BACHELOR THESIS & COLLOQUIUM – ME 184841

THE DEVELOPMENT OF LIFE-SAVING APPLIANCES INSPECTION TRAINING USING VIRTUAL REALITY APPLICATION

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SUPERVISOR :
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DOUBLE DEGREE PROGRAM OF
DEPARTEMENT OF MARINE ENGINEERING
FACULTY OF MARINE TECHNOLOGY
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SKRIPSI– ME 184841

Pengembangan Pelatihan Inspeksi Alat-Alat Keselamatan Dengan Menggunakan Aplikasi Virtual Reality

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SURABAYA
2019

APPROVAL FORM

THE DEVELOPMENT OF LIFE-SAVING APPLIANCES INSPECTION TRAINING USING VIRTUAL REALITY APPLICATION

BACHELOR THESIS

Submitted to Comply One of the Requirements to Obtain a Bachelor Engineering Degree
on
Laboratory of Marine Operational and Maintenance (MOM)
Bachelor Program Departement of Marine Engineering
Faculty of Marine Technology
Sepuluh Nopember Institute of Technology

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DECLARATION OF HONOR

I hereby who signed below declare that:

This final project has written and developed independently without any plagiarism act. All contents and ideas drawn directly from internal and external sources are indicated such as cited sources, literatures and other professional sources.

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Departement	:	Marine Engineering

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Surabaya, July 2019

Rafiqi Zulfauzi Pribadi

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THE DEVELOPMENT OF LIFE-SAVING APPLIANCES INSPECTION TRAINING USING VIRTUAL REALITY APPLICATION

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ABSTRACT

The evolution of technology has made it possible to enhance the development in marine industry. Indonesia is one country that has a great maritime potential. Indonesia consist of a group of islands with a coastline with long until 95,000 km. With existing geographical circumstances, Indonesia has a great potential for marine industry. Indonesia has sector of the economy that is not reliant on the mainland, but also in maritime field and make maritime based economy continues to grow in Indonesia and enhance the development of other industries. One of the developments in the maritime sector applications of advanced computer graphics technology. Ranging from marketing and design over manufacturing support to familiarization, training and maintenance assistance for marine survey, there is no phase in the lifecycle of a ship or seaborne structure that would not profit from 3D modelling, simulation, virtual/augmented reality or computer vision. In this application there are two features that are inspection mode to complete some mission when inspection are carried out and free-roam mode to explore and provide information about inspection cheklist item. With VR a user can build their competence for ship inspections, and experience tells them where to focus attention without any risk. Virtual reality brings the knowledge and can give experience of many users that can be accessed for training anywhere and any time with easily.

Keywords: Virtual Reality, Inspection Training, Life Saving Appliances, 3d Modelling

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PENGEMBANGAN PELATIHAN INSPEKSI ALAT-ALAT KESELAMATAN DENGAN MENGGUNAKAN APLIKASI VIRTUAL REALITY

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ABSTRAK

Evolusi teknologi telah memungkinkan untuk meningkatkan pengembangan di industri kelautan. Indonesia adalah salah satu negara yang memiliki potensi maritim yang besar. Indonesia terdiri dari beberapa pulau dengan garis pantai dengan panjang hingga 95.000 km. Dengan keadaan geografis yang ada, Indonesia memiliki potensi besar dalam bidang industri kelautan. Indonesia tidak hanya bergantung pada ekonomi daratan, tetapi juga memanfaatkan bidang maritim dan menjadikan bidang maritim untuk menunjang ekonomi yang terus tumbuh dan meningkatkan pengembangan industri lain. Penerapan teknologi grafis komputer yang canggih. Mulai dari pemasaran dan desain dukungan manufaktur untuk pengenalan, pelatihan dan bantuan pemeliharaan untuk survei kelautan, tidak ada fase dalam siklus hidup kapal atau struktur yang tidak akan mendapat keuntungan dari pemodelan 3D, simulasi virtual / augmented reality atau komputer. Dalam tesis ini terdapat penjelasan mengenai aplikasi yang mempunya dua fitur yaitu mode inspeksi untuk menyelesaikan beberapa misi ketika inspeksi dilakukan dan mode bebas jelajah untuk mengeksplorasi dan memberikan informasi tentang daftar periksa untuk inspeksi. Dengan VR, pengguna dapat membangun kompetensi mereka untuk inspeksi kapal, dan pengalaman memberi tahu mereka di mana harus memusatkan perhatian tanpa risiko. Realitas virtual dapat memberikan pengetahuan dan dapat diakses untuk pelatihan di mana saja dan kapan saja dengan mudah.

Keywords: Realitas Virtual, Pelatihan Inspeksi, Alat-Alat Keselamatan, 3d Model

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PREFACE

All the gratitude towards Almighty Allah for all the blessings and gifts so that the author can complete bachelor thesis with title of "The Development of Life-Saving Application Inspection Training Using Virtual Reality Application" in order to fulfill the requirements to obtaining the bachelor degree program at Marine Engineering Department, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember Surabaya.

During the accomplishment of this final project, author want to thank every parties who helped, assisted, and supported the author so that the author is able to complete this very well. All thanks are delivered to:

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8. And other parties whom author can't mention all but very meaningful for author.

Because this work is also far from a perfect work, author will really apreciated for every advice, suggestion and idea from all parties for this bachelor thesis correction and improvement in the future. By the completion of this bachelor thesis, author hopes this thesis will be helpful and beneficial for other parties who are going to conduct the similar research.

Surabaya, July 2019

Author

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CHAPTER I

INTRODUCTION

1.1. Background

The evolution of technology has made it possible to enhance the development in marine industry. Indonesia is one country that has a great maritime potential. Indonesia consist of a group of islands with a coastline with long until 95,000 km. With existing geographical circumstances, Indonesia has a great potential for marine industry. Indonesia has sector of the economy that is not reliant on the mainland, but also in maritime field and make maritime based economy continues to grow in Indonesia and enhance the development of other industries. The business industry which is closely related to sea transport are the port business, multi-modal transport, an insurance company, shipbuilding industry and more. The industry have relation each other and grow together.

One of the developments in the maritime sector applications of advanced computer graphics technology. Ranging from marketing and design over manufacturing support to familiarization, training and maintenance assistance for marine survey, there is no phase in the lifecycle of a ship or seaborne structure that would not profit from 3D modelling, simulation, virtual/augmented reality or computer vision.

Virtual Reality (VR) is not an entirely new concept; it has existed in various forms since the late 1960s. It has been known by names such as synthetic environment, cyberspace, artificial reality, simulator technology and so on and so forth before VR was eventually adopted. The latest manifestation of VR is desktop VR. Desktop VR is also known by other names such as Window on World (WoW) or non-immersive VR (Onyesolu, 2006). As a result of proliferation of desktop VR, the technology has continued to develop applications that are less than fully immersive. These non-immersive VR applications are far less expensive and technically daunting and have made inroads into industry training and development. VR has perhaps at last come within the realm of possibility for general creation and use most especially in education where computer-based virtual learning environments (VLE) are packaged as desktop VR. This, in turn, points the way for its inclusion in educational programs (Ausburn & Ausburn, 2004). These computer-based virtual learning environments (VLEs) have opened new realms in the teaching, learning, and practice of medicine, physical sciences and engineering among others. VLEs provide students with the opportunity to achieve learning goals. VLE-based applications have thus emerged in mainstream education in schools and universities as successful tools to supplement traditional teaching methods. These learning environments have been discovered to have greater pedagogical effectiveness on learners. Virtual learning environments provide three-dimensional (3D) insights into the structures and functions of any system desired. Students can thereby learn the principles of such system in a fast, effective and pleasurable way by interacting with and navigating through the environment created for such system (Onyesolu, 2009a; Onyesolu, 2009b). It is known that VR can make the artificial as realistic as, and even more realistic than, the real (Negroponte, 1995).

Virtual reality can be used to support the maritime industry sector specially in marine survey training. With VR a surveyor can build their competence for ship inspections, and experience tells them where to focus attention – in the spots where deficiencies are most likely to occur. The best surveyors are in high demand and have limited time to spend training others. Virtual Reality brings the knowledge and can give experience of many surveyors that can be accessed for training anywhere and any time.

1.2. Research Problems

Based on background mentioned above, it can be concluded some problems of this final project are:

a. How to develop Life-Saving Appliances inspection training in Virtual Reality Application.

1.3. Research Limitations

This final project can be focused and organized, with limitations on problem which are:

a. In this research using Unity3D to build simulation in Virtual Reality Application.
b. Research purposes is for Life Saving Appliances training base on CMID (Common Marine Inspection Document)
c. The Virtual Reality Program will give simulation training of life-saving appliances in navigation deck, b deck and upper forecastle deck.

1.4. Research Objectives

Based on problems mention above, the objectives of this final project are:

a. To build simulation in Virtual Reality Application for Life-Saving Appliances inspection training.

1.5. Research Benefits

This final project is expected to give benefits for the various kind of parties. The benefits that can be obtained are:

a. Provide a unique and effective way to learn for surveyor because VR has great value in situations where exploration of environments or interactions with objects or people is impossible or inconvenient, or where an environment can only exist in computer-generated form. VR is also valuable when the experience of actually creating a simulated environment and can be accessed for training in anywhere and any time.

CHAPTER II

LITERATURE STUDY

2.1 Life Saving Appliances

Life Saving Appliances is a tool used for rescuers during emergencies situation. Life-saving appliances on all ships have to be fitted with retro-reflective material where it will assist in detection and in accordance with the recommendations of the Organization. The International Life-Saving Appliance (LSA) Code gives specific technical requirements for LSAs and is mandatory under Regulation 34, which states that all life-saving appliances and arrangements shall comply with the applicable requirements of the LSA Code. The purpose of this Code is to provide international standards for life-saving appliances required by chapter III of the International Convention for the Safety of Life at Sea (SOLAS), 1974. On and after 1 July 1998, the requirements of this Code will be mandatory under the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended.

2.1.1 General Requirements for Life Saving Appliances

The genaral requirements for life saving appliances base on SOLAS all life saving appliances shall :

1. Constructed with proper workmanship and materials;
2. Not be damaged in stowage throughout the air temperature range -30°C to +65°C;
3. If they are likely to be immersed in seawater during their use, operate throughout the seawater temperature range -1°C to +30°C;
4. Where applicable, be rot-proof, corrosion-resistant, and not be unduly affected by seawater, oil or fungal attack;
5. Where exposed to sunlight, be resistant to deterioration;
6. Highly visible colour on all parts where this will assist detection;
7. Fitted with retro-reflective material where it will assist in detection and in accordance with the recommendations of the Organization*;
8. If they are to be used in a seaway, be capable of satisfactory operation in that environment;
9. Clearly marked with approval information including the Administration which approved it, and any operational restrictions; and
10. Where applicable, be provided with electrical short circuit protection to prevent damage or injury.

2.1.2 Life Saving Appliances On Board

There are some life saving appliances that must be on board and checked before the ship voyage and port entry.

2.1.2.1 Lifebuoy

Every lifebuoy shall :

- Have an outer diameter of not more than 800 mm and an inner diameter of not less than 400 mm;
- Be constructed of inherently buoyant material; it shall not depend upon rushes, cork shavings or granulated cork, any other loose granulated material or any air compartment which depends on inflation for buoyancy;
- Be capable of supporting not less than 14.5 kg of iron in fresh water for a period of 24 hours;
- Have a mass of not less than 2.5 kg;
- Not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 seconds;
- Be constructed to withstand a drop into the water from the height at which it is stowed above the waterline in the lightest seagoing condition or 30 m, whichever is the greater, without impairing either its operating capability or that of its attached components;
- If it is intended to operate the quick release arrangement provided for the self-activated smoke signals and self-igniting lights have a mass sufficient to operate the quick release arrangement;
- Be fitted with a grabline not less than 9.5 mm in diameter and not less than 4 times the outside diameter of the body of the buoy in length. The grabline shall be secured at four equidistant points around the circumference of the buoy to form four equal loops.

Figure 2.1 Lifebuoy
Source : Marine LSA (2019)

2.1.2.2 Lifejacket

A life-jacket shall be so constructed that:

- Shall not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 seconds.
- At least 75% of persons, who are completely unfamiliar with the lifejacket, can correctly don it within a period of one min without assistance, guidance or prior demonstration;
- After demonstration, all persons can correctly don it within a period of one minute without assistance;
- It is clearly capable of being worn in only one way or, as far as is practicable, cannot be donned incorrectly;
- It is comfortable to wear;
- It allows the wearer to jump from a height of at least 4.5 m into the water without injury and without dislodging or damaging the lifejacket.
- Shall have buoyancy which is not reduced by more than 5% after 24h submersion in fresh water.
- Shall be fitted with a whistle firmly secured by a cord

Figure 2.2 Lifejacket
Source : Twshop (2019)

2.1.2.3 Lifeboat

All lifeboats shall be properly constructed and shall be of such form and proportions that they have ample stability in a seaway and sufficient freeboard when loaded with their full complement of persons and equipment. All lifeboats shall have rigid hulls and shall be capable of maintaining positive stability when in an upright position in calm water and loaded with their full complement of persons and equipment and holed in any one location below the waterline, assuming no loss of buoyancy material and no other damage.

Free-fall lifeboats shall comply with the requirements of totally enclosed lifeboats described above. The carrying capacity of a free-fall lifeboat is the number of persons that can be provided with a seat without interfering with the means of propulsion or the operation of any of the lifeboat's equipment. The width of the seat shall be at least 430 mm. Free clearance in front of the backrest shall be at least 635 mm. The backrest shall extend at least 1,000 mm above the seat pan. (SOLAS, 2008)

Figure 2.3 Lifeboat
Source : Myseatime (2019)

2.1.2.4 Liferaft

Every liferaft shall be so constructed as to be capable of withstanding exposure for 30 days afloat in all sea conditions. The liferaft shall be so constructed that when it is dropped into the water from a height of 18 m, the liferaft and its equipment will operate satisfactorily. If the liferaft is to be stowed at a height of more than 18 m above the waterline in the lightest seagoing condition, it shall be of a type which has been satisfactorily drop-tested from at least that height.

The floating liferaft shall be capable of withstanding repeated jumps on to it from a height of at least 4.5 m above its floor both with and without the canopy erected. The liferaft and its fittings shall be so constructed as to enable it to be towed at a speed of 3 knots in calm water when loaded with its full complement of persons and equipment and with one of its sea-anchors streamed.

Figure 2.4 Liferaft
Source : Marineinsight (2019)

The liferaft shall have a canopy to protect the occupants from exposure which is automatically set in place when the liferaft is launched and waterborne. No liferaft shall be approved which has a carrying capacity of less than six persons Unless the liferaft is to be launched by an approved launching appliance or is not required to be stowed in a position providing for easy side-to-side transfer, the total mass of the liferaft, its container and its equipment shall not be more than 185 kg. The liferaft shall be fitted with an efficient painter of length equal to not less than 10 m plus the distance from the stowed position to the waterline in the lightest seagoing condition or 15 m whichever is the greater. (SOLAS, 2008)

2.1.2.5 Rescue Boats

Rescue boats may be either of rigid or inflated construction or a combination of both and shall:

- Be not less than 3.8 m and not more than 8.5 m in length; and
- Be capable of carrying at least five seated persons and a person lying on a stretcher.

Rescue boats shall be capable of manoeuvring at a speed of at least 6 knots and maintaining that speed for a period of at least 4 hors. Rescue boats shall have sufficient mobility and manoeuvrability in a seaway to enable persons to be retrieved from the water, marshal liferafts and tow the largest liferaft carried on the ship when loaded with its full complement of persons and equipment or its equivalent at a speed of at least 2 knots. A rescue boat shall be fitted with an inboard engine or outboard motor. If it is fitted with an outboard motor, the rudder and tiller may form part of the engine. Arrangements for towing shall be permanently fitted in rescue boats and shall be sufficiently strong to marshal or tow liferafts. Inflated rescue boats shall be so constructed as to be capable of withstanding exposure:

- When stowed on an open deck on a ship at sea;
- For 30 days afloat in all sea conditions.

Figure 2.5 Rescue Boats
Source : Zodiacmilpro (2019)

The buoyancy of an inflated rescue boat shall be provided by either a single tube subdivided into at least five separate compartments of approximately equal volume or two separate tubes neither exceeding 60% of the total volume. In addition to complying with the requirements lifeboats, inflated rescue boats shall be marked with a serial number, the maker's name or trade mark and the date of manufacture. The inflated rescue boat shall be maintained at all times in a fully inflated condition. (SOLAS, 2008)

2.2 Virtual Reality

Virtual Reality is an alternate world filled with computer-generated images that respond to human movements. These simulated environments are usually visited with the aid of an expensive data suit which features stereophonic video goggles and fiber-optic gloves. Defined in terms of human experience, VR is a mediated environment which creates the sensation in a user of being present in a (physical) surrounding.

