced and engaging training experience for cadets. This step is crucial for identifying potential gameplay issues and adjusting before adding detailed textures and assets.

i) Inspection level

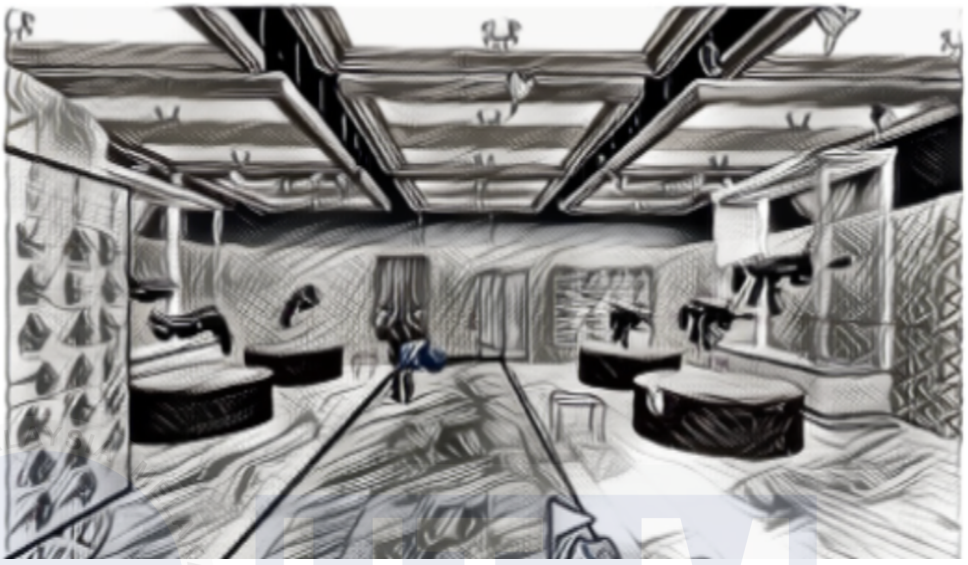


Figure 3.6 The sketch of top down view of inspection level

ii) Shooting range

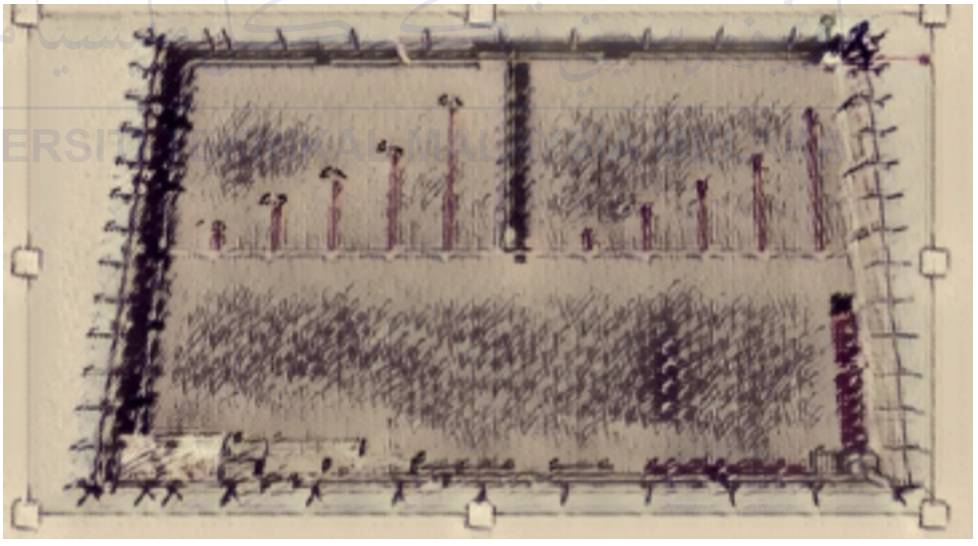


Figure 3.7 The sketch of top down view of shooting range

iii) Game

Figure 3.8 The sketch of top down view of game

3.4.1.2 Basic GUI

The basic GUI (Graphical User Interface) and game flow design involves developing the initial user interface elements and the overall progression of the game. This includes designing menus, HUD (Heads-Up Display) elements that players will use to interact with the game.

i) Main menu

Figure 3.9 The sketch of main menu screen

ii) Winning screen

Figure 3. 10 The sketch of winning screen

iii) Losing screen

Figure 3.11 The sketch of losing screen

3.4.1.3 AI NPC Using Speech-To-Text

AI NPCs (non-Player Characters) with speech-to-text functionality involve creating intelligent characters that can interact with players using voice commands. These NPCs are programmed to respond to player inputs, carry out specific tasks, and engage in realistic dialogues. ConvAI API has shown in figure 3.12 is used for the proposed project for the free accessibility and unique features which includes spatial audio from the characters, narrative design triggers and backstory for the characters. The speech-to-text technology allows players to issue commands verbally, enhancing immersion and providing a more natural way to interact with the game. This feature requires sophisticated AI programming and natural language processing to ensure accurate and responsive interactions.

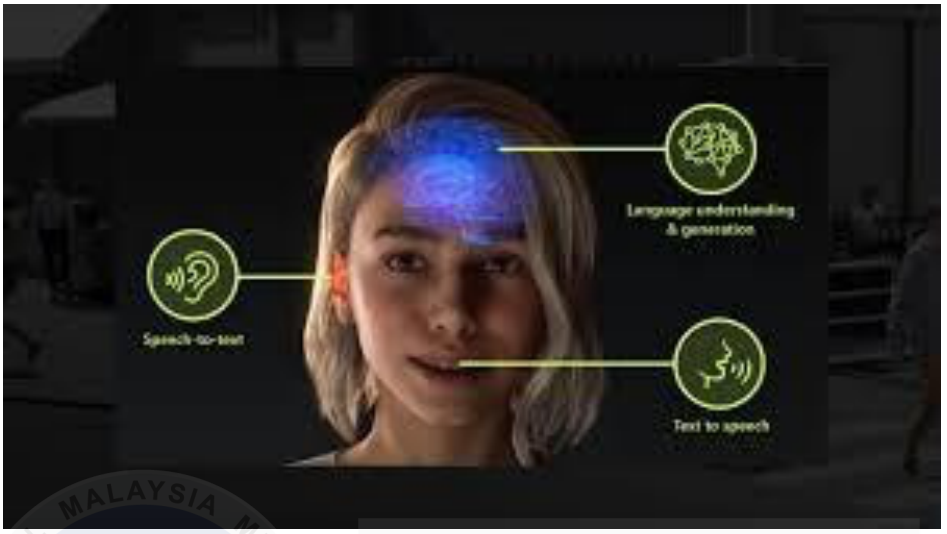


Figure 3.12 The highly conventional ConvAI API for creating functionalities like speech-based action, text-to-speech and language understanding.

3.4.2 Asset Creation

Asset creation in 3D game development consists of conceptualization, shaping, modelling and texturing. Assets are what makes a certain project come to life with the sense of realism and immersion.

3.4.2.1 World Asset

World assets encompass all the environmental elements used to build the game world. This includes terrain, buildings, props, and other objects that populate the game levels. These assets are designed to be highly detailed and realistic, contributing to immersive experience. They are created using 3D modeling software and are textured and

optimized for performance to ensure they run smoothly within the game engine.

i) Ammo

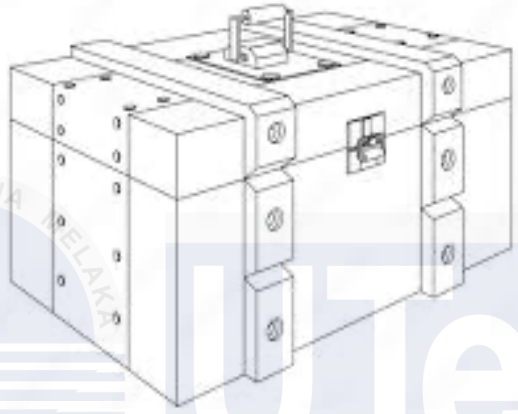


Figure 3.13 The sketch of Ammo

ii) Barbed Wire

Figure 3.14 The sketch of barbed wires

iii) Barrel

Figure 3.15 The sketch of Barrel

iv) Bombshell

Figure 3.16 The sketch of Bombshell

v) Bush

Figure 3.17 The sketch of Bush

vi) Concrete

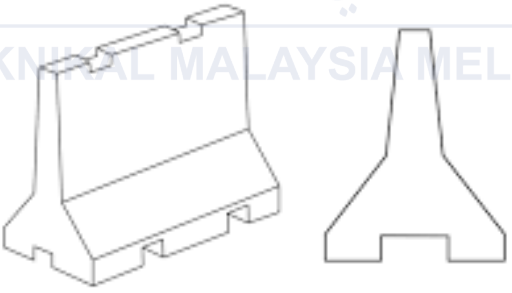


Figure 3.18 The sketch of Concrete

vii) Container

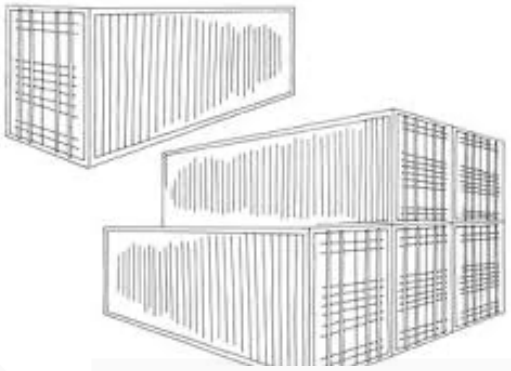


Figure 3.19 The sketch of Container

viii) Fence

Figure 3.20 The sketch of Fence

ix) Fuel container

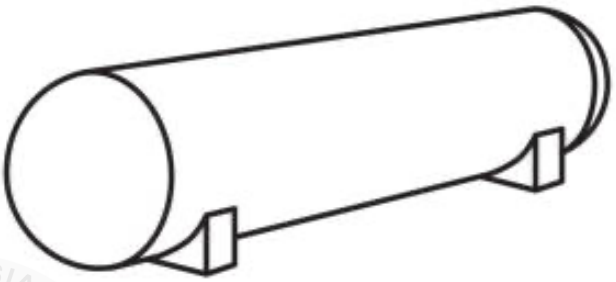


Figure 3.21 The sketch of Fuel container

x) Wood pallet

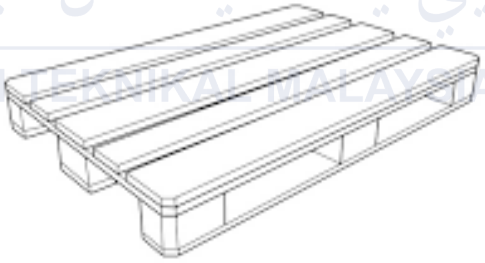


Figure 3.22 The sketch of Wood pallet

xi) Spotlight

Figure 3.23 The sketch of Spotlight

3.4.2.2 Metahuman

Metahuman characters are highly detailed and realistic human models created using advanced character creation tools like Unreal Engine's MetaHuman Creator as shown in figure 3.15. These characters feature lifelike animations, facial expressions, and body movements, providing a high degree of realism. Metahumans are used to represent both player characters and NPCs, enhancing the visual quality and authenticity of the game.

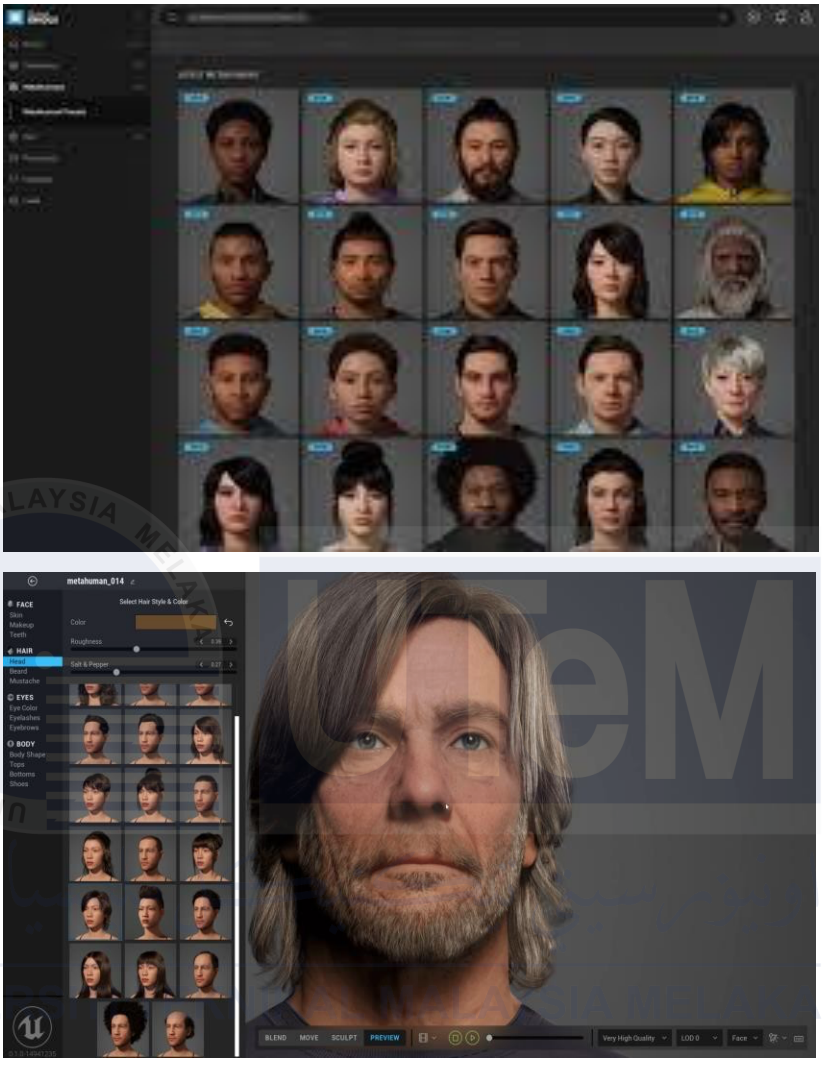


Figure 3.24 shows the MetaHuman bro

3.4.2.3 Animation

With every asset possessing skeleton, it is easier to animate the object using Unreal Engine 5.1 using the level sequence acting as a cutscene and character animation as a personal use on every actor. In Unreal Engine, the process of animating movements involves utilizing Level Sequences, keyframes, and Blueprints to bring characters and objects to life within the virtual environment. Level Sequences provide a timeline-based editing environment where animators can arrange and manipulate keyframes to create complex animations. Keyframes serve as points of reference for specific poses or states within an animation, allowing animators to define the beginning and end points of movements. By setting keyframes at different intervals along the timeline, animators can interpolate between them to generate smooth transitions and lifelike motion.

Additionally, Blueprints play a crucial role in defining the behavior and interactions of animated elements within the Unreal Engine environment. Through Blueprint scripting, we can create dynamic animations that respond to user input or environmental triggers. This may include implementing logic for character movement, object interactions, or environmental effects. By leveraging Blueprints, animators have the flexibility to customize animations and incorporate interactive elements that enhance the overall immersion and interactivity of the virtual experience. Together, Level Sequences, keyframes, and Blueprints as shown in figure 3.25 form a powerful toolkit for animating movements in Unreal Engine, enabling animators to craft compelling and dynamic animations for use in virtual reality applications.

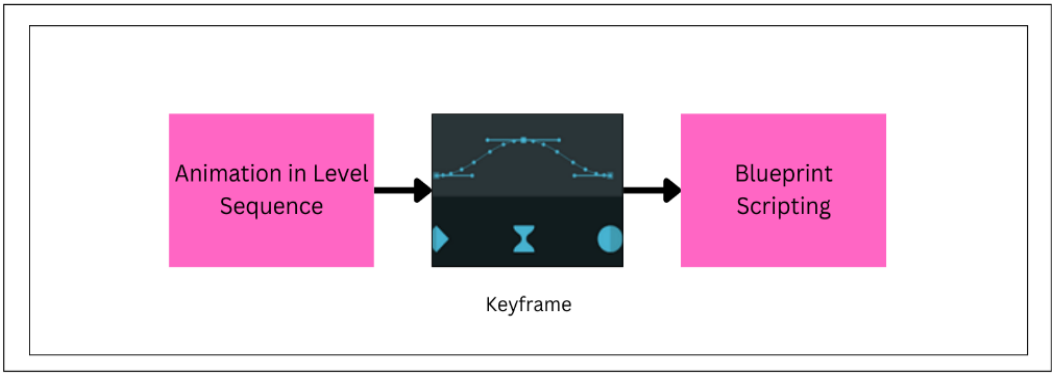


Figure 3.25 The proposed workflow for animation.

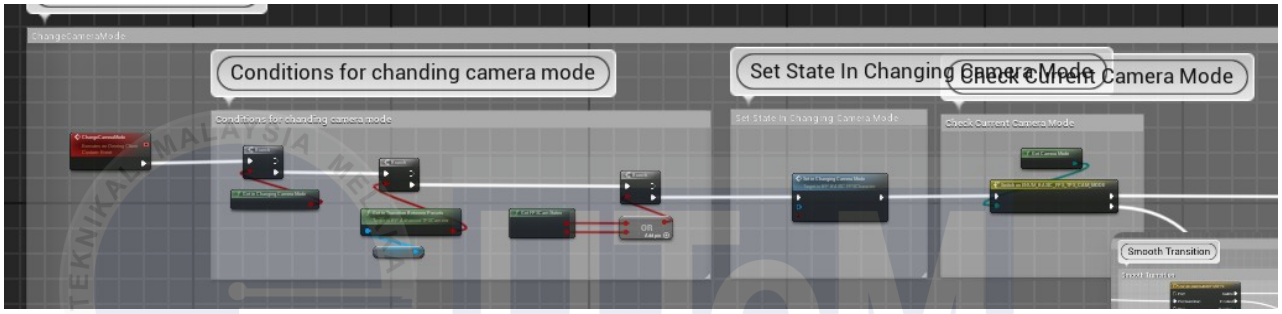
3.4.2.4 Sound Asset

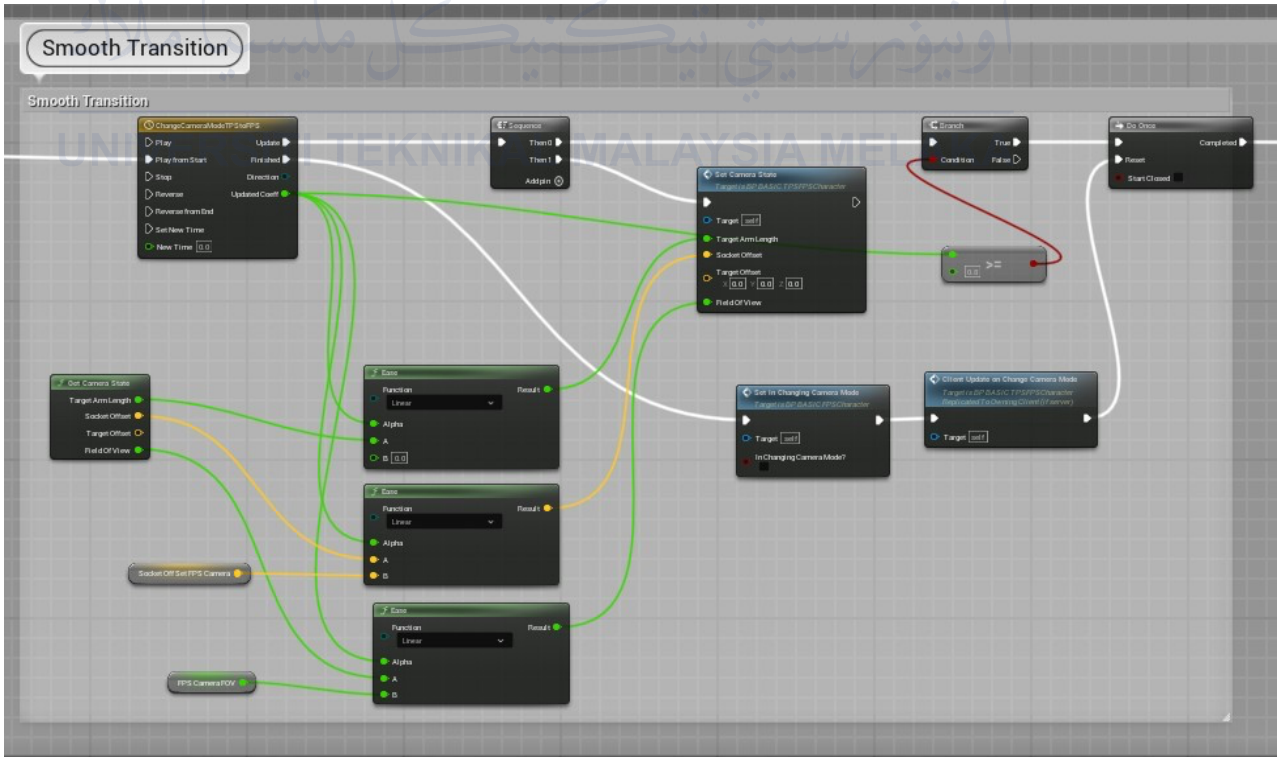
Sound assets include all audio elements used in the game, such as sound effects, ambient sounds, dialogue, and music. These assets are crucial for creating an immersive atmosphere and providing auditory feedback to players. High-quality sound design ensures that every action, from weapon fire to environmental sounds, is accurately represented.