Virtual Reality (VR) is not an entirely new concept; it has existed in various forms since the late 1960s. It has been known by names such as synthetic environment, cyberspace, artificial reality, simulator technology and so on and so forth before VR was eventually adopted. The latest manifestation of VR is desktop VR. Desktop VR is also known by other names such as Window on World (WoW) or non-immersive VR (Onyesolu, 2006). As a result of proliferation of desktop VR, the technology has continued to develop applications that are less than fully immersive. These non-immersive VR applications are far less expensive and technically daunting and have made inroads into industry training and development. VR has perhaps at last come within the realm of possibility for general creation and use most especially in education where computer-based virtual learning environments (VLE) are packaged as desktop VR. This, in turn, points the way for its inclusion in educational programs (Ausburn & Ausburn, 2004). These computer-based virtual learning environments (VLEs) have opened new realms in the teaching, learning, and practice of medicine, physical sciences and engineering among others. VLEs provide students with the opportunity to achieve learning goals. VLE-based applications have thus emerged in mainstream education in schools and universities as successful tools to supplement traditional teaching methods. These learning environments have been discovered to have greater pedagogical effectiveness on learners. Virtual learning environments provide three-dimensional (3D) insights into the structures and functions of any system desired. Students can thereby learn the principles of such system in a fast, effective and pleasurable way by interacting with and navigating through the environment created for such system (Onyesolu, 2009a; Onyesolu, 2009b). It is known that VR can make the artificial as realistic as, and even more realistic than, the real (Negroponte, 1995).

Figure 2.6 Virtual Reality
Source : (Understanding Virtual Reality Technology: Advances and Applications, 2011)

2.2.1 The Technology of Virtual Reality

There are some people to whom VR is a specific collection of technologies; that is, headset, glove and walker (Haag et al., 1998). VR is defined as a highly interactive, computer-based multimedia environment in which the user becomes the participant in a computer-generated world (Kim et al., 2000; Onyesolu, 2009a; Onyesolu & Akpado, 2009). It is the simulation of a real or imagined environment that can be experienced visually in the three dimensions of width, height, and depth and that may additionally provide an interactive experience visually in full real-time motion with sound and possibly with tactile and other forms of feedback. VR is a way for humans to visualize, manipulate and interact with computers and extremely complex data (Isdale, 1998). It is an artificial environment created with computer hardware and software and presented to the user in such a way that it appears and feels like a real environment (Baieier, 1993). VR is a computer-synthesized, three-dimensional environment in which a plurality of human participants, appropriately interfaced, may engage and manipulate simulated physical elements in the environment and, in some forms, may engage and interact with representations of other humans, past, present or fictional, or with invented creatures. It is a computer-based technology for simulating visual auditory and other sensory aspects of complex environments (Onyesolu, 2009b). VR incorporates 3D technologies that give a reallife illusion. VR creates a simulation of real-life situation (Haag et al., 1998).

Therefore, VR refers to an immersive, interactive, multi-sensory, viewer-centered, 3D computer-generated environment and the combination of technologies required to build such an environment (Aukstakalnis & Blatner, 1992; Cruz-Niera, 1993). By immersing viewers in a computer-generated stereoscopic environment, VR technology breaks down barriers between humans and computers. VR technology simulates natural stereoscopic viewing processes by using computer technology to create right-eye and left-eye images of a given 3D object or scene. The viewer’s brain integrates the information from these two perspectives to create the perception of 3D space. Thus, VR technology creates the illusion that on-screen objects have depth and presence beyond the flat image projected onto the screen. With VR technology, viewers can perceive distance and spatial relationships between different object components more realistically and accurately than with conventional visualization tools (such as traditional CAD tools).

2.2.2 Virtual Reality Components

The components necessary for building and experiencing VR are divided into two main components-the hardware components and the software components.

2.2.2.1 Hardware Components

The hardware components are divided into five sub-components: computer workstation, sensory displays, process acceleration cards, tracking system and input devices.

2.2.2.1.1 Computer Station

A computer workstation is a high-end microcomputer designed for technical or scientific applications. Intended primarily to be used by one person at a time, workstations are commonly connected to a local area network and run multi-user operating systems. The term workstation has also been used to refer to a mainframe computer terminal or a personal computer (PC) connected to a network.

Workstations had offered higher performance than personal computers, especially with respect to CPU and graphics, memory capacity and multitasking capability. They are optimized for the visualization and manipulation of different types of complex data such as 3D mechanical design, engineering simulation animation and rendering of images, and mathematical plots. Workstations are the first segment of the computer market to present advanced accessories and collaboration tools. Presently, the workstation market is highly commoditized and is dominated by large PC vendors, such as Dell and HP, selling Microsoft Windows/Linux running on Intel Xeon/AMD Opteron. Alternative UNIX based platforms are provided by Apple Inc., Sun Microsystems, and Silicon Graphics International (SGI) (http://en.wikipedia.org/wiki/Workstation). Computer workstation is used to control several sensory display devices to immerse you in 3D virtual environment.

2.2.2.1.2 Sensor Displays

Sensory displays are used to display the simulated virtual worlds to the user. The most common sensory displays are the computer visual display unit, the head-mounted display (HMD) for 3D visual and headphones for 3D audio.

2.2.2.1.3 Head Mounted Displays

Head mounted displays place a screen in front of each of the viewer's eyes at all times. The view, the segment of the virtual environment generated and displayed, is controlled by orientation sensors mounted on the "helmet". Head movement is recognized by the computer, and a new perspective of the scene is generated. In most cases, a set of optical lens and mirrors are used to enlarge the view to fill the field of view and to direct the scene to the eyes (Lane, 1993).

Figure 2.7 Visette 45 SXGA Head Mounted Display (HMD)
Source : (Understanding Virtual Reality Technology: Advances and Applications, 2011)

2.2.2.1.4 Binocular Omni-Orientation Monitor (BOOM)

The BOOM is mounted on a jointed mechanical arm with tracking sensors located at the joints. A counterbalance is used to stabilize the monitor, so that when the user releases the monitor, it remains in place. To view the virtual environment, the user must take hold of the monitor and put her face up to it. The computer will generate an appropriate scene based on the

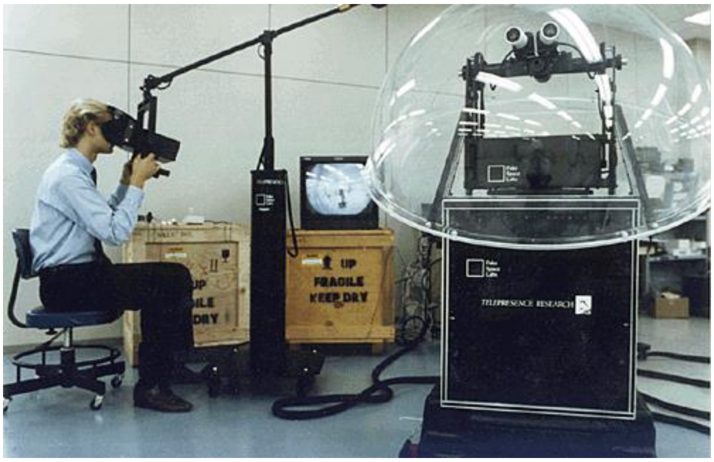

Figure 2.8 Binocular Omni-Orientation Monitor (BOOM)

Source : (Understanding Virtual Reality Technology: Advances and Applications, 2011)

position and orientation of the joints on the mechanical arm (Aukstakalnis & Blatner 1992). Some of the problems associated with HMDs can be solved by using a BOOM display. The user does not have to wear a BOOM display as in the case of an HMD. This means that crossing the boundary between a virtual world and the real world is simply a matter of moving your eyes away from the BOOM.

2.2.2.1.5 Visual Display Unit (VDU) or Monitors

There are two types of computer visual display unit. The CRT monitors and the LCD monitors. The distinguishing characteristics of the two types are beyond the scope of this piece.

2.2.2.1.6 Process Acceleration Cards

These cards help to update the display with new sensory information. Examples are 3D graphic cards and 3D sound cards.

2.2.2.1.7 Tracking System

This system tracks the position and orientation of a user in the virtual environment. This system is divided into: mechanical, electromagnetic, ultrasonic and infrared trackers.

Figure 2.9 Patriot wireless electromagnetic tracker
Source : Polhemus (2019)

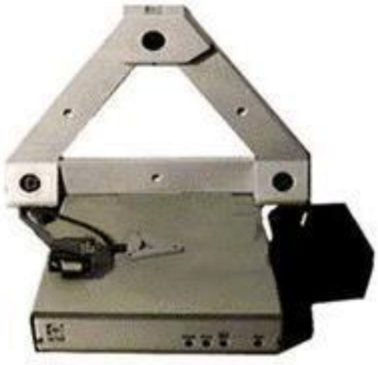

Figure 2.10 Logitech ultrasonic tracker
Source : Docplayer (2019)

2.2.2.1.8 Input Devices

They are used to interact with the virtual environment and objects within the virtual environment. Examples are joystick (wand), instrumented glove, keyboard, voice recognition etc.

2.2.2.2 Software Components

The software components are divided into four sub-components: 3D modeling software, 2D graphics software, digital sound editing software and VR simulation software.

Figure 2.11 An instrumented glove (Nintendo power glove)
Source : Research Gate (2019)

2.2.2.2.1 3D Modeling Software

3D modeling software is used in constructing the geometry of the objects in a virtual world and specifies the visual properties of these objects.

2.2.2.2.2 2D Graphics Software

2D graphics software is used to manipulate texture to be applied to the objects which enhance their visual details.

2.2.2.2.3 2D Digital Sound Editing Software

Digital sound editing software is used to mix and edit sounds that objects make within the virtual environment

2.2.2.2.4 2D VR Simulation Software

Simulation software brings the components together. It is used to program how these objects behave and set the rules that the virtual world follows.

2.2.3 Classification of Virtual Reality Systems

VR is classified into three major types: (a) Non-Immersive VR Systems, (b) Semi-Immersive VR Systems and (c) Immersive (Fully Immersive) VR systems. Other forms of classification are levels of VR and methods of VR. Levels of VR deals with efforts employed to develop VR technology. Under this classification we have entry level, basic level, advanced level, immersive systems and big-time systems. Methods of VR classification deals with methods employed in developing VR system. Under this class we have simulation based systems, projector based systems, avatar-image based systems and desktop based system.

2.2.3.1 Non-Immersive VR Systems

As the name suggests, are the least implementation of VR techniques. It involves implementing VR on a desktop computer. This class is also known as Window on World (WoW) (Onyesolu, 2006). Using the desktop system, the virtual environment is viewed through a portal or window by utilizing a standard high resolution monitor. Interaction with the virtual environment can occur by conventional means such as keyboard, mouse or trackball.

2.2.3.2 Semi-Immersive VR Systems

A semi immersive VR system comprise of a relatively high performance graphics computing system which can be coupled with either a large screen monitor; a large screen projection system or multiple television projection system. Using a wide field of view, these systems increase the feeling of immersion or presence experienced by the user and stereographic imaging can be achieved using some type of shutter glasses.

2.2.3.3 Immersive (fully immersive) VR systems

An Immersive VR system is the most direct experience of virtual environments. Here the user either wears an head mounted display (HMD) or uses some form of head-coupled display such as a Binocular Omni-Orientation Monitor (BOOM) to view the virtual environment, in addition to some tracking devices and haptic devices. An HMD or BOOM uses small monitors placed in front of each eye which provide stereo, bi-ocular or monocular images.

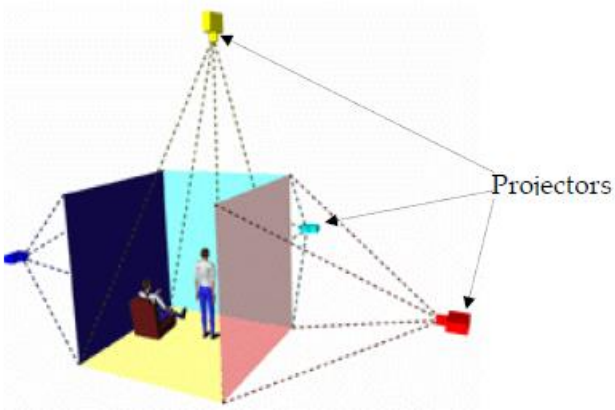

Figure 2.12 Schematic representation VR
Source : (Understanding Virtual Reality Technology: Advances and Applications, 2011)

2.2.4 How Virtual Reality works

The idea behind VR is to deliver a sense of being there by giving at least the eye what it would have received if it were there and, more important to have the image change instantly as the point of view is changed (Smith & Lee, 2004). The perception of spatial reality is driven by various visual cues, like relative size, brightness and angular movement. One of the strongest is perspective, which is particularly powerful in its binocular form in that the right and left eyes see different images. Fusing these images into one 3D perception is the basis of stereovision.

The perception of depth provided by each eye seeing a slightly different image, eye parallax, is most effective for objects very near you. Objects farther away essentially cast the same image on each eye. The typical dress code for VR is a helmet with goggle-like displays, one for each eye. Each display delivers a slightly different perspective image of what you would see if you were there. As you move your head, the image rapidly updates so that you feel you are making these changes by moving your head (versus the computer actually following your movement, which it is). You feel you are the cause not the effect.

2.2.5 VR Development Tools and Resources

There are many VR development tools and resources. Some of these tools and resources are free (open source to use), some are proprietary (closed source) (Wang & Canon, 1996). VR related development is in progress regarding the availability, usability and capability of customization for existing development tools and resources. VR development tools and resources are quite numerous; some examples are presented:

2.2.5.1 Unity 3D

Unity is a cross-platform game engine developed by Unity Technologies, first announced and released in June 2005 at Apple Inc.'s Worldwide Developers Conference as an OS X-exclusive game engine. As of 2018, the engine has been extended to support 27 platforms. The engine can be used to create both three-dimensional and two-dimensional games as well as simulations for its many platforms.

Unity gives users the ability to create simulation in both 2D and 3D, and the engine offers a primary scripting API in C#, for both the Unity editor in the form of plugins, and games themselves, as well as drag and drop functionality. Prior to C# being the primary programming language used for the engine, it previously supported Boo, which was removed in the Unity 5 release, and a version of JavaScript called UnityScript.

The engine has support for the following graphics APIs: Direct3D on Windows and Xbox One; OpenGL on Linux, macOS, and Windows; OpenGL ES on Android and iOS; WebGL on the web; and proprietary APIs on the video game consoles. Additionally, Unity supports the low-level APIs Metal on iOS and macOS and Vulkan on Android, Linux, and Windows, as well as Direct3D 12 on Windows and Xbox One.

Figure 2.13 Unity 3D
Source : Unity 3D (2019)

Within in 2D, Unity allows importation of sprites and an advanced 2D world renderer. For 3D simulation, Unity allows specification of texture compression, mipmaps, and resolution settings for each platform that the game engine supports, and provides support for bump mapping, reflection mapping, parallax mapping, screen space ambient occlusion (SSAO), dynamic shadows using shadow maps, render-to-texture and full-screen post-processing effects.

2.2.5.2 Autodesk 3d Max (3D Studio MAX)

Autodesk 3d Max (formerly known as 3D Studio MAX) is a modeling, animation and rendering package developed by Autodesk Media and entertainment. 3d Max is the third most widely-used off the shelf 3D animation program by content creation professionals. It has strong modeling capabilities, a flexible plugin architecture and a long heritage on the Microsoft Windows platform. It is mostly used by video game developers, television commercial studios and architectural visualization studios. It is also used for movie effects and movie pre-visualization.

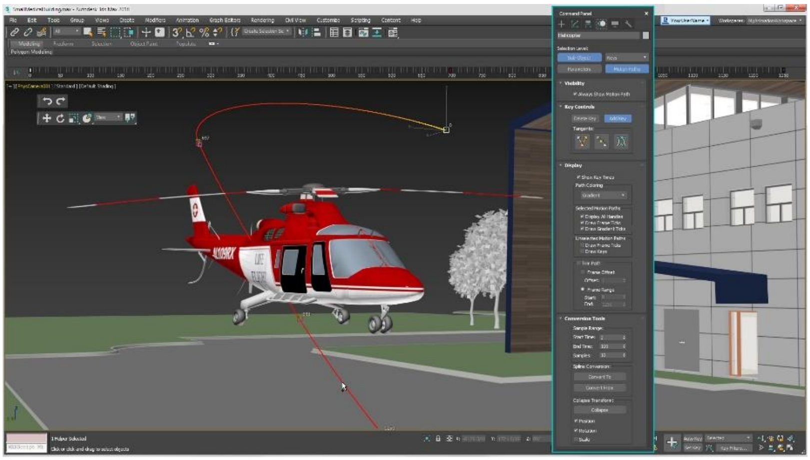

Figure 2.14 Autodesk 3d Max (3D Studio MAX)
Source : Autodesk (2019)

2.2.6 Applications and Advancements in VR technology

There are a lot of applications and advancements in VR technology. VR is being applied in all areas of human endeavour and many VR applications have been developed for manufacturing, training in a variety of areas (military, medical, equipment operation, etc.), education, simulation, design evaluation (virtual prototyping), architectural walk-through, ergonomic studies, simulation of assembly sequences and maintenance tasks, assistance for the handicapped, study and treatment of phobias (e.g., fear of height), entertainment, rapid prototyping and much more (Onyesolu, 2006). This has been made possible due to the power of VR in transporting customers to a virtual environment and convincing them of their presence in it (Wittenberg, 1993).