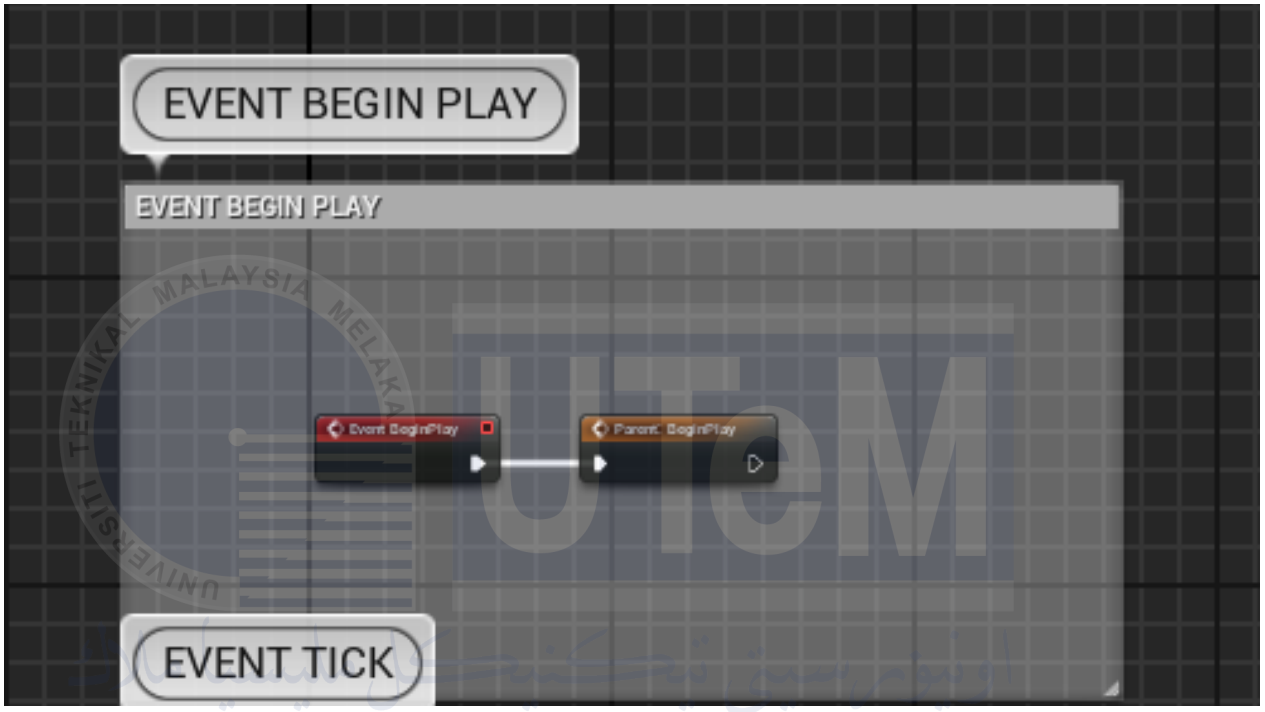
3.4.2.5 Coding and Implementation

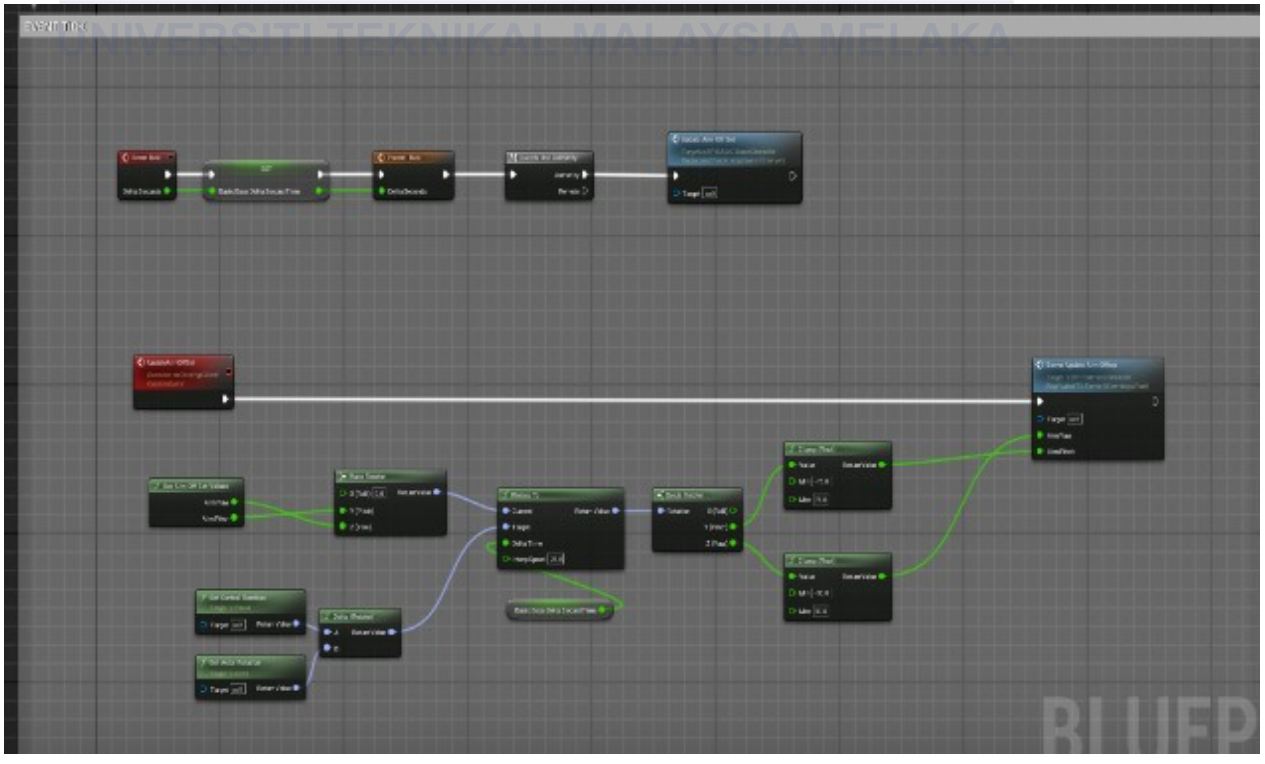
This game will be coded and implemented utilising the Unreal Engine's Blueprint visual scripting technology. This powerful tool enables the design of sophisticated gameplay mechanisms without requiring substantial programming skills, making it ideal for rapid development and iteration. The Blueprint framework will be used to create and implement a variety of game features, including character behaviours, weapon mechanics, user interface interactions, and environmental interactions. Furthermore, adopting Blueprints facilitates debugging and testing because visual scripts can be instantly altered and tested in real time,

resulting in a smooth and fast development process. This strategy not only speeds up the implementation process, but it also assures that the game remains flexible and adaptive to future upgrades and enhancements depending on student input and changing training requirements.






EVENT BEGIN PLAY
EVENT BEGIN PLAY
Event BeginPlay
Parent: BeginPlay
EVENT TICK



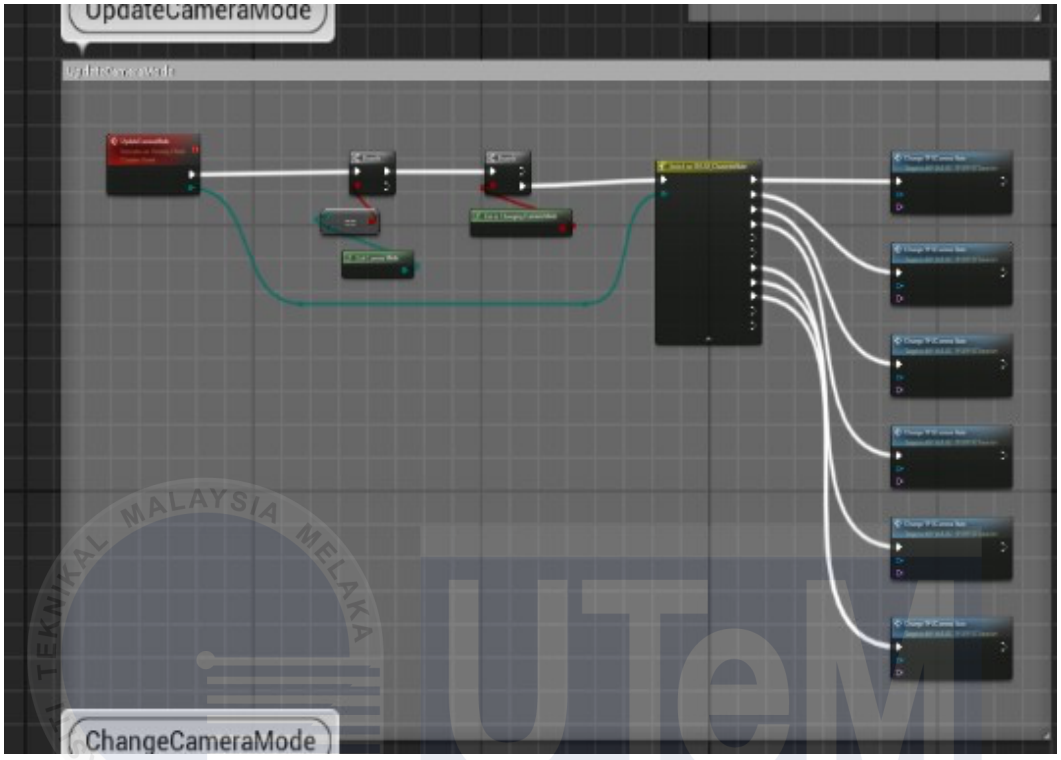


Figure 3.27 The screenshot of blueprint.

3.5 Phase 3: Evaluation

For the final phase, evaluation was conducted to achieve the third objective of the research stated in Chapter 1. The evaluation was with two types of analysis which were qualitative analysis and quantitative analysis.

3.5.1 Quantitative analysis

Quantitative analysis involves the systematic empirical investigation of observable phenomena via statistical, mathematical, or computational techniques. In the context of game development for military training, this type of analysis focuses on measurable data and

outcomes. It evaluates the effectiveness of the game through various performance metrics such as accuracy, completion times, scores, and progression rates. Structured surveys and questionnaires can gather data from cadets about their experiences and outcomes, using Likert scales to quantify responses, which can then be statistically analyzed using software tools like SPSS or R (Tashakkori & Teddlie, 2010).

3.5.1.1 Participants

A total of 15 students were recruited randomly from the UPNM students and teachers at the age of 20 until 22 as test subjects. The participants will be undergoing the SUS questionnaire along with the SSQ questionnaire evaluation. The participants were all native Malay speakers and almost half spoke English as an additional language.

3.5.1.2 System Usability Scales (SUS)

A instrument utilized to evaluate the user-friendliness of an application or game is the System Usability Scale (SUS). It employs a rating scale, frequently ranging from 1 to 5 or 1 to 7, to allow users to indicate their level of accord or disagreement with statements. Nevertheless, the development of a successful SUS necessitates more than simply selecting any questions; it necessitates the careful selection of questions that accurately evaluate usability, rendering the process complex. Its main purpose is to measure how easy something is to use, but making it requires careful thought about the questions used in the scale (Brooke, 1995).

It is crucial to acknowledge that John Brooke's 1995 study had an impact on the development and implementation of the SUS. Brooke's research established the foundation for the development of

standardized and dependable usability measures in a variety of disciplines, such as the evaluation of software and video games. To accurately evaluate usability, his work underscores the significance of meticulously selecting and phrasing questions in SUS. This makes SUS a valuable instrument for evaluating user satisfaction and ease of use with interactive systems. Consequently, John Brooke's contribution is highly pertinent to the implementation of SUS in the assessment of the playability of PC games.cThe SUS is without a doubt the most frequently utilized questionnaire for the purpose of evaluating usability. It was developed by John Brooke in 1986 (UX Research, 2017). The proposed method's usability was evaluated using SUS. The SUS questionnaire was implemented to gather data from the participants during the evaluation phase.

Participants are required to respond to ten questions on a Likert scale of 1 (strongly disagree) to 5 (strongly agree) in the SUS. The ten SUS questions are as follows:

1. I think that I would like to play this game frequently.
2. I found this game unnecessarily complex.
3. I thought this game was easy to play.
4. I think that I would need assistance to be able to play this game.
5. I found the various functions in this game were well integrated.
6. I thought there was too much inconsistency in this game.
7. I would imagine that most people would learn to play this game very quickly.
8. I found this game very cumbersome/awkward to use.
9. I felt very confident playing this game.
10. I needed to learn a lot of things before I could get going with this game.

The procedure of calculating the SUS Score is straightforward; however, it is essential to interpret each question carefully, as not all questions receive the maximum 5 points. Standalone meanings are not maintained by individual item scores. Begin by adjusting the scores that participants provided to determine the SUS Score. Add the sum of the odd-numbered questions (question 1, 3, 5, 7, and 9) and then subtract 5 from the total to obtain the strange score. For instance, the formula is X-5 if the odd tally is 21. The participant's odd-numbered total score is denoted by X. Consequently, the calculation would be 21 minus 5. The score that is unusual would be 16.

Add the sum of the even-numbered questions (question 2, 4, 6, 8, and 10) and then subtract it from 25 to obtain the even score. For instance, the formula is 25-X if the even tally is 8. The participant's total result, which is even numbered, is denoted by X. Consequently, the calculation would involve subtracting 8 from 25. The tally that is even would be 17. Subsequently, the sum of the odd and even ratings is computed. The subsequent phase involves multiplying the sum by 2.5 after the scores from all 10 questions have been summed. This equation is used to determine the ultimate SUS Score out of 100.

$$P = \frac{T}{N} \; x \; 100$$

Where:

- **P represents the SUS Score**
- **T represents the total sum of adjusted scores for all questions**
- **N represents the total number of participants**

Table 5.1: Example SUS Score Calculation

No.	Q_1	Q_2	…	Q_{10}	Scores
P_1	4	1	…	2	70
P_2	3	2	…	3	80
…	…	…	…	…	…
			Average SUS Score (P)		…

The SUS Score helps us see how easy and efficient the game are. On average, a score of 68 I like being in the middle. Scores above 68 means good performance, but if it's lower, then it's proven that the system should require more improvement. Table 5.2 is the general guideline on the interpretation of SUS score

Table 3.2: General guideline on SUS Score interpretation

SUS Score	Grade	Adjective Rating
Above 80.3	A	Excellent
68 – 80.3	B	Good
68	C	Okay
51 – 68	D	Poor
Below 51	F	Awful

3.5.2 Qualitative analysis

On the other hand, qualitative analysis examines non-numerical data such as texts, interviews, and observations to understand concepts, opinions, or experiences. In military training games, qualitative analysis provides insights into the subjective experiences of cadets, helping to understand their attitudes, motivations, and challenges. This method involves conducting in-depth interviews and focus groups with cadets to gather detailed feedback, and direct observations of cadets as they interact with the game to identify behaviors and engagement levels (Denzin & Lincoln, 2018). Thematic analysis is used to code and identify patterns within the qualitative data, providing a broader context of cadet experiences (Braun & Clarke, 2006). Case studies offer detailed accounts of individual or group experiences, highlighting specific success stories or challenges faced by cadets (Yin, 2018). For instance, qualitative analysis might reveal that cadets find certain levels of the game particularly challenging due to unclear instructions or overly complex scenarios, which can then be addressed to refine and improve the game's design (Johnson, 2022).

3.5.2.1 User Evaluation - Expert Testing

For the quantitative analysis, expert testing was conducted to evaluate the satisfaction response of the experts towards the research's results. First, a selected range of experts were chosen to undergo the testing. Then, a questionnaire derived from the expert testing conducted by van der Struijk et al. (2018) which includes several factors including accuracy, realism, satisfaction and open-ended questions were carried out to the experts and their responses were evaluated accordingly.

Figure 3.26 The expert testing process planned for the research.

3.6 Summary

This chapter discussed the methodology used in this research. The research methodology was divided into three phases that were Pre-Production, Production and Testing. The first phase was the conceptualization design of the project and the proposed game mechanics for the project. The second phase is the development phase of creating a VR project and asset creation. Finally, the evaluation method was discussed to evaluate the proposed method. The evaluation was separated into two types of analysis, which were qualitative analysis and quantitative analysis. Qualitative analysis was conducted into two visual comparison methods which were video motion comparison and past research comparison. While the quantitative analysis was conducted through the expert testing where a group of selected experts were chosen as the evaluator.

CHAPTER 4

IMPLEMENTATION

4.1 Introduction

This chapter directs attention towards the practical conversion and integration of designed game art assets into the gameplay environment. This phase signifies the transition from conceptual visualizations to tangible in-game elements.

4.2 Game Art Creation

The creation of game art is a critical component of the implementation phase, extending from the established 2D or 3D pipeline. This process entails transforming concept art and visual designs into functional game assets that players can engage with directly.

4.3 Phase 1 - Pre-production

In this phase, the first idea is sketched out on paper and then turned into a 3D plan using special software in this step. During this step, hand-drawn sketches and idea art are turned into detailed 3D models that can then be used to make real-world game assets. carefully builds these models using tools like Blender and Unreal Engine, giving them depth, texture, and realism to make the ideas come to life. This change from 2D sketches to 3D models is

important for visualizing the characters and game world, and it sets the stage for the next steps of development.

4.3.1 Production of world game and game environments

The game world was created with great care and all around are demonstrated the capabilities of Unreal Engine. Unreal Engine game environment creation is an organized, iterative approach that makes the most of the engine's potent potential. Install Unreal Engine first using the Epic Games Launcher. Then, make a new project that is specific to the genre of your game, or start from a blank template for complete customisation. First, create the basic layout and structure of the level by blocking it out with Basic Shape Polygons (BSP) brushes or Geometry Mode. Place these items in the level in a way that defines the gameplay's composition and flow. To create authenticity, use the Landscape tool in Unreal Engine to build terrain features and paint textures.

Utilizing the Material Editor, apply materials and textures to create the desired visual effects. Set up lighting sources with different settings for dynamic lighting effects and shadows to improve ambiance and realism. To improve immersion, use the particle system in Unreal Engine to add weather and background noise. Create interactive objects and AI behaviors without the need for traditional coding by using Blueprints or Visual Scripting to script gameplay mechanics and interactions. Iterate through testing phases to make gameplay more polished, performance more optimal, and elements like lighting and textures more polished for a seamless and captivating experience. Finally, make sure all of the components are integrated and optimized for fluid gameplay before deploying your project

across the various Unreal Engine-supported platforms.

4.3.2 Production of metahuman character

MetaHuman Creator's thorough and streamlined technique creates realistic and customisable human models for Unreal Engine. An Epic Games account is needed to access MetaHuman Creator on the Unreal Engine's online platform. Users choose a basic model from a variety of pre-built human figures in different ethnicities, genders, and ages to meet their needs. The tool's easy sliders and control points let users customize facial characteristics including eyes, nose, mouth, and jawline for distinctive and intricate looks.To ensure the character's physique matches the design, height, build, and muscular definition are adjusted.

There are several skin tones, hairstyles, and eye colors to choose from, and MetaHuman Creator offers realistic textures and materials to improve the character's appearance. Costumes and accessories are tailored to the character's role in the game.MetaHuman Creator has pre-built animation rigs and facial controls for realistic movements and expressions that can be previewed in the program to ensure genuine movement and emotion. Quixel Bridge, a plugin that transfers assets, exports the character to Unreal Engine after customisation. The final stage is importing MetaHuman into Unreal Engine to integrate it into the game. Developers can set up interactions, behaviors, and animations using Unreal Engine's powerful animation tools and Blueprints to make the character suit the game world. This extensive procedure creates lifelike characters that boost game realism and immersion.

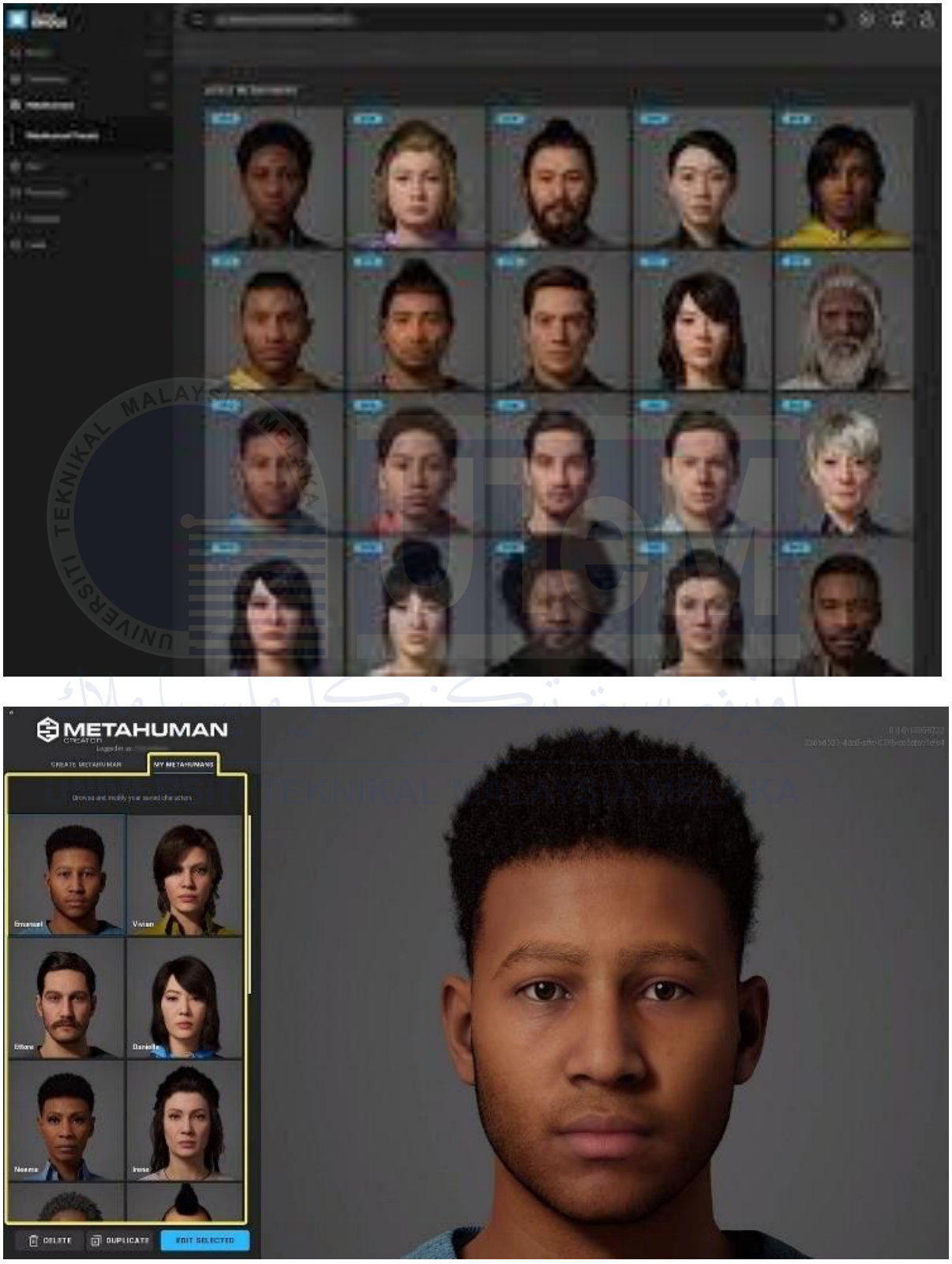


Figure 4.1 The modelling human character in MetaHuman

4.4 Phase 2 - Production

During the production stage of game development, a suite of software tools was integral to crafting various components of the game. Unreal Engine Editor served as the central hub for designing the game world, enabling tasks such as terrain sculpting, asset placement, lighting configuration, and implementing dynamic environmental effects. Blender was pivotal for creating 3D models and animations, including characters, props, and environmental elements, offering robust tools for modeling, texturing, and rigging. The MetaHuman Creator played a crucial role in developing realistic and expressive human characters with advanced facial animations. Unreal Widget was utilized for designing the game's Graphical User Interface (GUI), encompassing menus, HUD elements, and interactive interfaces. Additionally, Audacity facilitated sound design and editing, refining audio assets like sound effects, music tracks, and voiceovers to enhance immersion. These software tools collectively enabled the production team to bring together visual aesthetics, interactive elements, lifelike characters, and immersive audio into a cohesive and engaging gaming experience

4.4.1 Fps Project

4.4.1.1 Production of level design

Blender was essential to the process of turning 2D ideas into realistic 3D environments during the level design creation. I used Blender to model and sculpt objects like scenery, houses, and props to transform 2D photos into intricate 3D models. The

lighting was carefully tweaked to give the level a shiny, realistic appearance, which improved the level's aesthetic appeal and atmospheric effects. The procedure also included the creation of unique textures and materials to embellish surfaces and give the world more depth and realism. Blender's tremendous capabilities made these tasks possible. This Blender methodology made it easier to create a visually appealing and well-coordinated game world while making sure that the level design complied with gameplay and aesthetic standards.

i) Inspection level

Figure 4.2 The front view of exhibition

ii) Shooting range

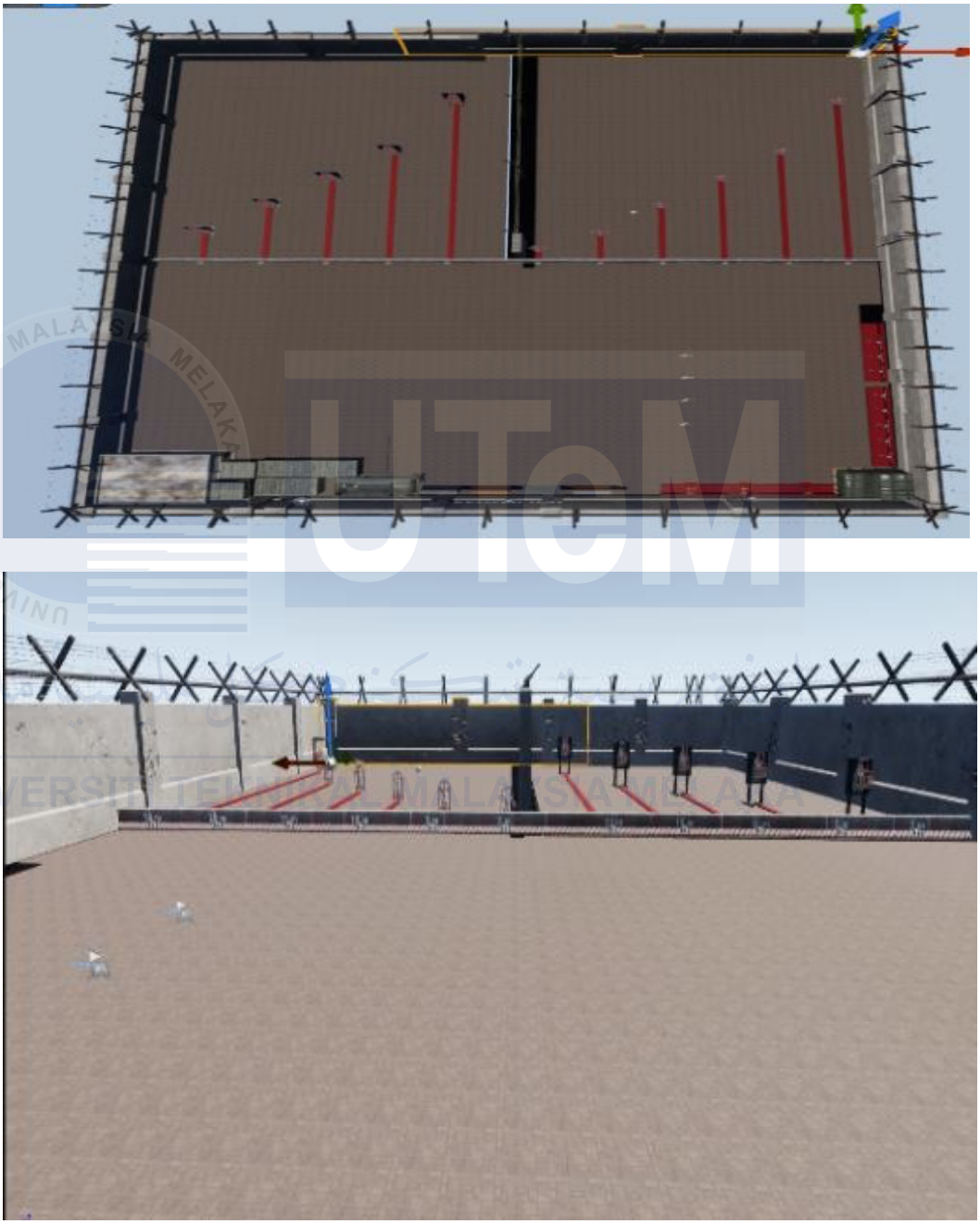


Figure 4.3 The top down view and front view of shooting range level

Figure 4.4 The top down view and front view of shooting range level but in Raining mode