In industry, VR has proven to be an effective tool for helping workers evaluates product designs. In 1999, BMW explored the capability of VR for verifying product designs (Gomes de Sa & Zachmann, 1999). They concluded that VR has the potential to reduce the number of physical mockups needed to improve overall product quality, and to obtain quick answers in an intuitive way during the concept phase of a product. In addition, Motorola developed a VR system for training workers to run a pager assembly line (Wittenberg, 1995). They found that VR can be used to successfully train manufacturing personnel, and that participants trained in VR environments perform better on the job than those trained for the same time in real environments.

In 1998, GE Corporate Research developed two VR software applications, Product Vision and Galileo, which allowed engineers to interactively fly through a virtual jet engine (Abshire, & Barron, 1998). They reported that the two applications were used successfully to enhance design communication and to solve maintenance problems early, with minimal cost, delays, and effort. They also reported that using the VR applications helped make maintenance an integral part of their product design process. The success stories from industry show that VR-technology-literate professionals are a present and future industry need. However, most students currently do not have an opportunity to experience VR technologies while they are in school. Therefore, introducing VR into design and graphics curricula is imperative, to keep pace with the changing needs of industry.

Boeing (the largest aircraft manufacturers in the world) developed the Virtual Space eXperiment (VSX). VSX is a demonstration of how virtual environment systems can be applied to the design of aircraft and other complex systems involving human interactions (Kalawsky, 1993). It is a 3D virtual model of the interior and exterior of a tilt-rotor aircraft in virtual space that allows persons to interact with various items such as maintenance hatch, cargo ramp. McDonnell Douglas uses a ProVision 100 VPX system to evaluate how a virtual environment can aid the design of new engine types. The system is utilized to explore the processes for installing and removing engines, especially for detecting the potential interface with other devices. The automotive industry starts to use the VR technology to design and build cars. It can take two years or more to advance from the development of an initial concept for a new type of car to the moment that a production version rolls off the assembly line.

Virtual Reality is a powerful tool for education since people comprehend images much faster than they grasp lines of text or columns of numbers. VR offers multisensory immersive environments that engage students and allow them visualize information (Eslinger, 1993). Mathematics and science teachers have used VR for explaining abstract spatial data. Winn and Bricken (1992) used VR to help students learn elementary algebra. They used three-dimensional space to express algebraic concepts and to interact with spatial representations in a virtual environment. They concluded that VR has the potential for making a significant improvement in the way students learn mathematics. Haufmann et al (2000) used VR in mathematics and geometry education, especially in vector analysis and descriptive geometry. Their survey showed that all participants (10 students) rated VR as a very good playground for experiments, and all participants wanted to experience VR again. Students also thought it was easier to view a 3D world in VR rather than on a flat screen.

VR technology promises to shorten a product development cycle greatly by skipping the need for physical mockups. The Ford’s Alpha simultaneous engineering team developed a VR system for evaluating process installation feasibility in automotive assembly. In Japan, customers bring the architectural layout of their home kitchen to the Matsushita store and plug it into the computer system to generate its virtual copy. They can install appliances and cabinets, and change colors and sizes to see what their complete kitchen will look like without ever installing a single item in the actual location. Similarly, Mike Rosen and Associates has been using an interactive and immersive VR technology to assist its building industry clients in the design, visualization, marketing, and sales (Neil, 1996). The applications let the customers become actively involved in the visualization process, such as making changes of colors, textures, materials, lighting, and furniture on the fly.

2.2.7 Advantages and uses of VR

Researchers in the field have generally agreed that VR technology is exciting and can provide a unique and effective way to learn and that VR projects are highly motivating to learners. From research, several specific situations have emerged in which VR has strong benefits or advantages. For example, VR has great value in situations where exploration of environments or interactions with objects or people is impossible or inconvenient, or where an environment can only exist in computer-generated form. VR is also valuable when the experience of actually creating a simulated environment is important to learning. Creating their own virtual worlds has been shown to enable some students to master content and to project their understanding of what they have learned (Ausburn & Ausburn, 2004).

One of the beneficial uses of VR occurs when visualization, manipulation, and interaction with information are critical for its understanding; it is, in fact, its capacity for allowing learners to display and interact with information and environment that some believe is VR's greatest advantage. Finally, VR is a very valuable instructional and practice alternative when the real thing is hazardous to learners, instructors, equipment, or the environment. This advantage of the technology has been cited by developers and researchers from such diverse fields as firefighting, anti-terrorism training, nuclear decommissioning, crane driving and safety, aircraft inspection and maintenance, automotive spray painting and pedestrian safety for children (Ausburn & Ausburn, 2004).

CHAPTER III

METHODOLOGY

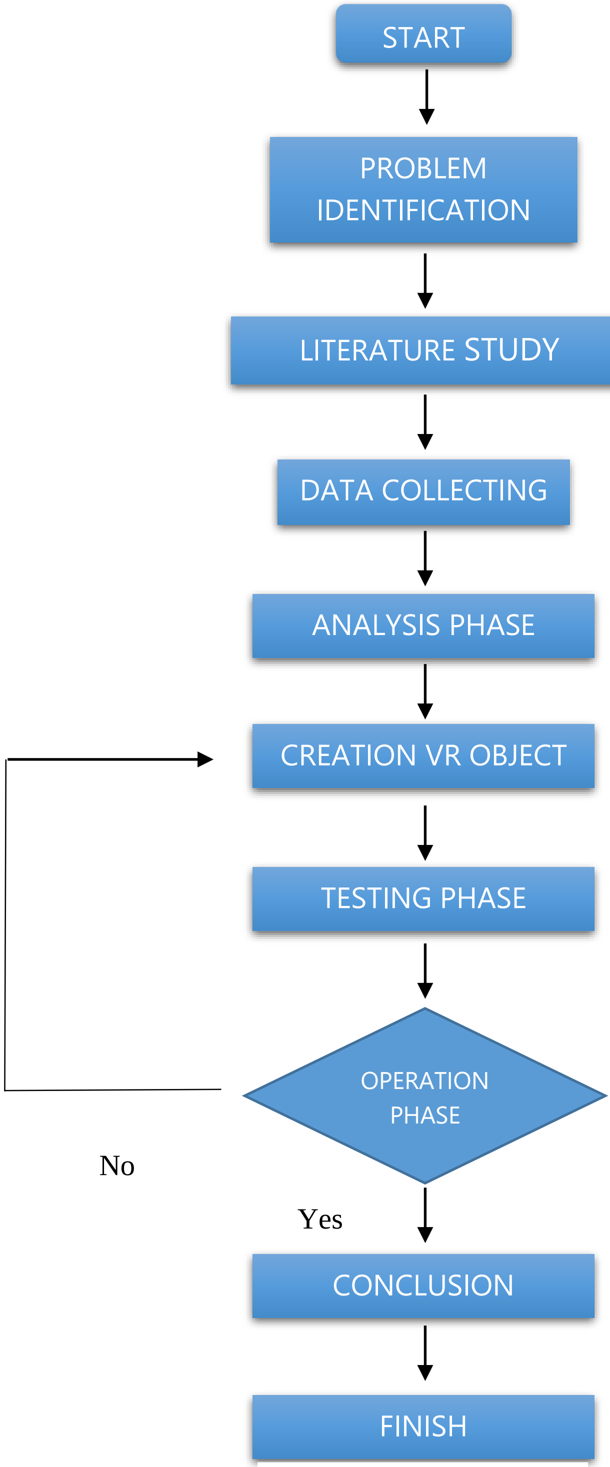

Figure 3.1 Methodology

3.1 Problem Identification

This first stage is identifying the problem from life saving appliances survey for training purposes. According SOLAS the LSA is one of the important aspects when the ship voyage. In order to improve ability and give more knowledge of marine surveyor in surveying life saving appliances of ship. So, in this final project will be developing life saving appliances training with build simulation in virtual reality program.

3.2 Literature Study

In literature study will explaining the depth of review, summarizing the basic theory, general and specific reference, and obtaining various other supporting information related to the final project. In this final project, the authors conducted a literature study on Life-Saving Appliances and Virtual Reality obtained from books, journals, papers, and from the internet that support this final project.

3.3 Data Collecting

In this stage, a survey will be carried out directly to the field for determine exactly task of surveyor when checking the life saving appliances equipment to obtaining the data. The data will collecting is lifebuoy, liferaft, lifeboat, lifejacket.

3.4 Analysis Phase

In this phase begins with make the detailed scenario in virtual reality program by defining every objects that need to build in VR simulation. The output of this phase now needs to be analyzed to get the foundation to build the whole application upon. This must be conducted especially carefully, because minor faults in this phase will steer the direction of progress off course.

3.5 Creation VR Object

This phase consists of creating the assets of the virtual environment, the small bricks that build the whole virtual world. The requirements for some assets can be clear from earlier phases of the analyses or even from the scenario draft. All the object should be tested as soon as possible and documentation should be made accordingly. There are many kinds of assets, scripts, texts, graphics, animations, sounds and hardware.

3.6 Testing Phase

In testing phase will be done thoroughly during the whole project. The tests should focus not only errors and unhandled exceptions in the code, but also for the overall feel of the virtual environment. The purposes of this phase is to confirm that it is progressing in accordance with requirements.

3.7 Operation Phase

In this stage will be full tested for the virtual reality program that has been made in android platform base by using cardboard/ virtual reality glasses and smartphone. if it passes in this testing phase it will proceed to the next stage and if it doesn’t pass it will be back to creation VR object phase.

3.8 Conclusion

In the last stage, after the virtual reality program has been succesfully work. The author will make conclusion.

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CHAPTER IV

DATA ANALYSIS

4.1 Data Collection

4.1.1. Ship Data

The Data Consists of :

1. General info of the ship and the machineries
   The data is used as the basis to create the environment in virtual reality application.
2. General Arrangement and Safety Plan
   The General Arrangement and Safety Plan is used for make an inspection training plan scenario in virtual reality application and defining every objects that need to build in VR simulation
3. Life Saving Appliances Equipment Certificate
   Certificate collection from some of the equipment needed to support the creation of virtual reality applications.

4.1.2. Research Object

The first step of creation the Virtual Reality Application is to choose what are to be analyzed. Here I choose the vessels available at the PT Meratus Line company to be surveyed. As vessel under research is MV. Meratus Bontang.

Figure 4.1 MV. Meratus Bontang

Source : By Author (2019)

Figure 4.2 MV. Meratus Bontang
Source : By Author (2019)

Table 4.1 General Info of MV. Meratus Bontang

General Info	
IMO	9569865
MMSI	525025059
Call Sign	PNNW
Flag	Indonesia [ID]
AIS Vessel Type	Unspecified
Ship Type	Container Ship
Gross Tonnage	3668
Deadweight	5108 t
Length Overall x Breadth Extreme	106.68m × 20.6m
Draught	3.4 m
Speed	7.5 kn
TEU	368
Year Built	2010

Status	Active

4.2 Identification of Life Saving Appliances Inspection

In this final project, the inspection checklist will be comply from CMID (Common Marine Inspection Document). The purpose of the Common Marine Inspection Document (the 'CMID') is to provide the marine industry with a standardised format for vessel inspection reports and to reduce the number of inspections carried out on individual marine vessels, through the adoption of a common inspection process. This can be achieved by making completed inspection reports available to those with a justifiable requirement to confirm a vessel's safety and environmental integrity status.

4.2.1 Inspection Checklist

4.2.1.1 Lifejacket

a) Where required are there sufficient numbers and sizes of life jackets for the crew.
b) Life jackets and survival suits to be in good condition. Conduct checks on random sample to ensure associated equipment is functional. Confirm life jackets and survival suits are stowed in the locations detailed on LSA plan.
c) Life jacket donning instruction notices to be posted on each deck.

4.2.1.2 Lifebuoy

a) Life buoys, life buoy lights, self activating smoke floats and quick release mechanisms to be in good order, in date and functional;
b) Life buoys are provided protecting cover and stores correctly maintained and well stowed base on LSA plan.

4.2.1.3 Liferaft

a) Casings should be in good condition.
b) Are life rafts stowed as per the LSA plans.
c) Hydrostatic releases, if fitted, should be correctly attached, in good condition and in date.
d) Life raft operating instructions should be prominently displayed.
e) Life rafts should have valid inspection certificate(s)
f) Correctly marked with ships' name, servicing details, validity period and capacity

4.2.1.4 Lifeboat

a) Casings Lifeboats should be secured by a fall arrestor device before any internal inspection is carried out.
b) Lifeboats should be ready for immediate use. Internally they should be clean, dry and tidy.
c) All small equipment should be secured and stored in lockers or watertight containers as appropriate. Large equipment should be suitably secured.
d) All equipment should be readily accessible, including medicines not stowed on board.

e) Perform a random check to ensure that food and water, and pyrotechnics are in date.
f) Lifeboat operating instructions should be prominently displayed.

4.3 Creation Inspection Scenario

In this phase several scenarios will be made during the ship inspection process, every LSA object will be given a statement in the form of actual conditions, after that the user will be able to justify each LSA object base on the actual condition of equipment.

4.3.1 Example of Actual Condition Statement

4.3.1.1 Lifebuoy

a) Lifebuoy lights and self activating smoke floats and quick release in good order.
b) Lifebuoy is out of date.
c) Lifebuoy well stowed base on LSA plan.

4.3.1.2 Lifejacket

a) Lifejackets are not stowed in the locations detailed on LSA plan.
b) The expired is in date.
c) Lifejackets are not equipped with operational whistle
d) In good condition, securing tapes not knotted and not rotten

4.3.1.3 Liferaft

a) Casings in good condition.
b) Liferafts have valid inspection certificate(s)
c) Liferafts stowed as per the LSA plans
d) Hydrostatic releases is correctly attached, in good condition and out of date.

4.3.1.4 Lifeboat

a) Hull in good condition
b) Operational instructions correctly displayed inside and outside boat
c) Internally lifeboat is untidy
d) Some equipment not properly stowed

4.3.2 Question and Comments Recommedation

4.3.2.1 Lifebuoy

Question : Does the lifebuoy has met inspection standards ?
Answer Recommedation :

a) Lifebuoys are not placed according LSA plans.
b) Lifebuoys in good condition.
c) Lifebuoys is out of date and need renew.

4.3.2.2 Lifejacket

Question : Does the lifejackets has met inspection standards ?
Answer Recommedation :

a) Some lifejackets are not equipped with whistleLifebuoys in good condition.

b) Lifejackets are stowed in the locations detailed on LSA plan.
c) All life jacket material in good condition

4.3.2.3 Liferaft

Question : Are all liferafts available for immediate use?
Answer Recommedation :
a) Should be inspection in 19th April 2019
b) HRU Expired in May 2019
c) Casing not in good condition

4.3.2.4 Lifeboat

Question : Are the lifeboats available for immediate use?
Answer Recommedation :
a) The hull is cracked, and need to repair
b) Lifeboat operating instructions is prominently displayed.
c) Lifeboat is untidy state and some equipment not properly stowed

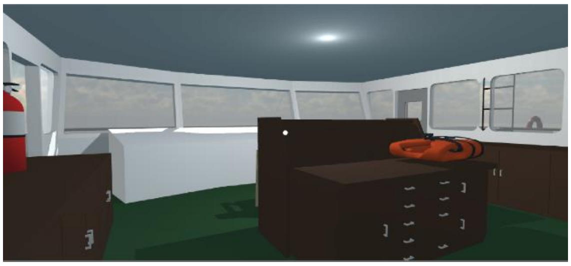
4.4 Creation VR Object

This phase consists of creating the assets of the virtual environment, the small bricks that build the whole virtual world. The requirements for some assets can be clear from earlier phases of the analyses or even from the scenario draft. All the object should be tested as soon as possible and documentation should be made accordingly. There are many kinds of assets, scripts, texts, graphics, animations, sounds and hardware.