iii) Game

Figure 4.5 The top down view of game level but in 3 different mode

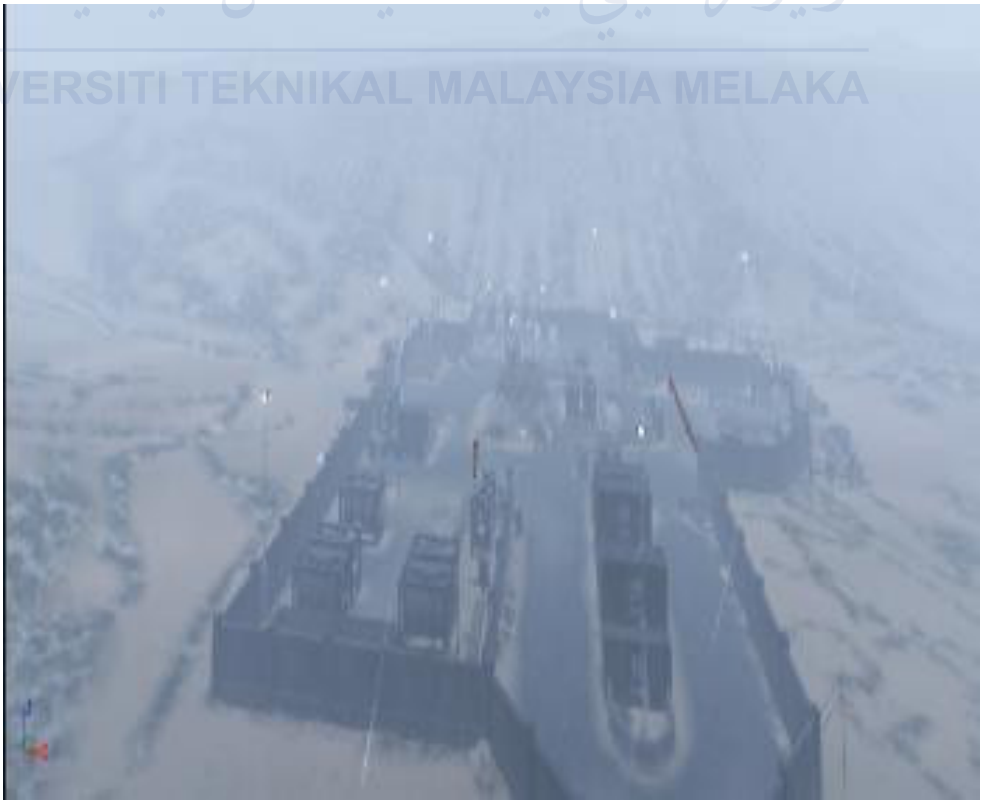


Figure 4.6 The front view of game level but in 3 different mode

4.4.1.2 Production of GUI game

Several crucial stages must be followed while creating a 3D User Interface (UI) in Unreal Engine to smoothly include interactive features into the gaming environment. Initially, designers use 3D modeling programs like Blender to create user interface elements, making sure every feature is purposefully and aesthetically designed. After that, these components are exported as FBX or OBJ files and added to the Content Browser of Unreal Engine. To achieve desired visual effects, such as translucency for panels or buttons, developers construct materials for each UI element within the Material Editor of Unreal Engine, specficing textures, colors, and transparency. The Widget Blueprint system in Unreal Engine is used by developers to construct the user interface layout by adding elements like text boxes, sliders, buttons, and images. The order of these elements in the

Widget Blueprint editor corresponds to the intended UI design. Developers can connect user interface (UI) elements to game logic using Blueprint scripting. This allows user inputs, including button clicks and slider adjustments, to impact game parameters or actions. The UI Widget Blueprint may be precisely positioned and scaled in relation to the game environment because it is implemented using the Level Viewport and placed directly within the 3D game world. The 3D user interface is continuously tested and iterated to ensure seamless operation. Changes are implemented in response to user feedback and usability testing. Lastly, to maintain optimal performance, optimization efforts concentrate on managing draw calls, texture sizes, and overall complexity; interactive elements and animations are introduced to improve user engagement and usability. Through a thorough procedure, the Unreal Engine 3D user interface is guaranteed to meet technological specifications while also improving immersion and usability in the gaming experience.

Figure 4.7 The main menu screen

Figure 4.8 The winning screen

Figure 4.9 The game over screen

4.4.1.3 AI NPC using Speech-to-text

The ConvAI API as shown as figure below is a powerful tool for any game developer because it has all the functionalities of making a character such as narrative design dialogue, knowledge bank, voices to match the characters and custom created characteristics. In this section, the research will guide through on how the proposed AI NPC character design is made and integrated into the game.

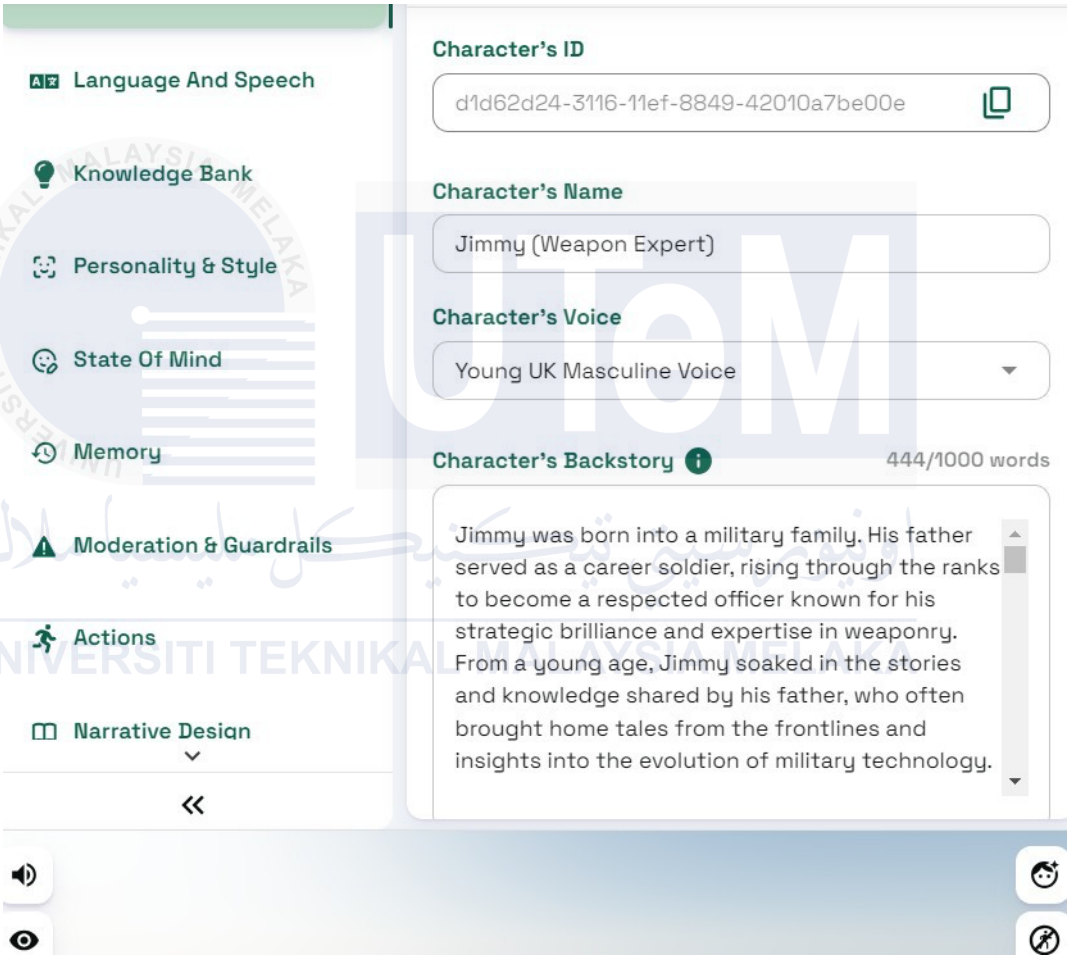


Figure 4.10 The proposed character design with the character's backstory

4.4.2 Asset creation

4.4.2.1 Production of world asset

Blender was used to carefully create world assets, which were then exported to Unreal Engine for integration. Blender's modeling and texturing skills enabled detailed and optimized 3D models. These components included buildings, topography, props, and interactive objects.Blender was used to create and model each object. This required high- quality polygons and complex texturing for realism and aesthetics. Sculpting and procedural texturing gave the models depth and complexity. After modeling and texturing, the components were optimized for Unreal Engine real-time rendering.After developing the assets in Blender, it were exported in FBX, which preserves geometry and material information. We imported these exported files into Unreal Engine's Content Browser. Integrating the imported components into Unreal Engine's game world brought the environment to life with real-time rendering. Lighting, physics, and collision attributes were adjusted to assure asset interaction in the game.This Blender-to-Unreal Engine pipeline created a rich and engaging gaming world with detailed visuals and interactive and dynamic features. This method made the gaming environment visually appealing, technically robust, and gameplay optimized.