4.4.1 Create 3D Object

There are 3 decks convert to 3D base on actual survey :

4.4.1.1 Bridge Deck

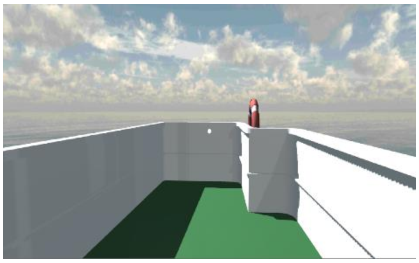


Figure 4.3 Bridge Deck
Source : By Author (2019)

4.4.1.2 C Deck

Figure 4.4 C Deck
Source : By Author (2019)

4.4.1.3 Upperforecastle Deck

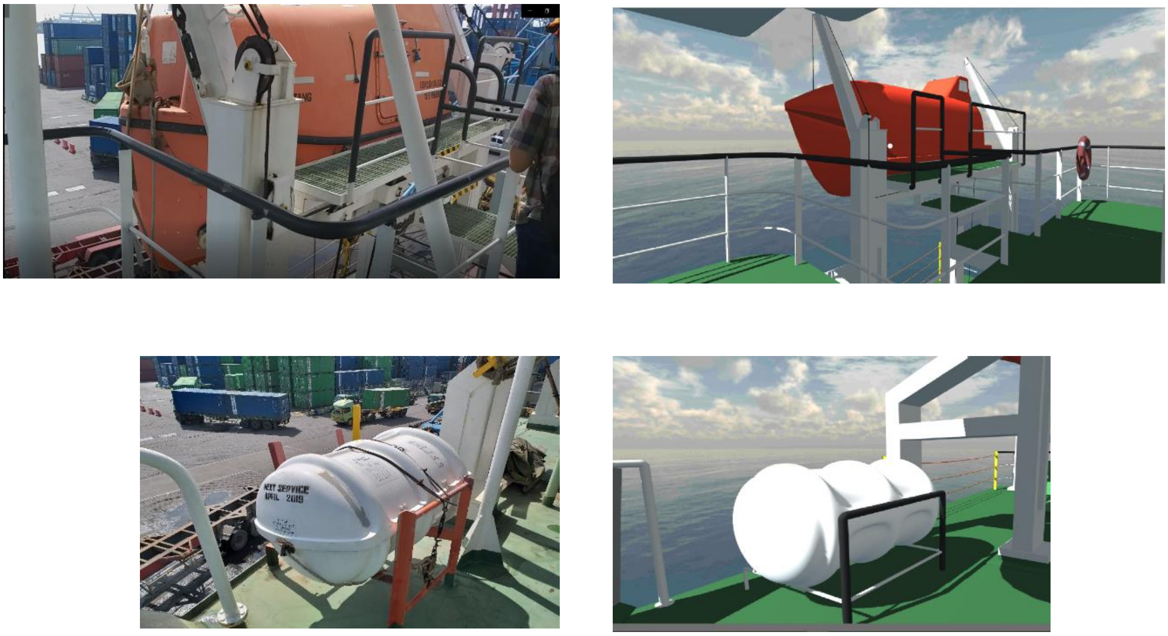


Figure 4.5 Upperforecastle Deck
Source : By Author (2019)

In process of creation 3d object the virtual environment must be reference from real environment, for example in figure 4.3, 4.4, and 4.5. The real environment convert to 3d object and will simulate in virtual reality application. This process using Blender 3D to create 3d object.

4.4.2 Features in Virtual Reality

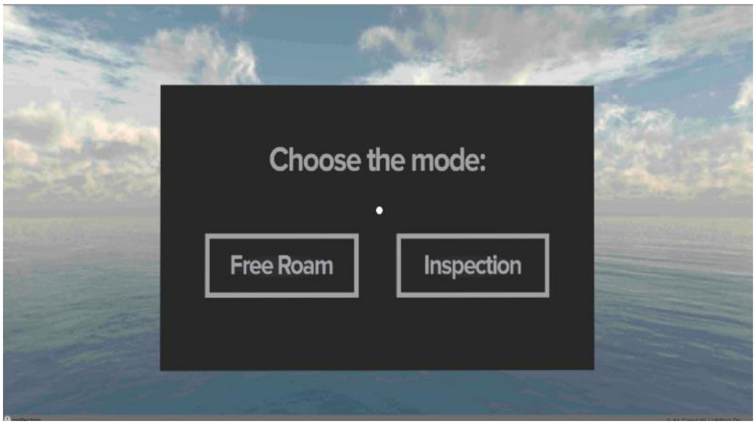


Figure 4.6 VR Mode
Source : By Author (2019)

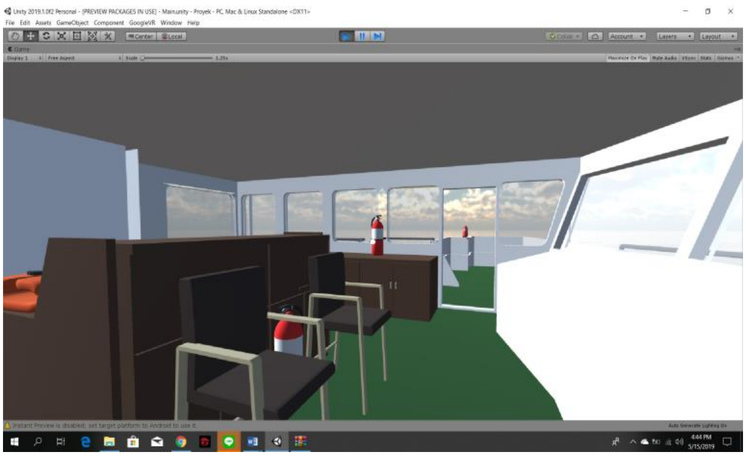


Figure 4.7 Free Room Mode
Source : By Author (2019)

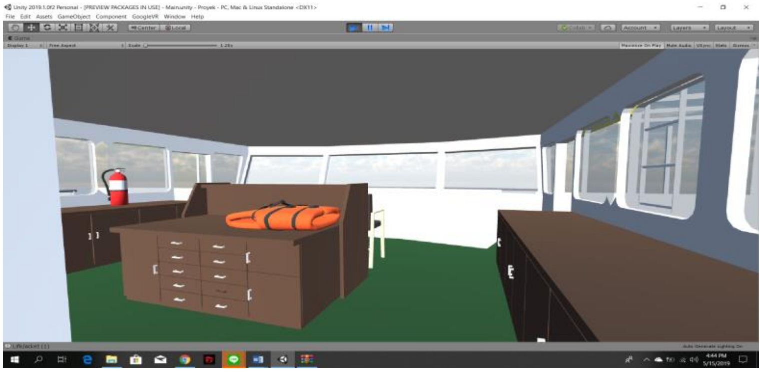


Figure 4.8 Bridge Deck
Source : By Author (2019)

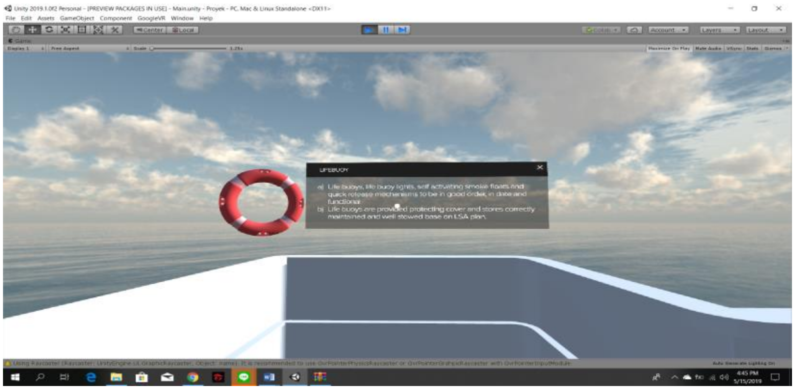


Figure 4.9 Object Review in Free Room
Source : By Author (2019)

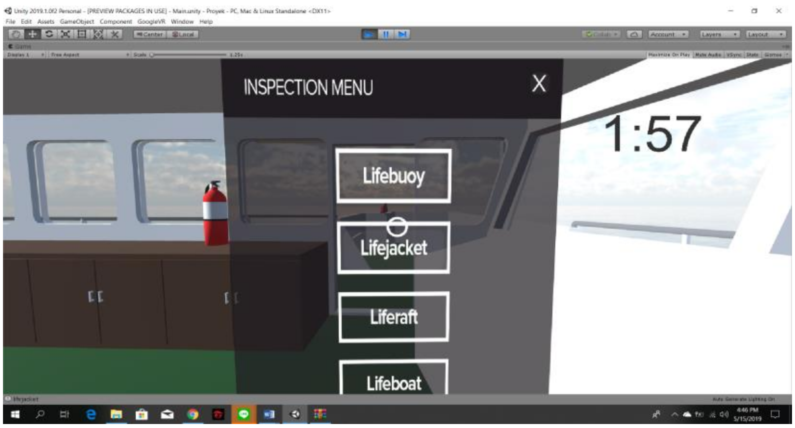


Figure 4.10 Inspection Test Menu
Source : By Author (2019)

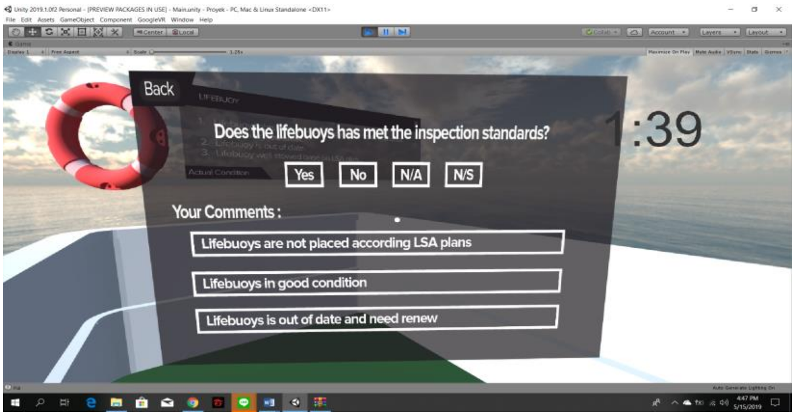


Figure 4.11 Inspection Justifiable
Source : By Author (2019)

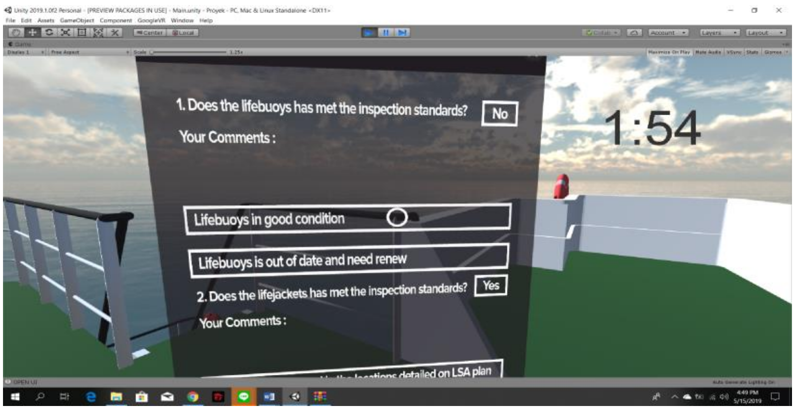


Figure 4.12 Assessment
Source : By Author (2019)

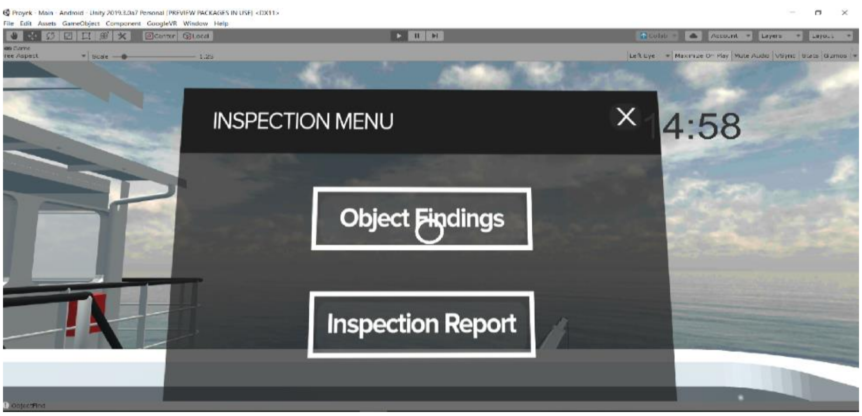


Figure 4.13 Inspection Menu
Source : By Author (2019)

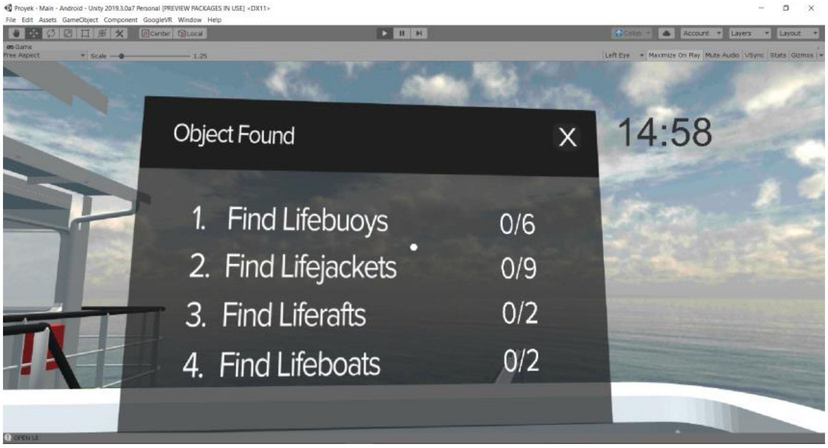


Figure 4.14 Inspection Menu
Source : By Author (2019)

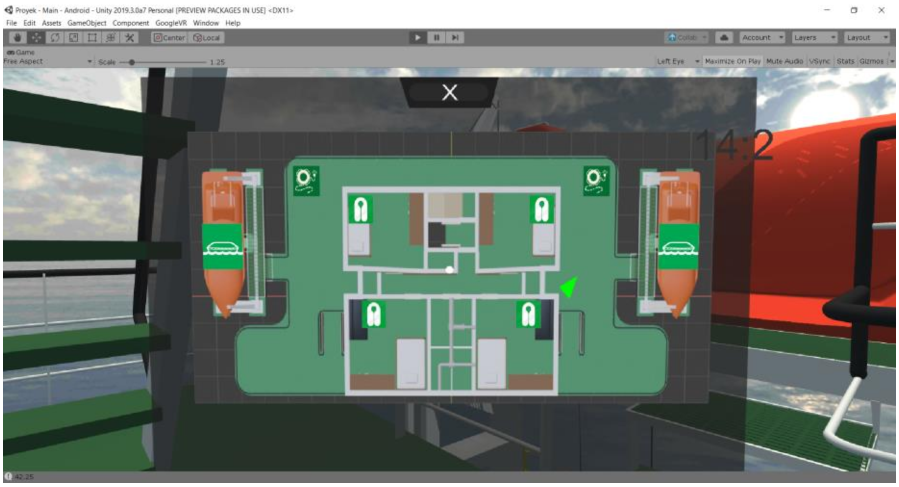


Figure 4.15 Map base on life saving appliances inspection menu
Source : By Author (2019)

After convert to 3d object next step is input the 3d object to unity 3d for build simulation in virtual reality application. There are some feature in virtual reality such as mode for free-roam and inspection in figure 4.6**,** free roam mode for gain the information about inspection checklist in figure 4.7 and figure 4.9, inspection task in figure 4.10, figure 4.11, figure 4.12, figure 4.13, figure 4.14 and life saving appliances plan in figure 4.15**.**

To create the 3d object some resources used in this thesis is Blender 3D and Unity 3d itu integration the 3d object and virtual reality application. The component hardware to running this application is using virtual reality glasses and joystick. These glasses behave in a similar way to a pair of 3D goggles in that they display two images. Ordinary glasses show a single image but 3D and virtual reality glasses contain polarised lenses which show two images, one per each eye. These images appear to give an illusion of depth which is a particular feature of virtual reality application. These glasses can be compared to a wearable android phone which along with an input device such as a joystick enables the wearer to experience a three dimensional world.

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CHAPTER V

CONCLUSION

5.1 Conclusion

In this virtual reality application displays a simulation adopted from the MV. Meratus Bontang. Simulations on virtual reality design the environment or work situation according to the reality on the ship. Where virtual reality is designed to conduct inspection training for life saving appliances on board.

The simulation developed in this thesis consists of 3 decks are bridge deck, c deck, and upperforecastle deck with life savinf appliances objects are lifeboat, lifejacket, liferaft, and lifebuoy. In this application there are two features that are inspection mode to complete some mission when inspection are carried out and free-roam mode to explore and provide information about inspection cheklist item.

In this virtual reality application the 3d are built is almost perfect in accordance with the real environment. But there are some details that are still lacking but overall the virtual environment is similar with the real environment.

The virtual reality simulation can be used to support the maritime industry sector specially in marine survey training. With VR a user can build their competence for ship inspections, and experience tells them where to focus attention without any risk. Virtual reality brings the knowledge and can give experience of many users that can be accessed for training anywhere and any time with easily.

5.2 Suggestion

The suggestion of this thesis are :

1. Before running the virtual reality application, the user must install .apk file on android phone that will be used.
2. Some features may experience bug, this is normal for an appliacation in developing process.
3. MV. Meratus Bontang has 5 decks and still can develop for virtual reality application.
4. The content in virtual reality application can still developed and updated base on real condition such as certificate, inspection scenario, and 3d details.