i) Ammo

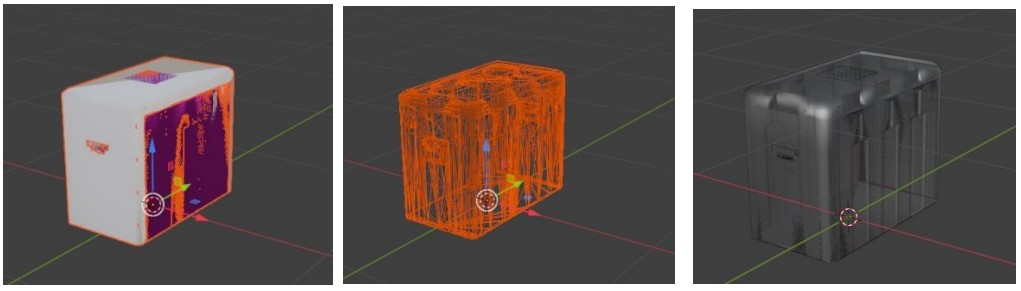


Figure 4.11 The model of ammo in Blender

ii) Barbed Wire

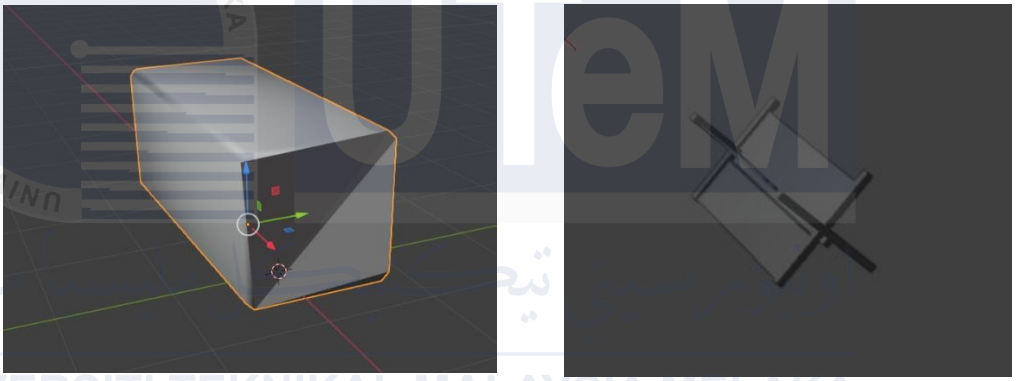


Figure 4.12 The model of Barbed Wire in Blender

iii) Barrel

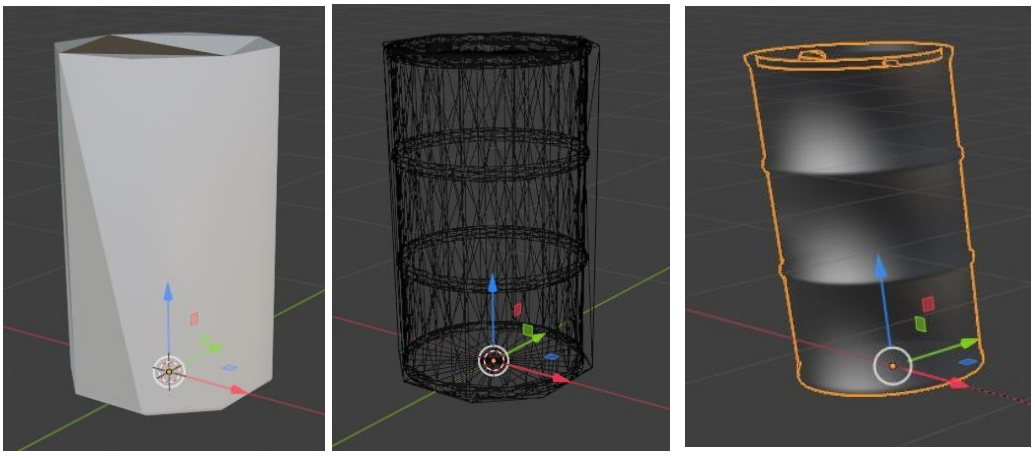


Figure 4.13 The model of Barrel in Blender

iv) Bombshell

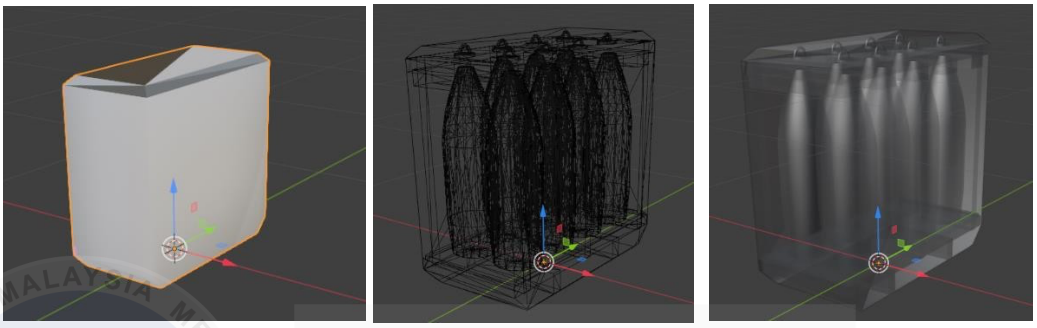


Figure 4.14 The model of Bombshell in Blender

v) Bush

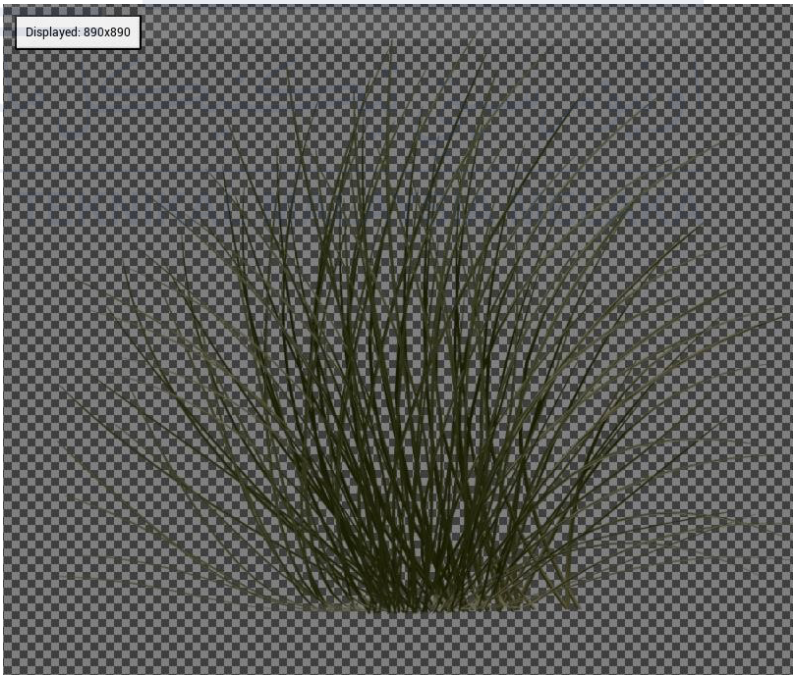


Figure 4.15 The image of Bush

4.4.2.2 Production of sound asset

Producing sound in Audacity involves a series of methodical steps that ensure high-quality audio for multimedia projects. The process begins with recording audio directly into Audacity by connecting a microphone to the computer. Alternatively, pre-recorded audio files can be imported using the File > Import option. Once the audio is loaded, it is edited using various tools to trim, cut, copy, and paste clips, allowing for precise adjustments and seamless combinations of different tracks. To enhance the audio, effects such as Equalization (EQ), Reverb, Noise Reduction, and Compression are applied. Volume adjustments are made using the Gain slider, and the Pan slider is used for stereo positioning to create a spatial audio experience. For projects like game sound design, creating seamless loops and layering multiple tracks to build complex audio scenes is essential. Once the editing and enhancement are complete, the final step is to export the audio in the desired format, such as WAV for high quality or MP3 for smaller file sizes, using the File > Export option. After exporting, the audio is tested on different devices to ensure it meets quality standards and is suitable for the intended context. Any necessary adjustments are made in Audacity before re-exporting the file, ensuring the final product is polished and professional.

4.4.2.2 Production of animation

i) Production weapon animation using level sequence

Creating animations in Unreal Engine using Level Sequences involves several detailed steps. Start by opening your project in Unreal Engine or creating a new one, ensuring all necessary assets (characters, props, environments) are imported. Navigate to the Content Browser and optionally create a new folder for organization. Right-click, go to **Animation**, and select

Level Sequence, naming it appropriately. Double-click the newly created Level Sequence to open the Sequencer editor, which consists of the timeline, track panel, and playback controls. To animate, drag and drop actors from the World Outliner or Content Browser into the Sequencer's track panel. For each actor, add tracks by clicking the **+ Track** button next to their name. You can add various tracks such as Transform, Animation, and Event tracks to control different aspects of the actors' animations. Adjust keyframes on the timeline to define movements, rotations, and other properties over time. Once your sequence is complete, you can preview it within the Sequencer and make any necessary adjustments. Finally, you can render your animation or use it within your game or cinematic sequence.

Figure 4.22 The making shortgun animation using level sequence in UnrealEngine

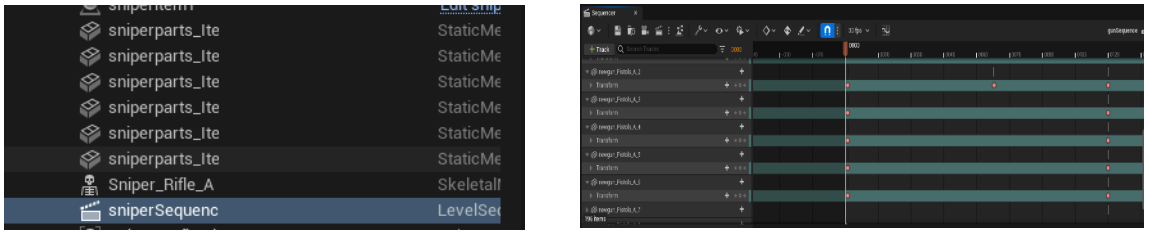


Figure 4.23 The making sniper animation using level sequence in UnrealEngine

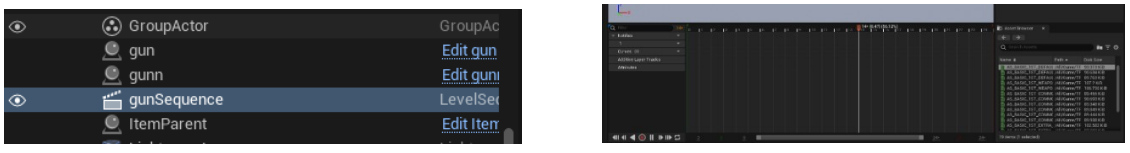


Figure 4.24 The making gun animation using level sequence in UnrealEngine

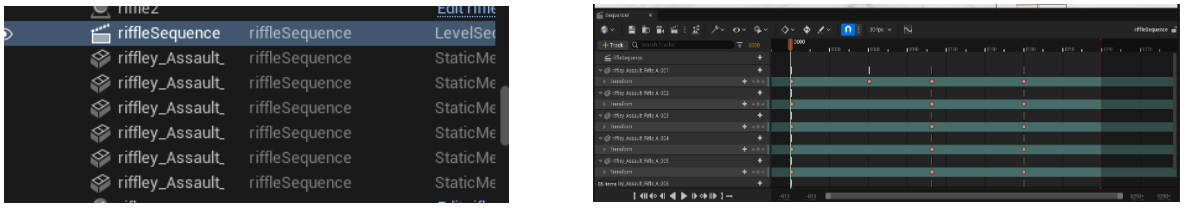


Figure 4.25 The making assault riffle animation using level sequence in UnrealEngine

ii) Production character animation using level sequence

Creating first-person shooter (FPS) arm animations for reloading, shooting, and running in Unreal Engine involves several detailed steps. Begin by opening your existing FPS project or creating a new one, ensuring that the necessary arm and weapon models are imported. Using a 3D modeling and animation software such as Blender, Maya, or 3ds Max, create the animations for reloading, shooting, and running, then export these animations in a compatible format like FBX. In Unreal Engine, import the FBX files containing your models and animations, and verify that they play correctly in the preview window. Next, create an Animation Blueprint by right-clicking in the Content Browser, selecting **Animation,** and choosing **Animation Blueprint** with the arm skeleton. Open the blueprint and navigate to the Anim Graph to create animation states for **Idle, Shooting, Reloading**, and **Running** using a State Machine to manage transitions. Finally, set up transition rules based on game inputs and conditions to ensure the animations play seamlessly during gameplay. This comprehensive setup will allow your FPS arms to move realistically when performing actions such as reloading, shooting, and running.

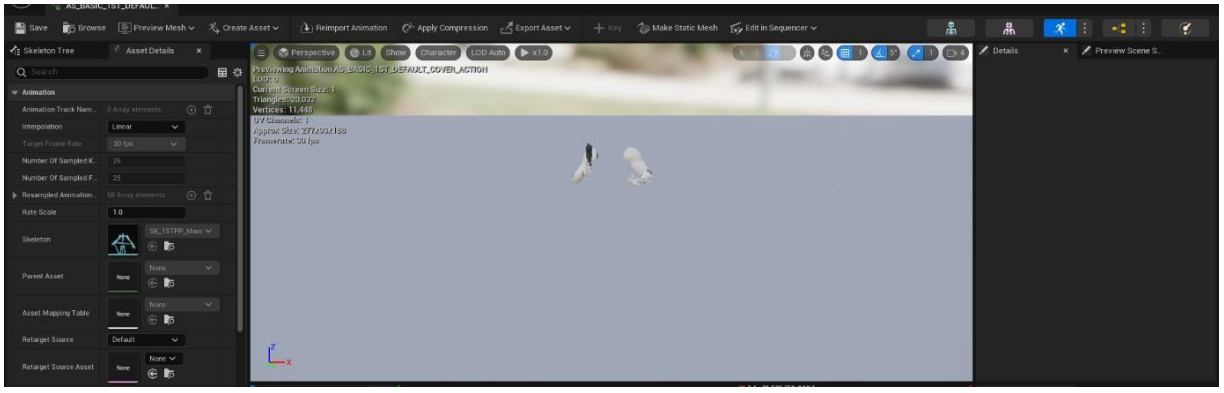


Figure 4.26 The making reload animation using level sequence in UnrealEngine

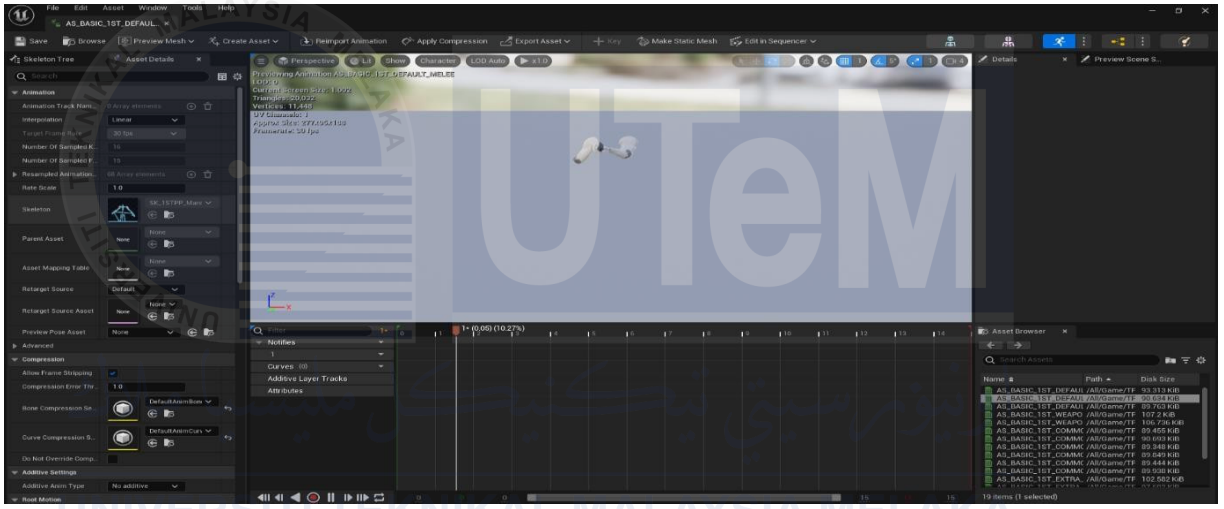


Figure 4.27 The making shooting animation using level sequence in UnrealEngine

4.5 Phase 3 - Evaluating the shooting performance based on few factors

Testing will be conducted to evaluate how distance and weather factors affect the shooting range and damage in a first-person shooter (FPS) game. Distance testing will focus on several key aspects. Bullet drop will be observed at various target distances to ensure that gravity's effect on projectiles is accurately simulated, requiring players to adjust their aim accordingly. The accuracy of shots will be measured over longer distances, accounting for

increased bullet spread and ensuring that weapons behave realistically. Additionally, the travel time of bullets will be assessed to determine how it impacts the player's ability to hit moving targets, necessitating adjustments in projectile speed and timing mechanics. Damage falloff will also be examined, where weapons deal progressively less damage at greater distances to maintain balanced gameplay.

Weather testing will introduce dynamic conditions such as rain and sunshine to the game environment, specifically focusing on their impact on accuracy. Rain will be evaluated for its effects on visibility and potential changes in bullet speed due to air density variations, which can lead to decreased accuracy. Sunny conditions, while generally improving visibility, might also introduce glare or heat haze that can affect a player's aim. By rigorously testing these factors, developers can refine the game's accuracy models, ensuring that players experience a realistic environment where weather significantly influences their shooting precision.

4.6 Summary

The implementation of the research methodology mentioned before in Chapter 3 was discussed further in this chapter.

CHAPTER 5

RESULTS AND EVALUATION

5.1 Introduction

This chapter discussed the evaluation of the extracted motions which are the result motions for the research based on the methodology planned in chapter 3. The evaluation involved were separated into two types of analysis which are qualitative analysis and quantitative analysis.

5.2 Quantitative Analysis

Quantitative analysis in game testing uses numerical data and statistical methods to evaluate a game's performance, usability, and overall quality, providing objective insights into how the game functions and how players interact with it (Nielsen, 1993). This approach enables developers to make data-driven decisions, identifying strengths and weaknesses to enhance the gaming experience. By analyzing metrics such as usability, performance, and player satisfaction, and combining these findings with qualitative feedback, developers gain a comprehensive understanding of the game's impact, leading to a more engaging and successful product

5.2.1 Participants

This section presented the results of participants' background. 15 participants were recruited. The participants are all boys. All the participants are students from Universiti Pertahanan

Malaysia UPNM

5.2.2 System Usability Scales (SUS)

Ten participants who participated in testing the research proposed method are picked and have filled in the SUS survey forms. Table 5.1 shows SUS results with the total result and the SUS means scores. Q stands for SUS number items while P stands for participants' number. Based on the result of the usability study, the SUS scores results are 87.17. Based on the Table 3.2 in section 3.5.1.2, the result shows that the research proposed method falls in grade A and has good usability scores.

System Usability Scales (SUS) Table

NO	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Scores
P1	4	4	5	1	5	1	5	1	4	1	87.5
P2	5	1	5	2	4	2	4	1	5	2	87.5
P3	5	3	3	3	3	3	3	3	3	3	55
P4	5	1	5	2	5	1	5	1	5	1	97.5
P5	5	1	5	1	5	1	5	1	5	1	100
P6	5	2	5	1	5	2	5	1	5	1	95
P7	4	2	4	2	4	1	4	1	5	2	82.5
P8	5	2	4	2	4	2	5	1	5	1	75
P9	5	1	5	1	5	1	5	1	5	1	100
P10	5	1	5	2	5	1	5	1	5	1	97.5
P11	4	2	4	2	3	3	4	3	3	1	67.5
P12	5	1	5	1	5	1	5	1	5	1	100

P13	**5**	**2**	**5**	**1**	**5**	**3**	**3**	**1**	**5**	**1**	**87.5**
P14	**5**	**1**	**5**	**1**	**5**	**1**	**5**	**1**	**5**	**1**	**100**
P15	**4**	**2**	**5**	**3**	**3**	**1**	**5**	**2**	**4**	**3**	**75**
SUM											**1307.5/15 = 87.17**

Table 5.21 SUS results

The System Usability Scale (SUS) result for the game testing was 87.17. This score indicates a high level of usability, suggesting that the game is well-designed and user-friendly, with participants finding it intuitive and easy to use.

5.2.2 **Accuracy of** weapon in the game with real weapon

The accuracy of a weapon is influenced by multiple factors, each affecting the precision with which a target can be hit. Understanding these factors is crucial for both game developers aiming to create realistic simulations and for users looking to optimize their performance in gameplay or real-world scenarios. The primary factors impacting weapon accuracy are distance and weather conditions. Distance plays a critical role, with closer targets generally resulting in higher accuracy due to a more predictable trajectory and minimal external interference, such as wind or gravity. At longer distances, however, accuracy decreases as gravity causes the projectile to drop, and it becomes more susceptible to wind, air resistance, and other environmental factors. This makes it harder for the shooter to maintain precision, especially as the target appears smaller and more challenging to judge. Weather conditions are equally important, with clear weather providing an ideal environment for accuracy due to stable air, minimal wind, and optimal visibility. In contrast, adverse weather conditions, such as rain or cloudy

skies, can significantly reduce accuracy. Rain increases air density, slowing down the projectile and potentially causing it to deviate, while moisture can affect the weapon's mechanics. Cloudy conditions, though less severe, can still affect accuracy by diffusing light and reducing visibility, and if accompanied by wind, can push the projectile off course.

5.2.2.1 Difference distance and weapon

When selecting a weapon for different ranges, each type offers distinct advantages based on its design and intended use. For close-range engagements, shotguns are highly effective due to their wide spread of pellets, which increases the likelihood of hitting the target and delivers a powerful blast, making them ideal for self-defense and confined spaces (Harris, 2013). Handguns are also suitable for close range, offering accuracy and maneuverability in tight quarters, thanks to their short barrels (Kopel, 2007). For medium-range combat, assault rifles are well-suited due to their combination of accuracy and rapid fire capability, making them versatile for distances typically ranging from 100 to 300 meters (Martin, 2007). While sniper rifles can also be used at medium range, they are generally overqualified for this distance and are typically reserved for long-range precision shooting. At long ranges, sniper rifles excel with their high-powered optics and ammunition designed for maintaining accuracy over extended distances, often beyond 1,000 meters, making them the best choice for precision shooting at these ranges (Harris, 2013). Assault rifles can be effective at long range but generally have reduced accuracy beyond 500 meters compared to sniper rifles, making them less specialized for extreme distances (Martin, 2007).

5.2.2.2 Weather

Rain and cloudy conditions each pose unique challenges that significantly impact shooting accuracy. Rain affects shooting precision in several ways. The increased air density due to rain creates additional drag on the projectile, slowing it down and causing it to deviate from its intended path, which is particularly noticeable over longer distances (Wilson, 2008). Moisture can also impact the weapon itself, making the barrel slick and potentially leading to malfunctions or decreased reliability (Kopel, 2007). Additionally, rain can reduce visibility by causing droplets on optics, which obscures the target and complicates aiming. The shooter's comfort and stability can be compromised as well, with wet conditions making grips slippery and increasing the likelihood of discomfort and distraction (Graham, 2010).

Cloudy conditions, on the other hand, primarily affect accuracy through diffused lighting and reduced contrast. Cloud cover spreads light more evenly, which can obscure the target and make it harder to see clearly, especially at longer ranges (Wilson, 2008). This reduced contrast can make it difficult for shooters to acquire and maintain a precise sight picture, and varying light conditions due to shifting clouds can create inconsistent brightness and shadows, further complicating aiming (Graham, 2010). Both rain and cloudy weather require shooters to adjust their techniques and equipment to mitigate these effects and maintain accuracy.

5.3 Qualitative Analysis

Qualitative analysis in game testing provides valuable insights by examining the subjective experiences and perceptions of players. Unlike quantitative analysis, which focuses on numerical data

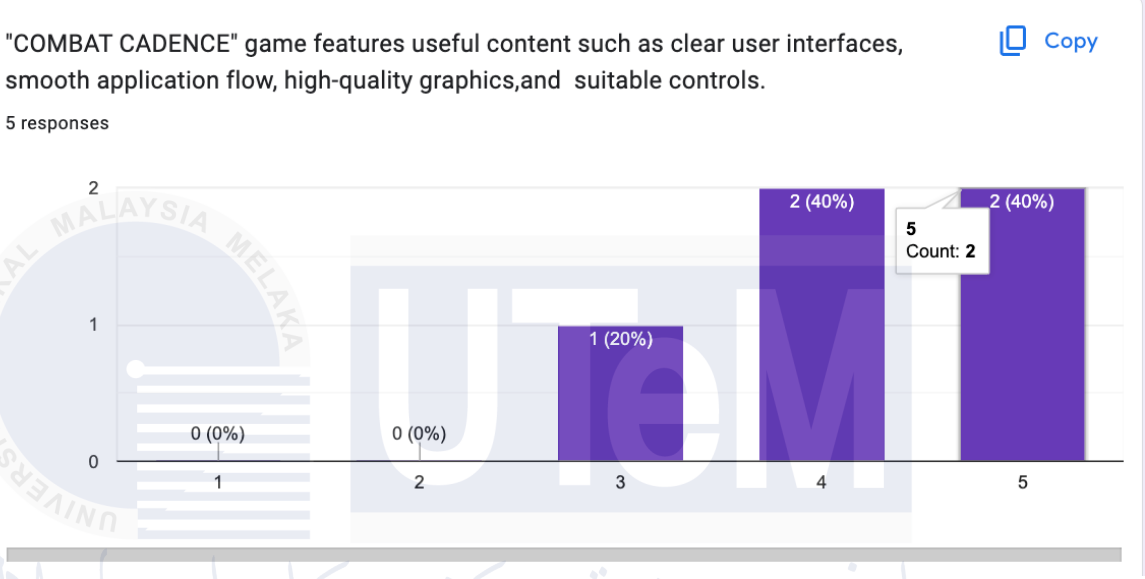
and statistical trends, qualitative analysis delves into the emotional, cognitive, and narrative aspects of gameplay. This approach involves gathering detailed feedback through methods such as interviews, focus groups, and observation of playtesting sessions. It helps developers understand how players interact with the game, identify usability issues, and evaluate the effectiveness of game mechanics, narrative elements, and artistic design. By capturing players' reactions, preferences, and challenges, qualitative analysis aids in refining gameplay, enhancing user experience, and ensuring that the game resonates on a deeper level with its audience. This holistic approach complements quantitative data, offering a well-rounded perspective on the game's overall quality and player engagement.

5.3.1 Expert Review

To test the game, reviews were gathered from five military experts holding various ranks and roles, including lieutenants, PTT (Persekutuan Tentera) personnel, staff members, and sergeants. These experts provided a specialized perspective based on their extensive experience in tactical and strategic scenarios. Their insights helped evaluate the game’s realism, mechanics, and overall effectiveness in simulating military operations. By leveraging their expertise, the testing process was able to assess the game's accuracy and functionality from a professional standpoint, ensuring that it met high standards of realism and operational integrity.

5.3.1.1 Question 1:

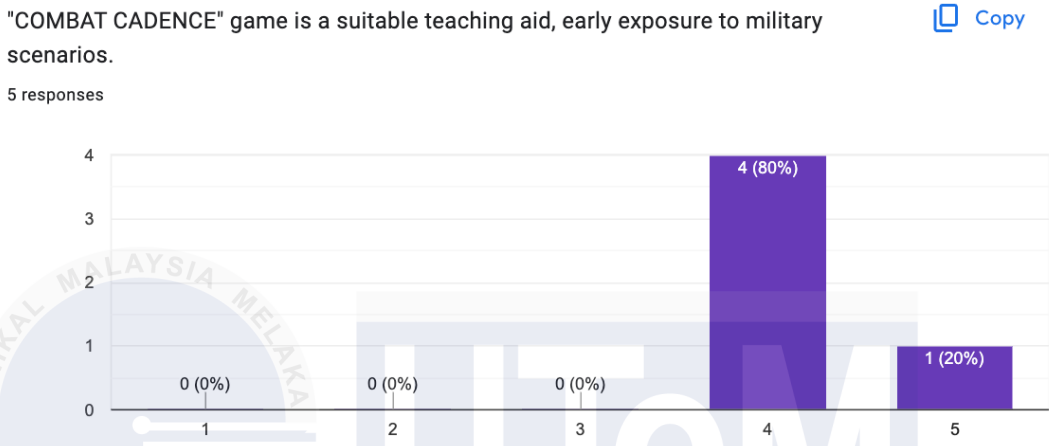
"COMBAT CADENCE" game features useful content such as clear user interfaces, smooth application flow, high-quality graphics,and suitable controls.



The expert feedback on the "COMBAT CADENCE" game, as depicted in the graph, reveals a generally positive assessment of its features, including the user interface, application flow, graphics quality, and controls. Specifically, 40% of the experts strongly agreed that the game excels in these areas, indicating a high level of satisfaction with the design and functionality. Another 40% of the experts agreed, reinforcing the perception that the game effectively incorporates these features, though perhaps with slightly less enthusiasm. Meanwhile, 20% of the experts remained neutral, suggesting they neither found the features particularly impressive nor lacking. Overall, the responses reflect a strong endorsement of the game's content and design from the majority of the experts, with only a minor degree of ambivalence.

5.3.1.2 Question 2:

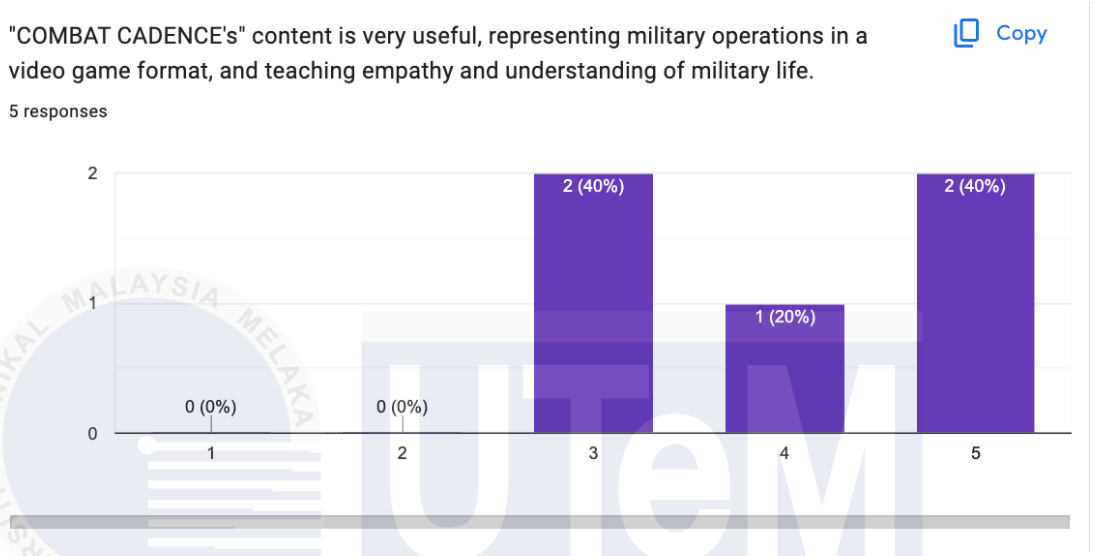
"COMBAT CADENCE" game is a suitable teaching aid, early exposure to military scenarios.