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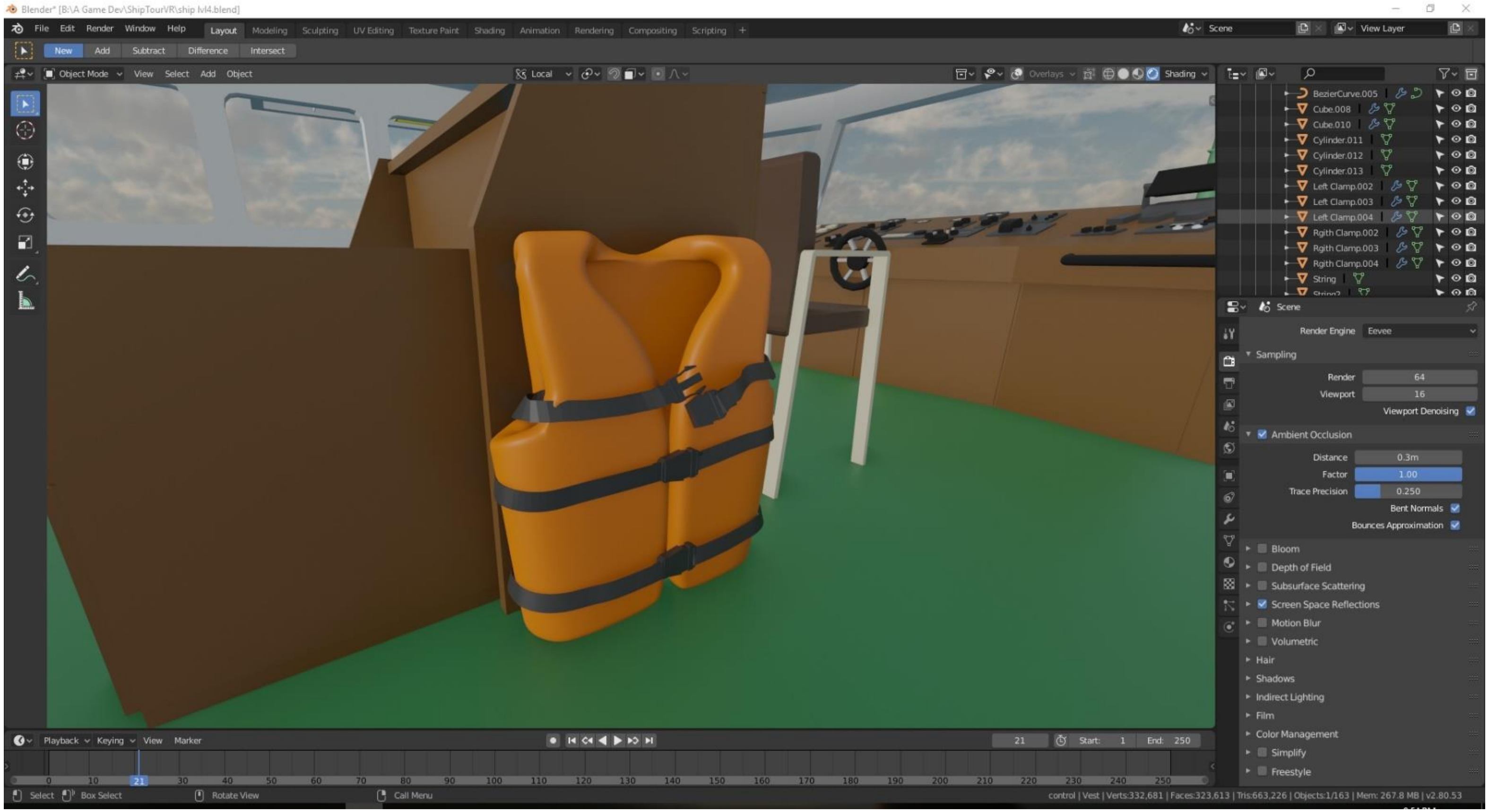
Appendix 1

Design Virtual Reality Simulation from Unity 3D Software



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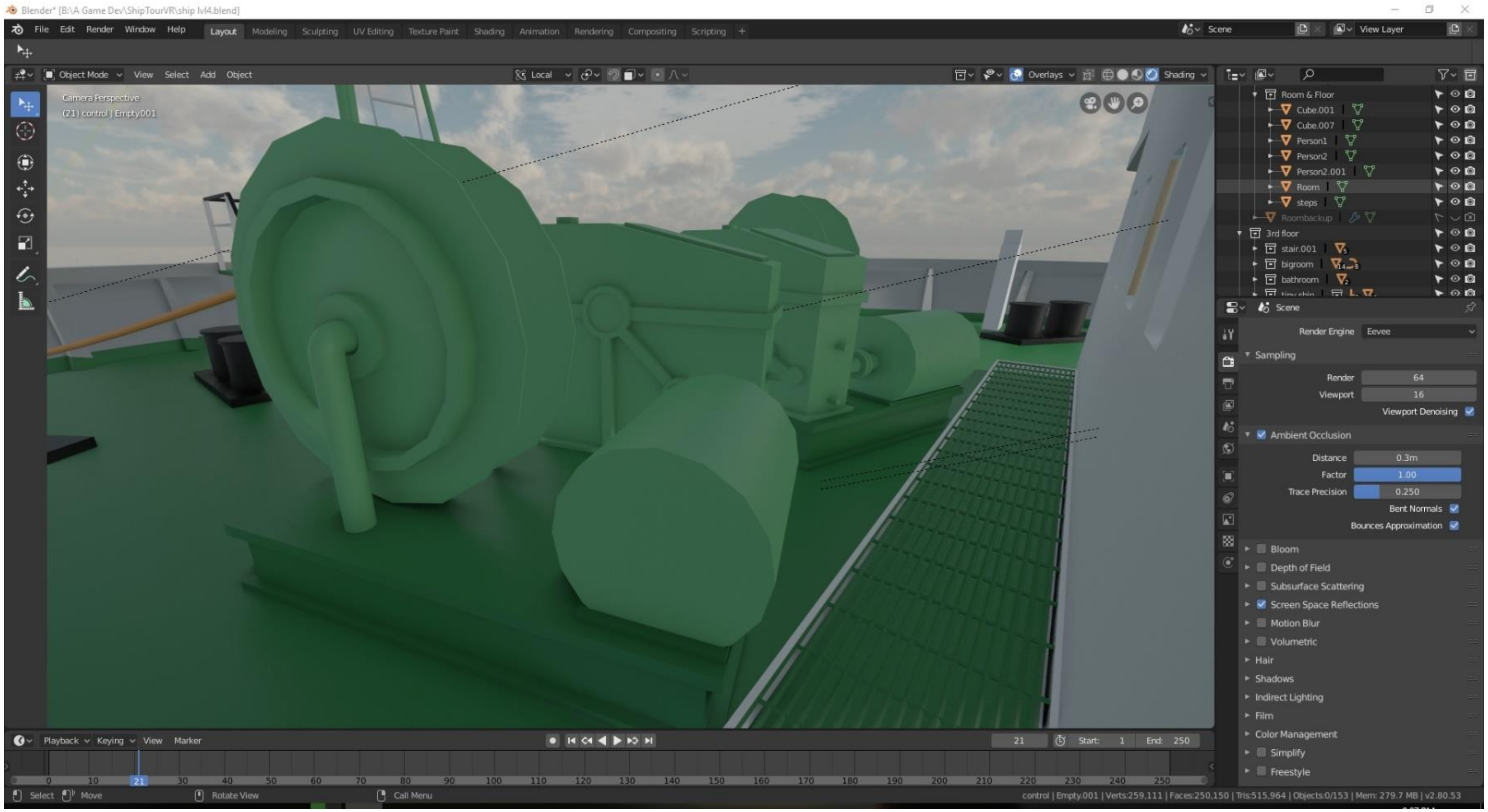

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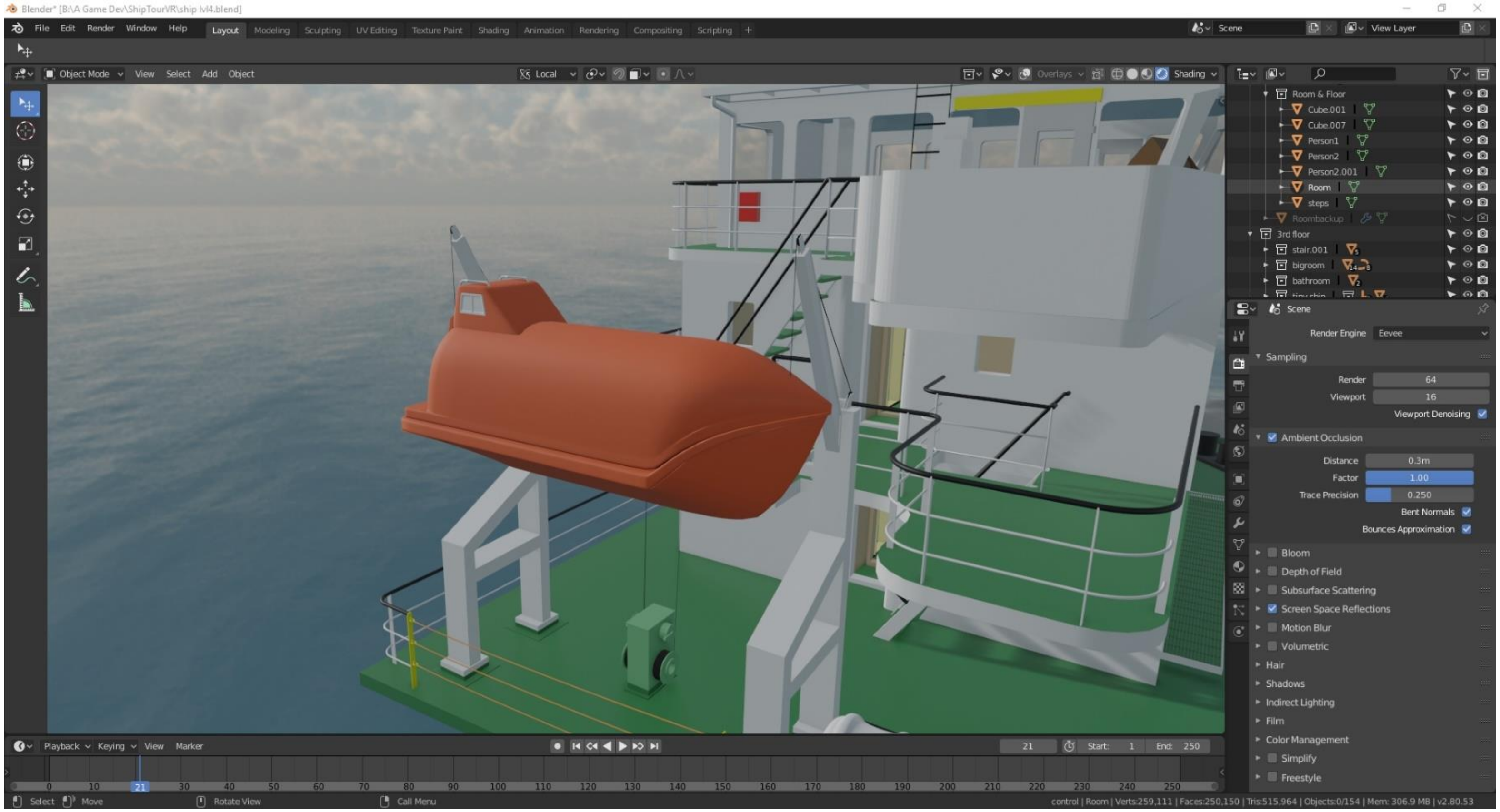

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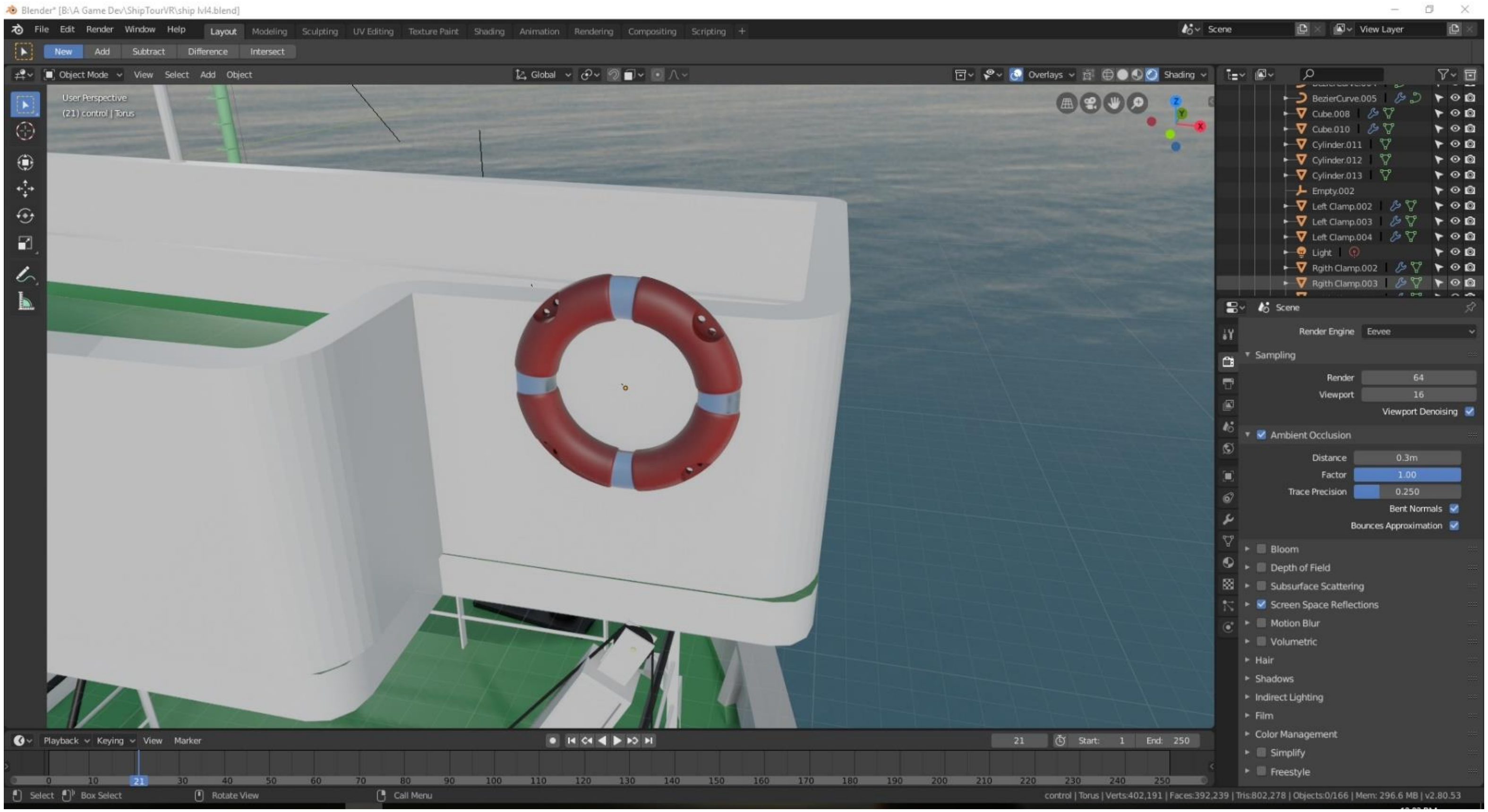

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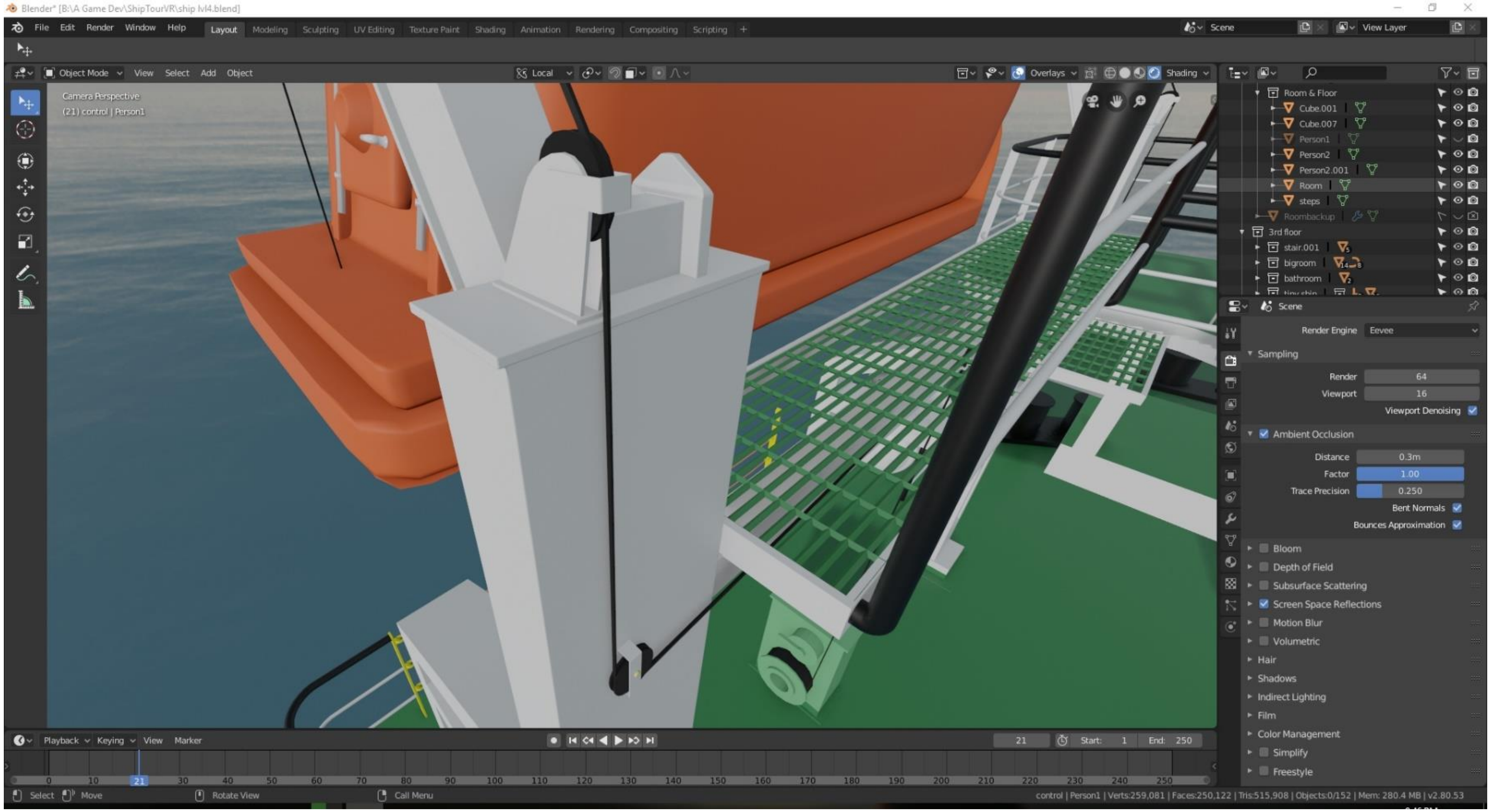

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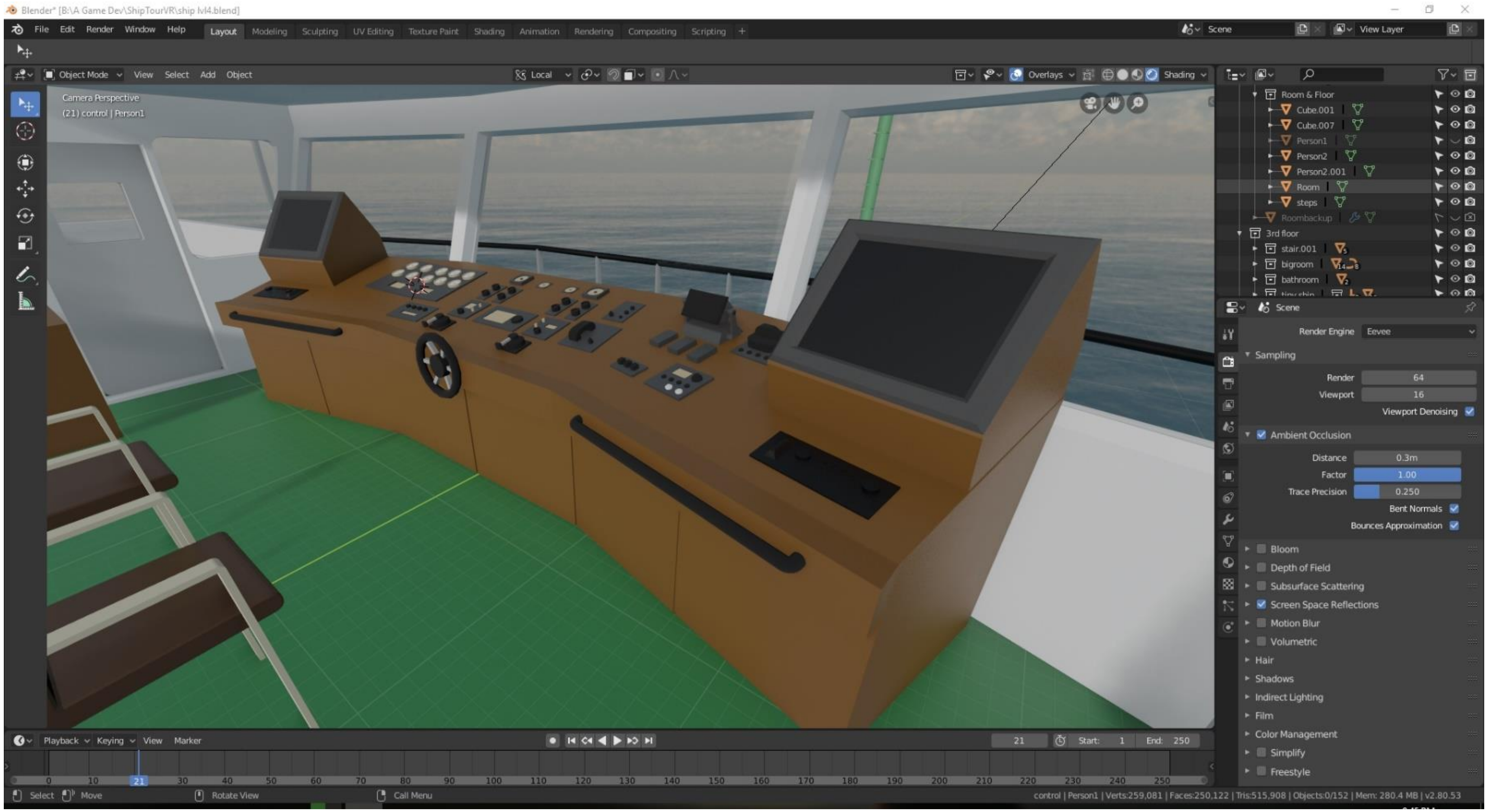

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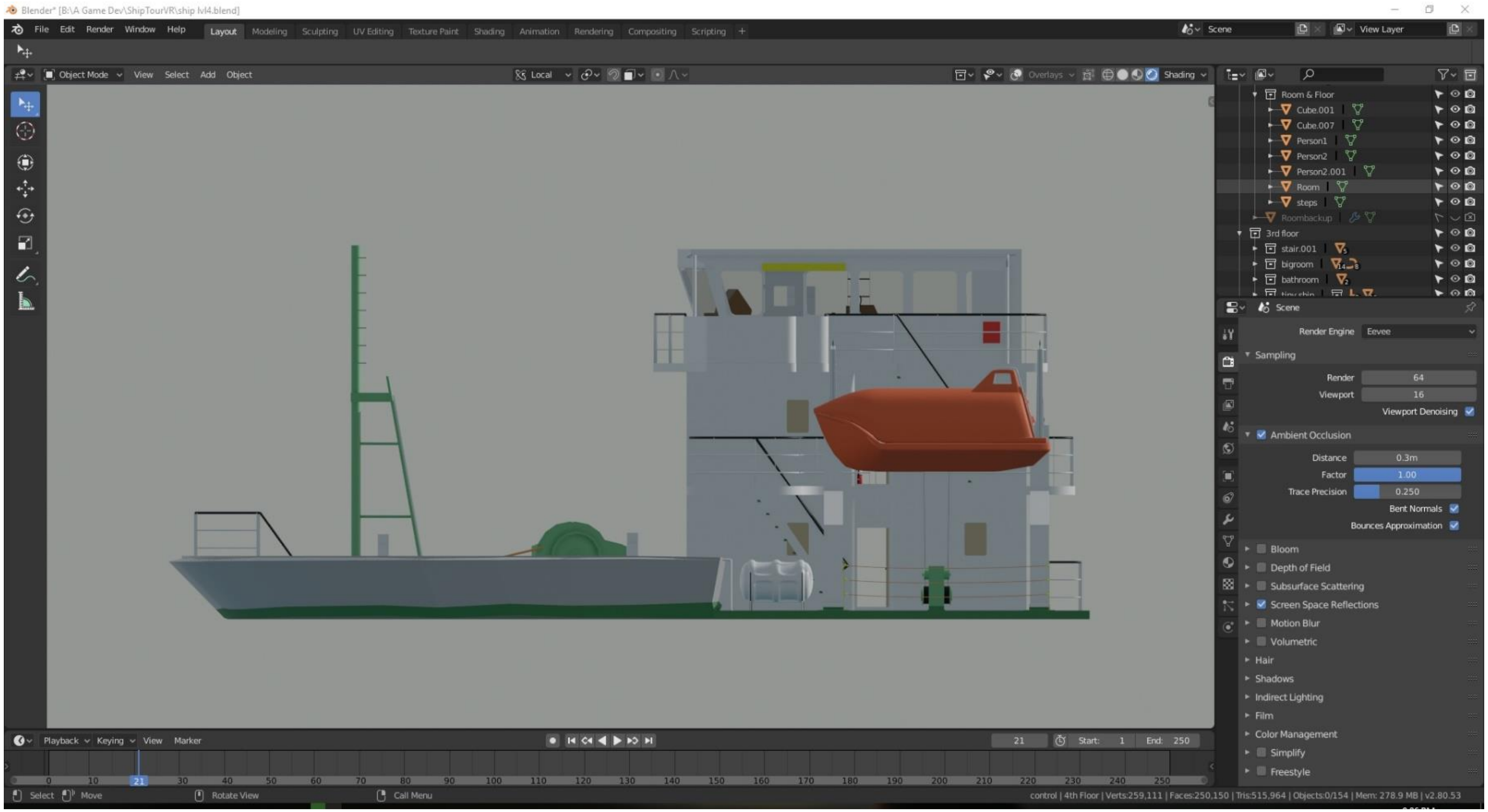

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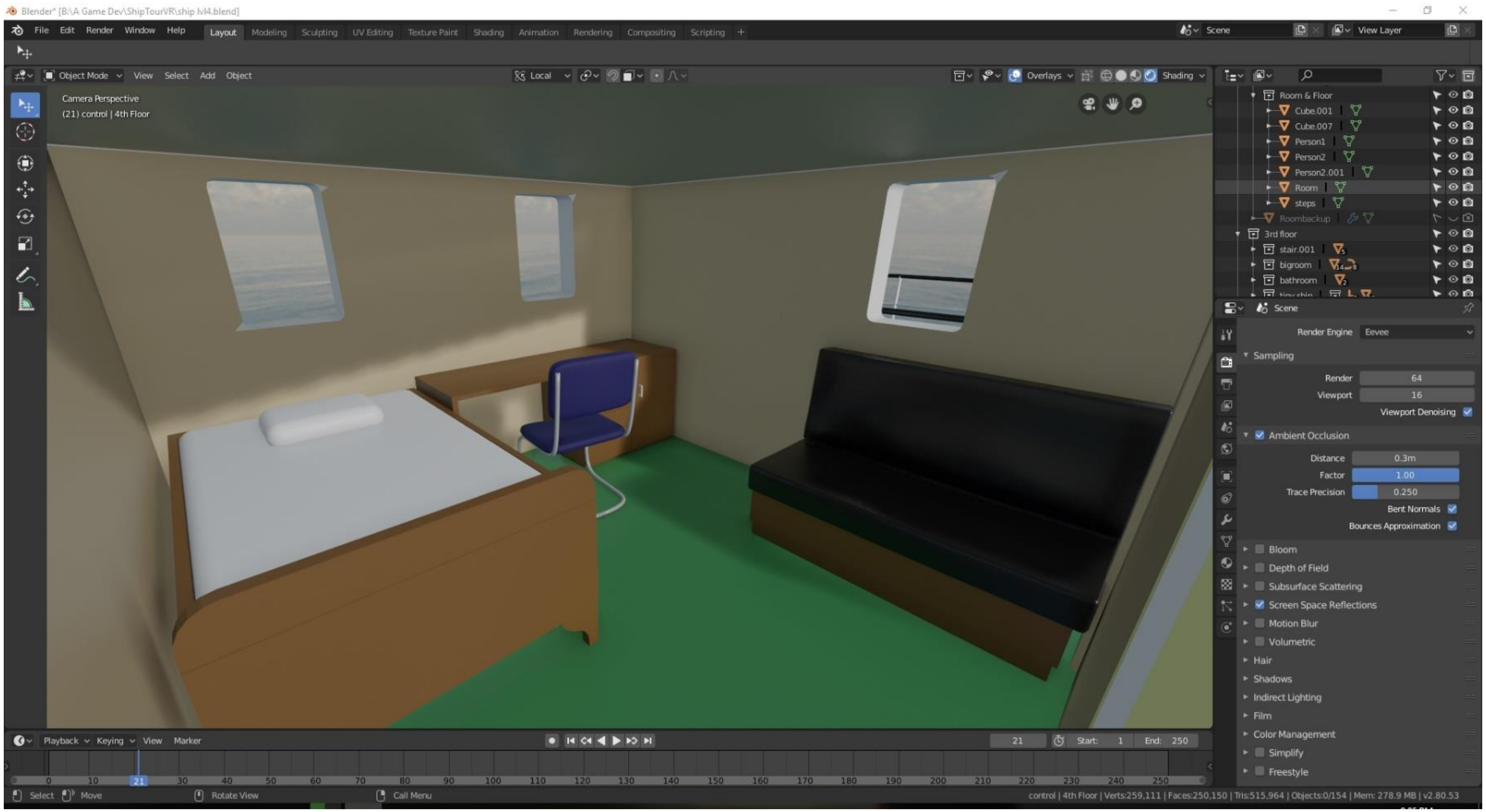

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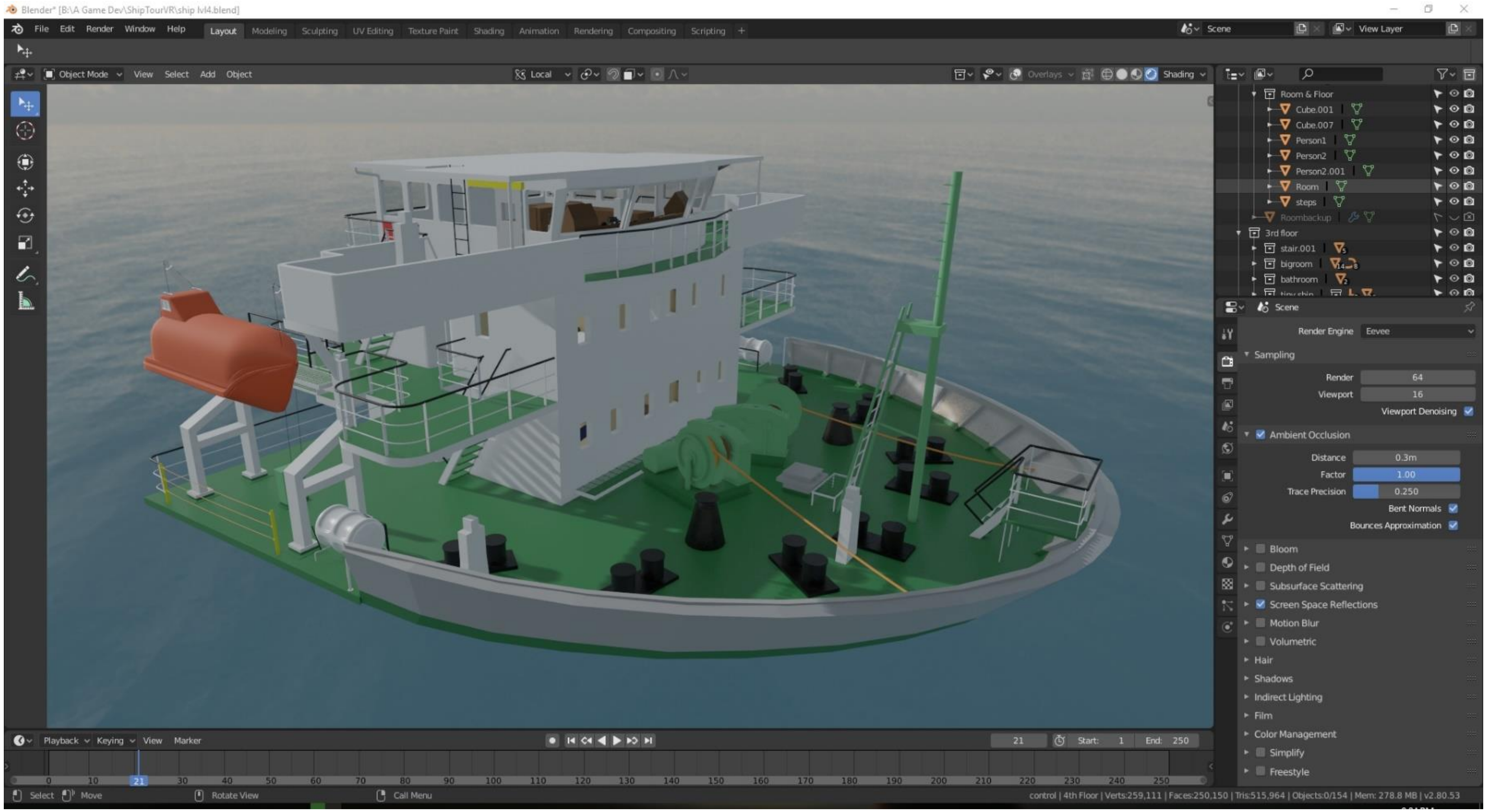