The graph illustrates the expert opinions on whether the "COMBAT CADENCE" game serves as a suitable teaching aid, providing early exposure to military scenarios. Among the five respondents, 80% (4 experts) agreed that the game is effective in this role, indicating a strong consensus that it has educational value in simulating military environments. Additionally, 20% (1 expert) strongly agreed, showing a high level of confidence in the game's ability to function as a teaching tool. Notably, there were no responses of disagreement or neutrality, suggesting that all experts acknowledge the game's potential in this educational context, with varying degrees of endorsement. The overall feedback is highly positive, with the majority of experts affirming the game's suitability for teaching and training purposes.

5.3.1.3 Question 3:

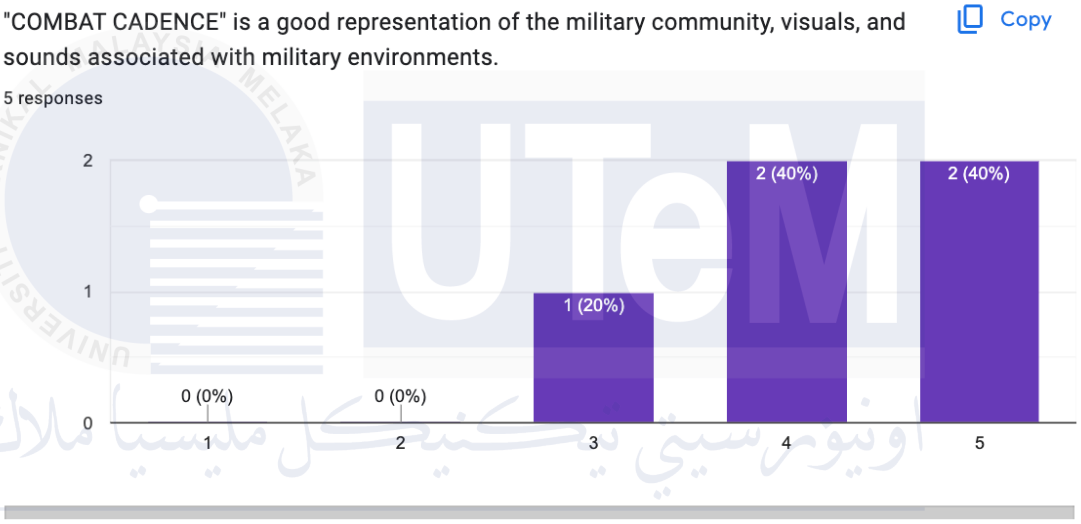
"COMBAT CADENCE's" content is very useful, representing military operations in a video game format, and teaching empathy and understanding of military life.



The responses to the third question regarding the usefulness of "COMBAT CADENCE" in representing military operations in a video game format, and its effectiveness in teaching empathy and understanding of military life, reveal a mixed but generally positive sentiment among the experts. According to the graph, 40% (2 experts) strongly agreed that the game's content is highly useful for these purposes, showing strong support for its educational and representational value. One expert (20%) agreed, further indicating that they found the content beneficial, though perhaps with less intensity. However, 40% (2 experts) remained neutral, neither endorsing nor criticizing the game's ability to convey military operations and foster empathy. This suggests that while a significant portion of the experts sees clear value in the game's content, there is also a notable proportion that is undecided, reflecting a range of perspectives on its effectiveness in achieving these specific educational goals.

5.3.1.4 Question 4:

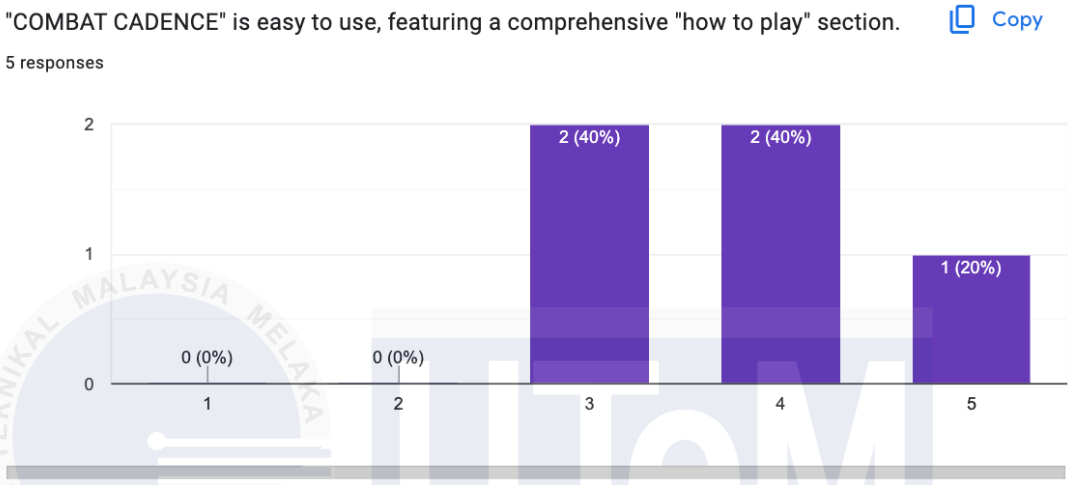
"COMBAT CADENCE" is a good representation of the military community, visuals, and sounds associated with military environments.



For Question 4, two experts strongly agreed that the content effectively represents the military community, including the visuals and sounds associated with military environments. These experts highlighted that the game authentically captures the essence of military life through its realistic portrayal of the atmosphere and elements like sound effects and visual design. Meanwhile, two other experts agreed with this assessment, reinforcing the overall positive reception of the game's representation of military themes. However, one expert remained neutral, neither fully endorsing nor criticizing the content, suggesting that while the game meets many expectations, there may still be areas for improvement.

5.3.1.5 Question 5:

"COMBAT CADENCE" is easy to use, featuring a comprehensive "how to play" section.



For Question 5, one expert strongly agreed that the game is user-friendly, particularly emphasizing the effectiveness of its comprehensive "how to play" section, which provides clear and detailed instructions for players. This expert found the guidance helpful in navigating the game with ease. Two other experts also agreed, indicating that the game's usability meets expectations and that the instructional content is generally accessible and helpful. However, two experts were neutral, suggesting that while the game is functional, there may be some aspects of the user experience or instructional clarity that could benefit from further refinement.

5.3.1.6 Question 6 - Open Ended Question and Suggestion

The feedback provided emphasizes the need to incorporate additional realistic elements to enhance the research project involving the game. Respondents specifically recommended including common weapons utilized by the Malaysian Army, such as grenade launchers, to improve students' understanding of military equipment. Furthermore, they suggested adding more detailed war scenarios to better train cadets in realistic combat situations. The respondents also noted the absence of certain critical real-life weapons and advised incorporating these to increase the overall realism of the game. These suggestions aim to improve the game's effectiveness as a training tool by aligning it more closely with real-world military operations.

5.4 Summary

The testing of the game employed both quantitative and qualitative analysis methods to ensure a comprehensive evaluation. Quantitative analysis was conducted using the System Usability Scale (SUS), resulting in a score of 87.17, indicating a high level of usability. This metric provided clear, measurable insights into the overall effectiveness and user satisfaction with the game. In addition to this, qualitative analysis was performed by gathering detailed feedback from participants. This feedback included suggestions for improving the game's realism by incorporating more authentic elements, such as weapons and combat scenarios used by the Malaysian Army. Together, these approaches offered a balanced assessment, combining statistical data with in-depth user perspectives to guide further enhancements of the game.

CHAPTER 6

CONCLUSION

6.1 Introduction

The research conducted aimed to address three key objectives: studying immersive and interactive learning experiences focused on weaponry for military students, developing and conducting accuracy testing for various weapons to assess their functionalities and effectiveness, and evaluating the effectiveness of a game-based approach in preparing students for real-life weapon handling scenarios. By integrating these objectives, the research sought to create a comprehensive tool that enhances military training through technology-driven, interactive learning.

6.2 Contribution

This study made several significant contributions to the field of military training and education. Firstly, it provided an in-depth analysis of how immersive and interactive learning environments can be effectively applied to military education, particularly in the context of weaponry. Secondly, the research introduced a systematic method for accuracy testing of various weapons, allowing users to gain practical insights into their functionalities and effectiveness.

Lastly, the evaluation of the game demonstrated its potential as an effective training tool, offering a realistic simulation that prepares students for the complexities of weapon handling in real-world scenarios.

6.3 Limitation

The research faced several critical limitations that influenced both the development process and the final outcomes. Firstly, time constraints were a significant challenge, limiting the scope of the project and the extent to which various features could be explored and integrated. The limited timeline restricted thorough testing, refinement, and iteration cycles, which are crucial for developing a fully polished and effective training tool.

Secondly, the lack of access to a high-end laptop presented substantial obstacles in the game's development. Game development, particularly when aiming for high levels of realism and interactivity, requires robust hardware to handle intensive tasks such as rendering detailed graphics, processing complex simulations, and ensuring smooth performance. Without access to such equipment, the development process was constrained, resulting in compromises on the graphical quality, complexity of scenarios, and overall user experience. This limitation also affected the ability to implement advanced features such as more realistic physics, detailed environments, and immersive sound design, which are essential for creating an authentic and effective military training simulation.

These constraints ultimately impacted the overall quality and effectiveness of the game. While the project successfully met its primary objectives, addressing these limitations could have allowed for a more comprehensive and refined final product. Future efforts to overcome these challenges would significantly enhance the game's capability as a training tool, providing a more

immersive and realistic experience for military students.

6.4 Future Work

Future work should focus on addressing the limitations identified in this study. Expanding the range of weapons and scenarios included in the game will enhance its realism and applicability to a wider array of military training contexts. Moreover, incorporating more advanced technologies, such as virtual and augmented reality, could further immerse students in the learning experience, providing even more accurate and effective training. Next , for future improvement this testing will test to IT students and IT expert to evaluate the game effectiveness. Additionally, future research should explore the long-term impact of using such games in military training, assessing how they influence skill retention and operational readiness over time. By building on the foundation established in this research, future developments can continue to improve the effectiveness of immersive and interactive learning tools for military education.

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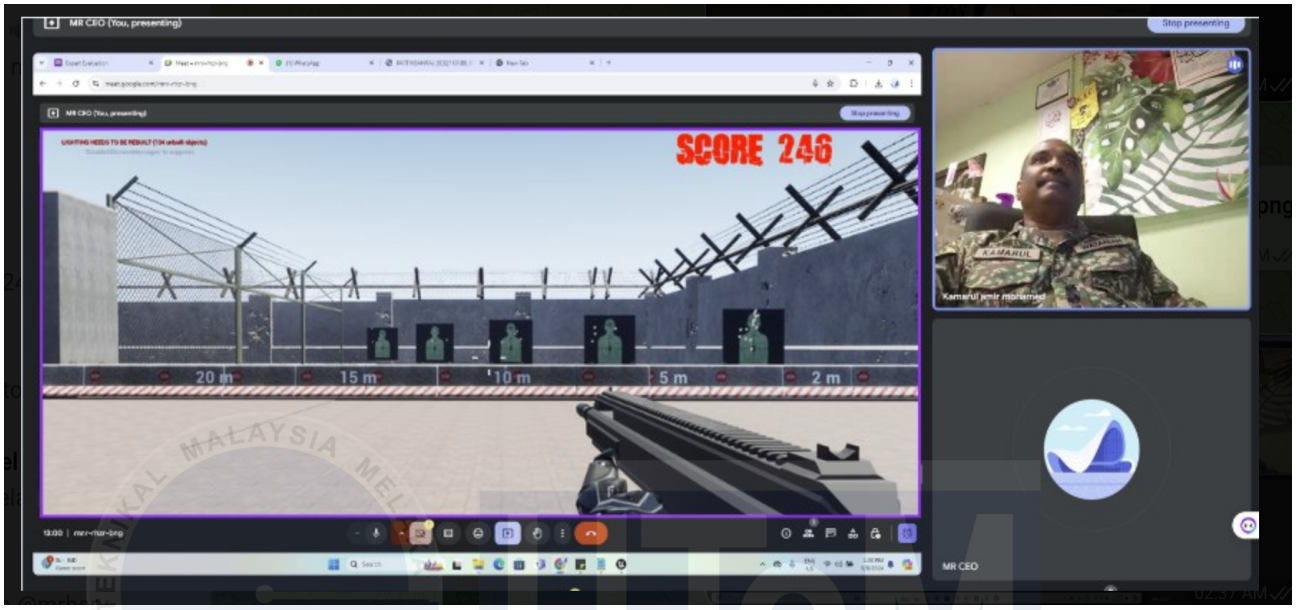
APPENDIX A- TESTING



APPENDIX B - SHOWCASE (G2DID)