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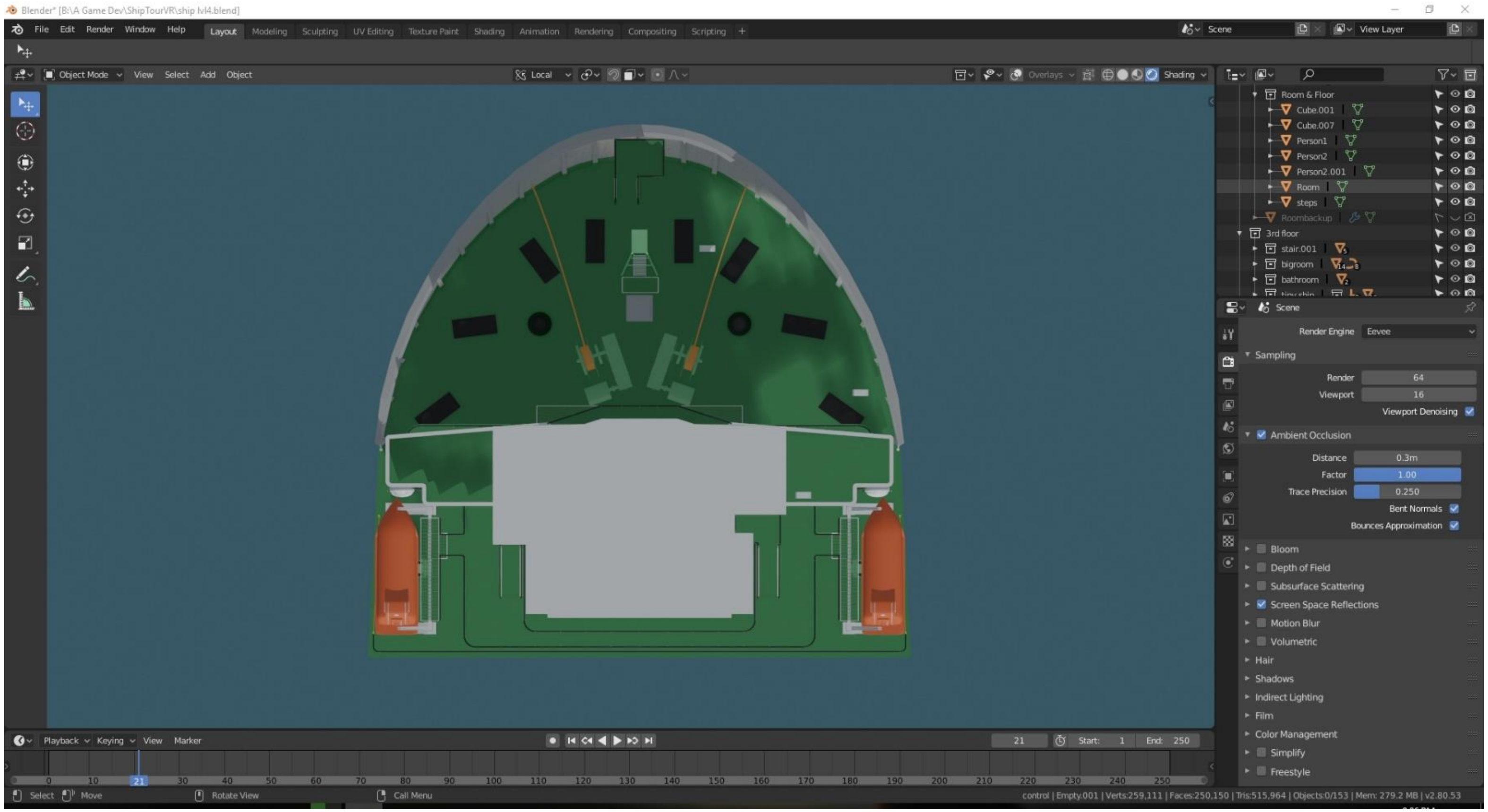

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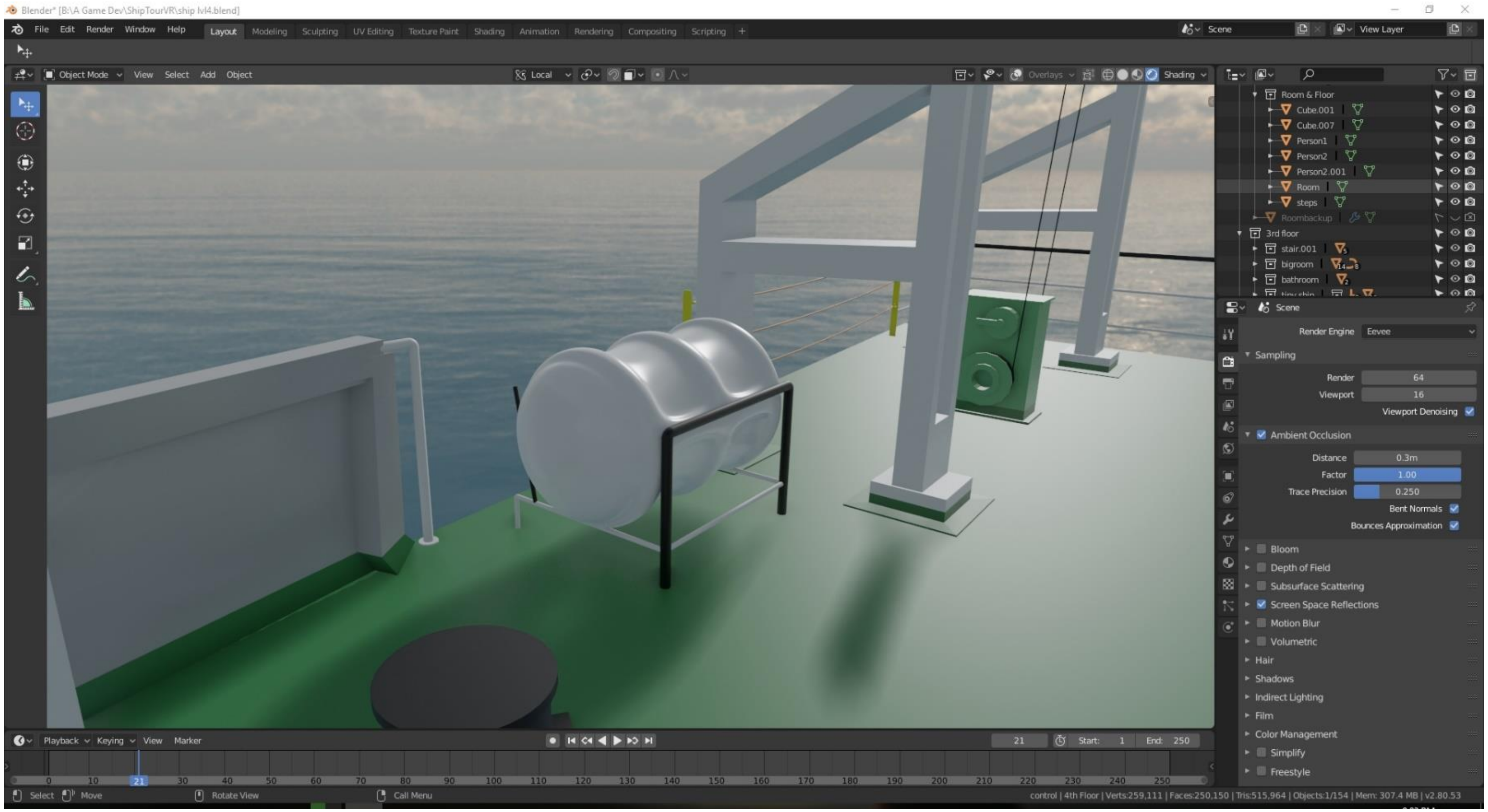

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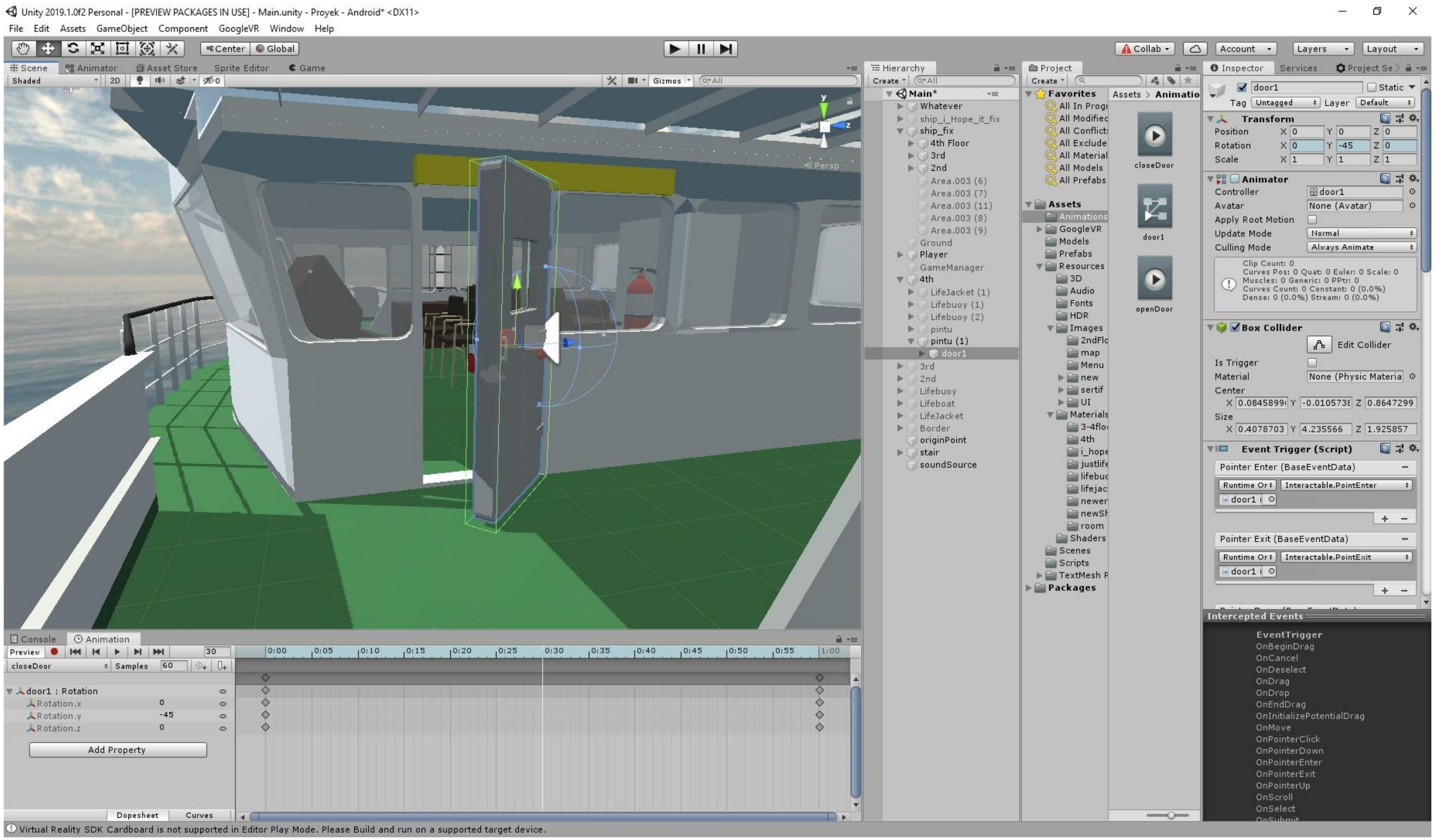

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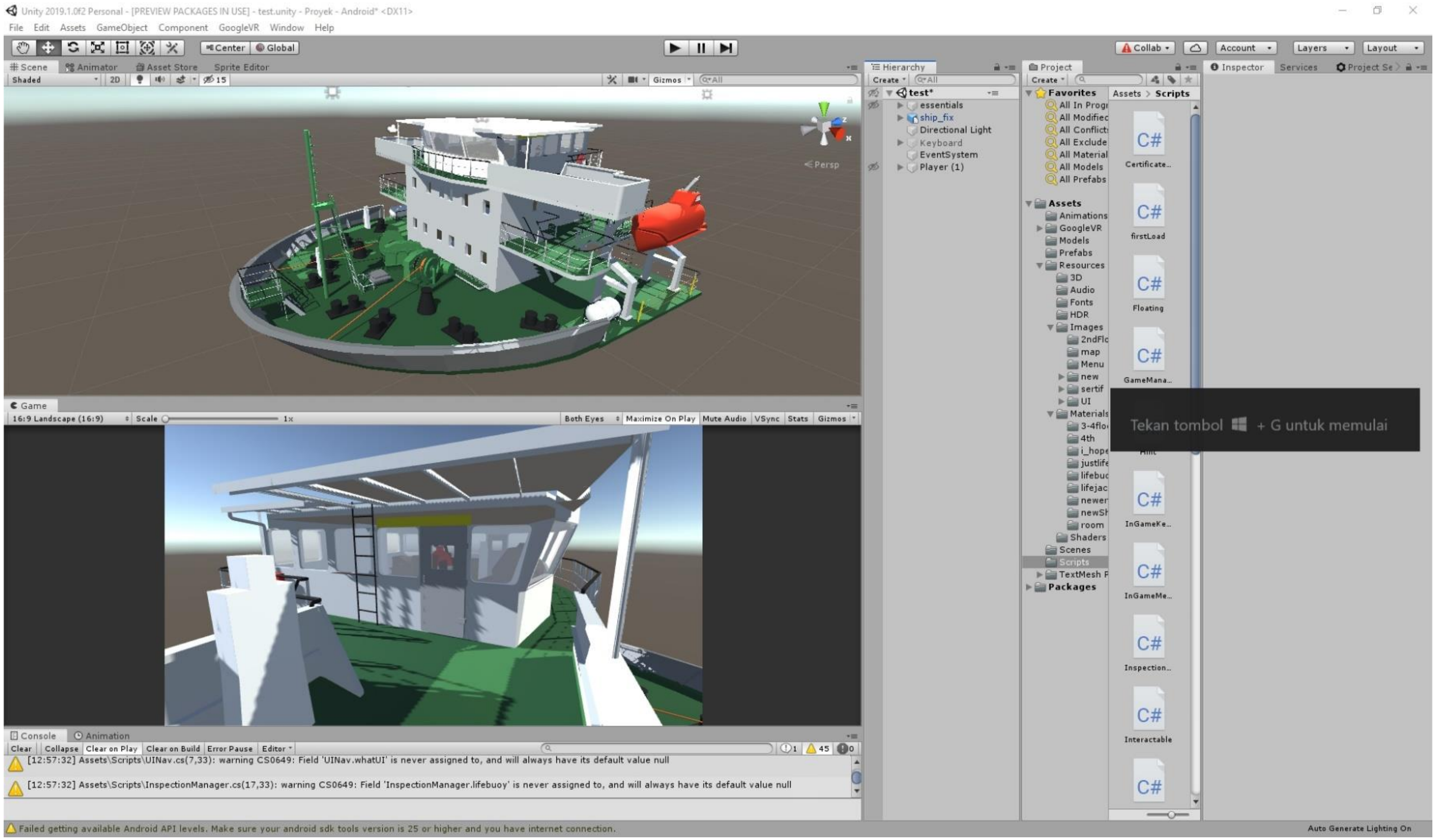

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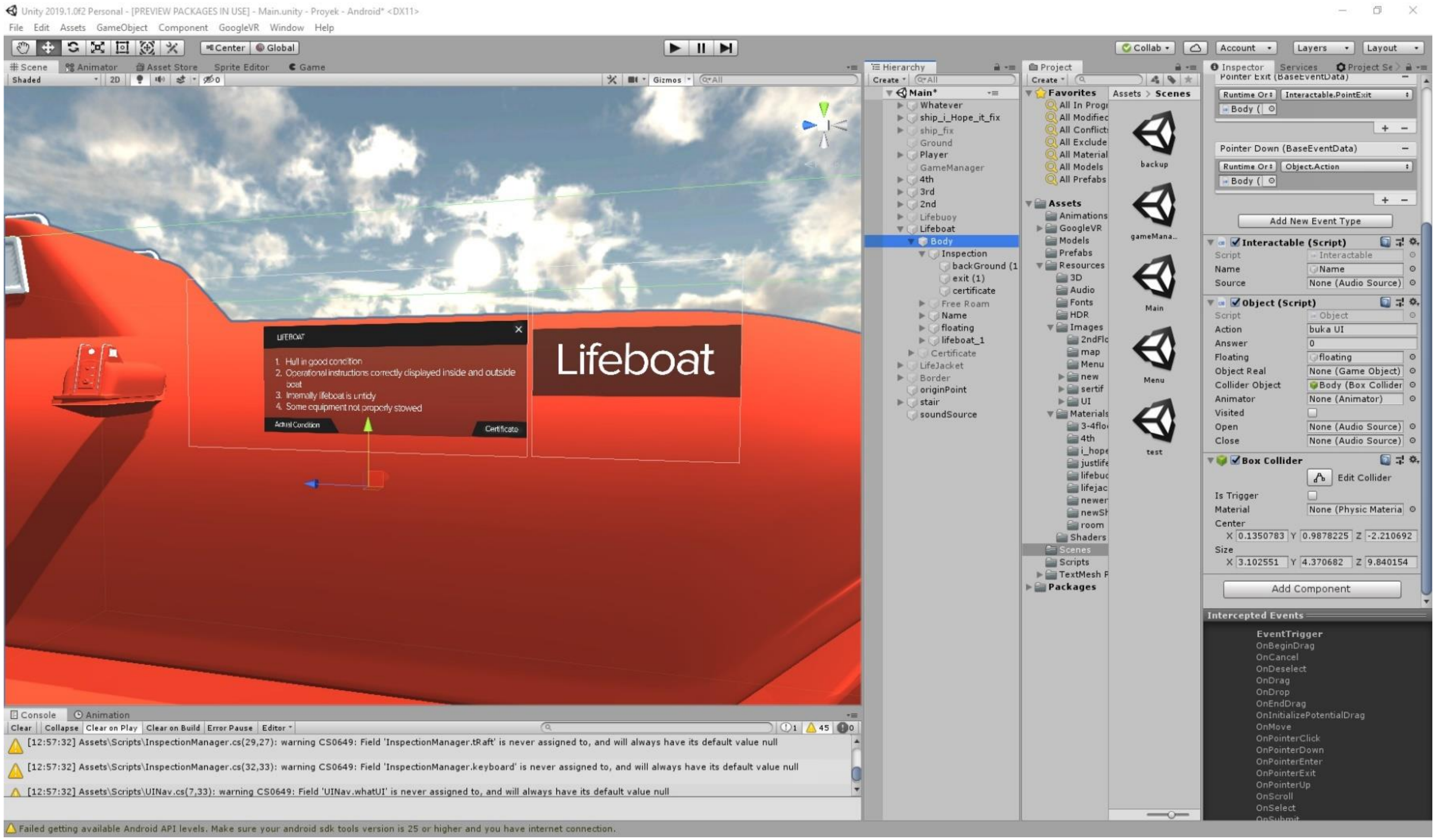

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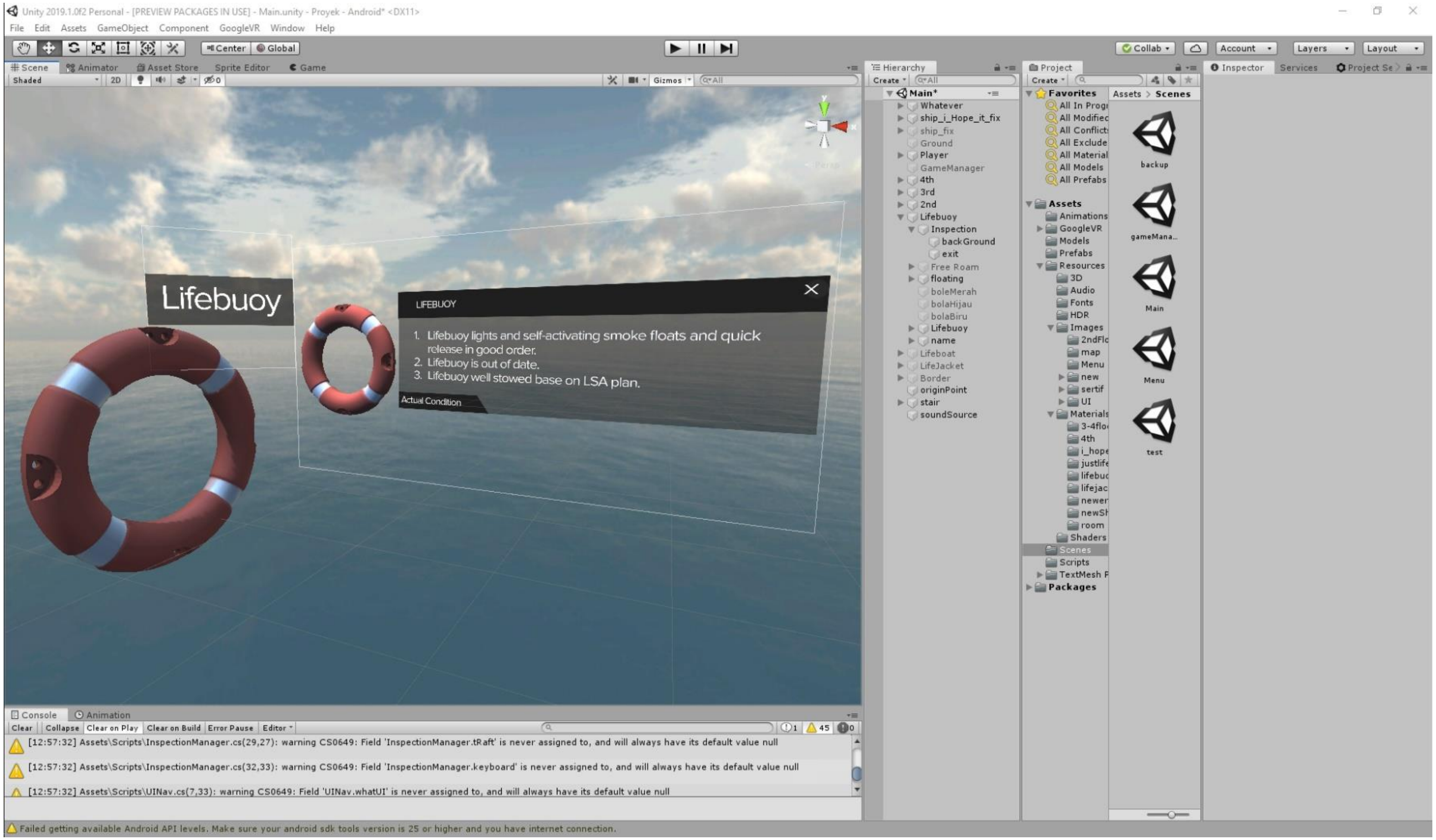

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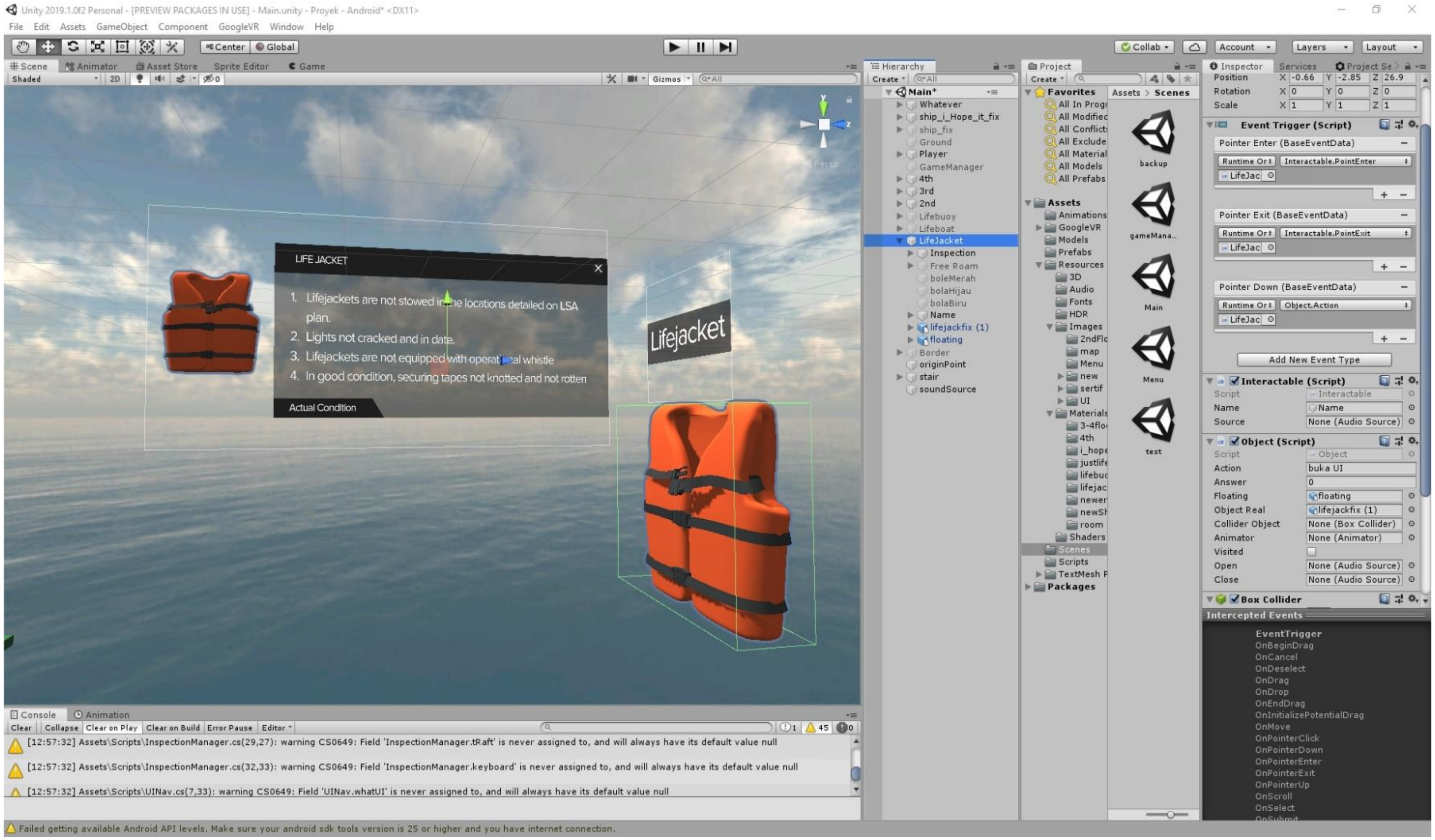

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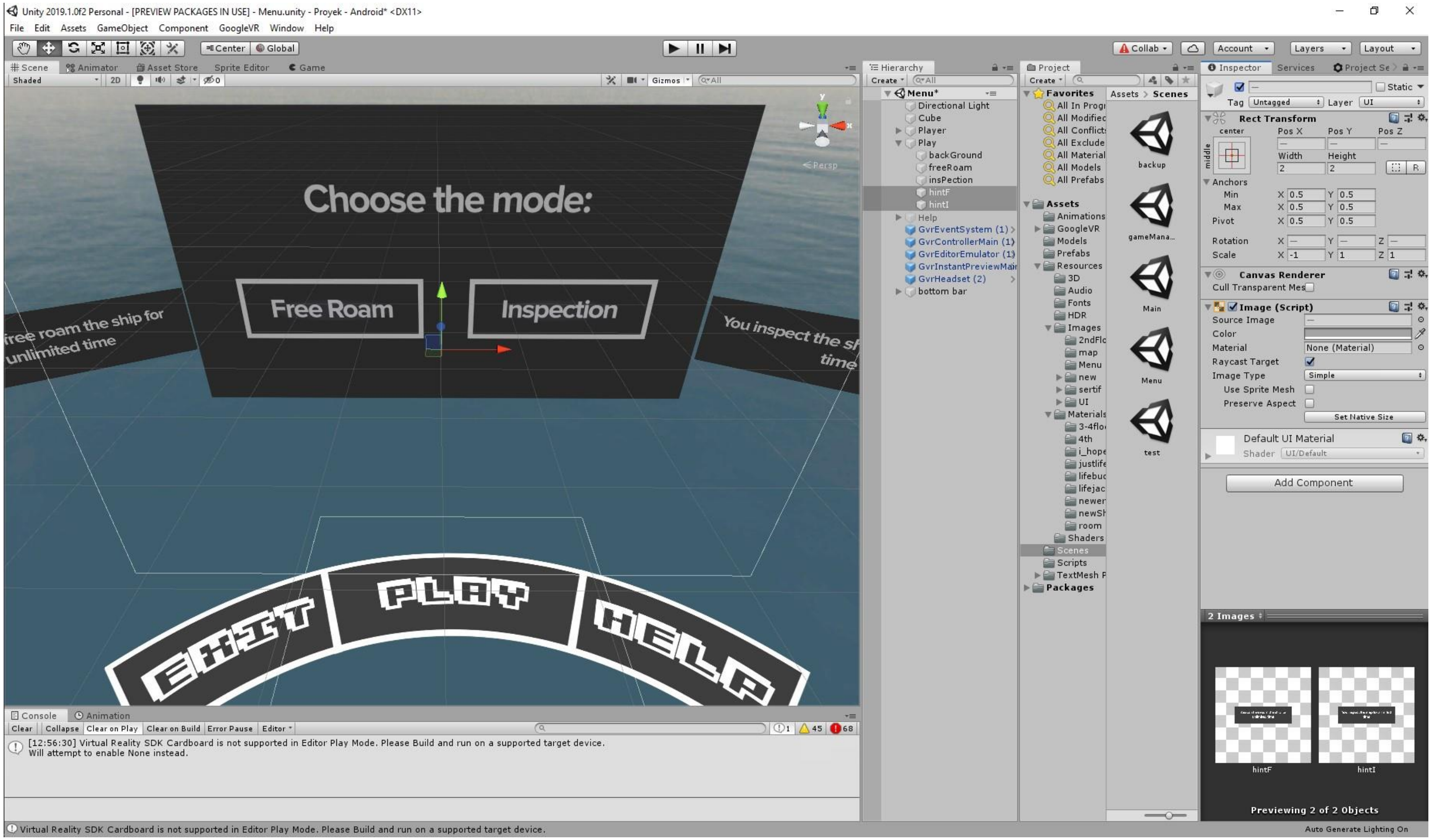

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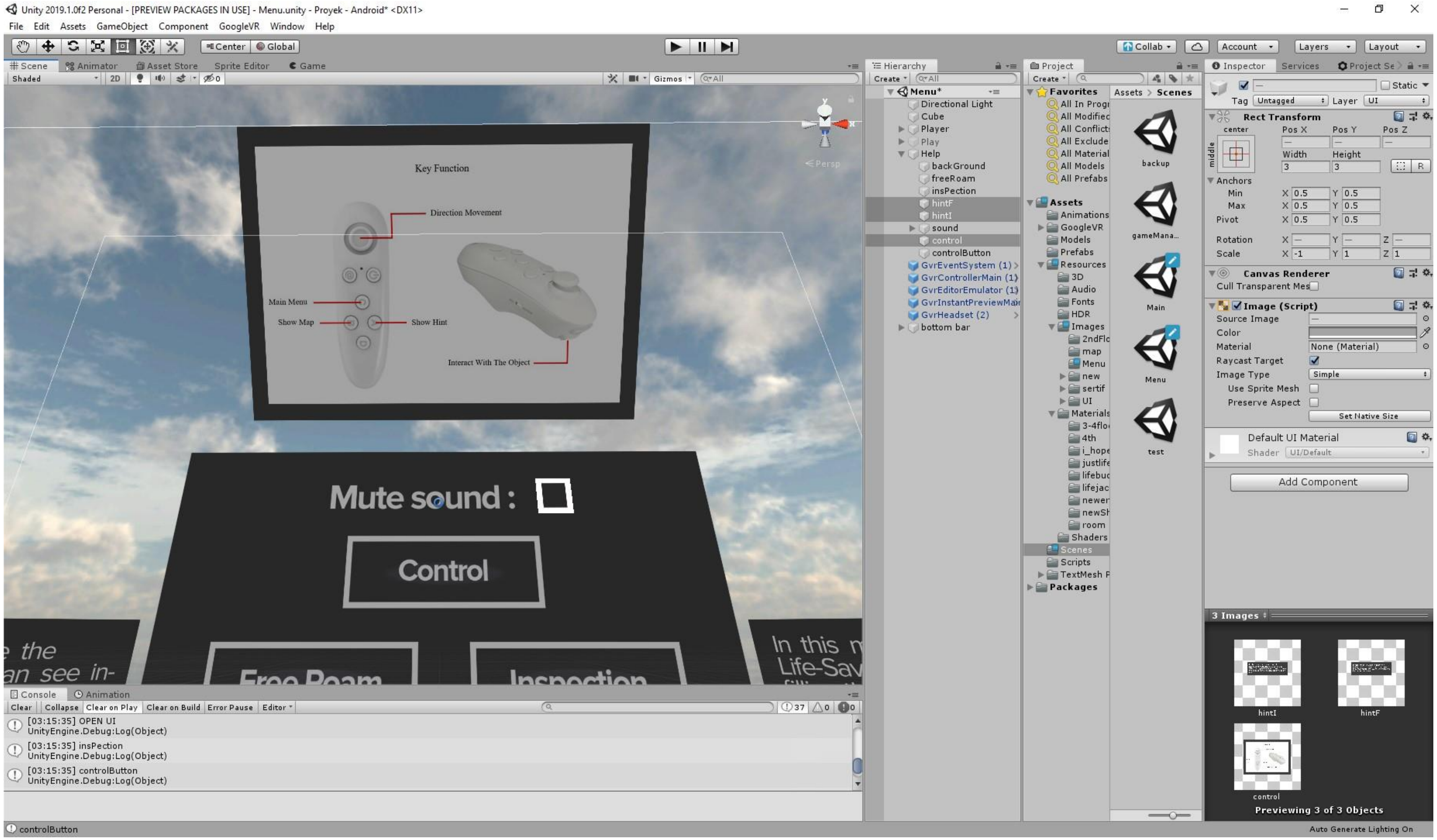

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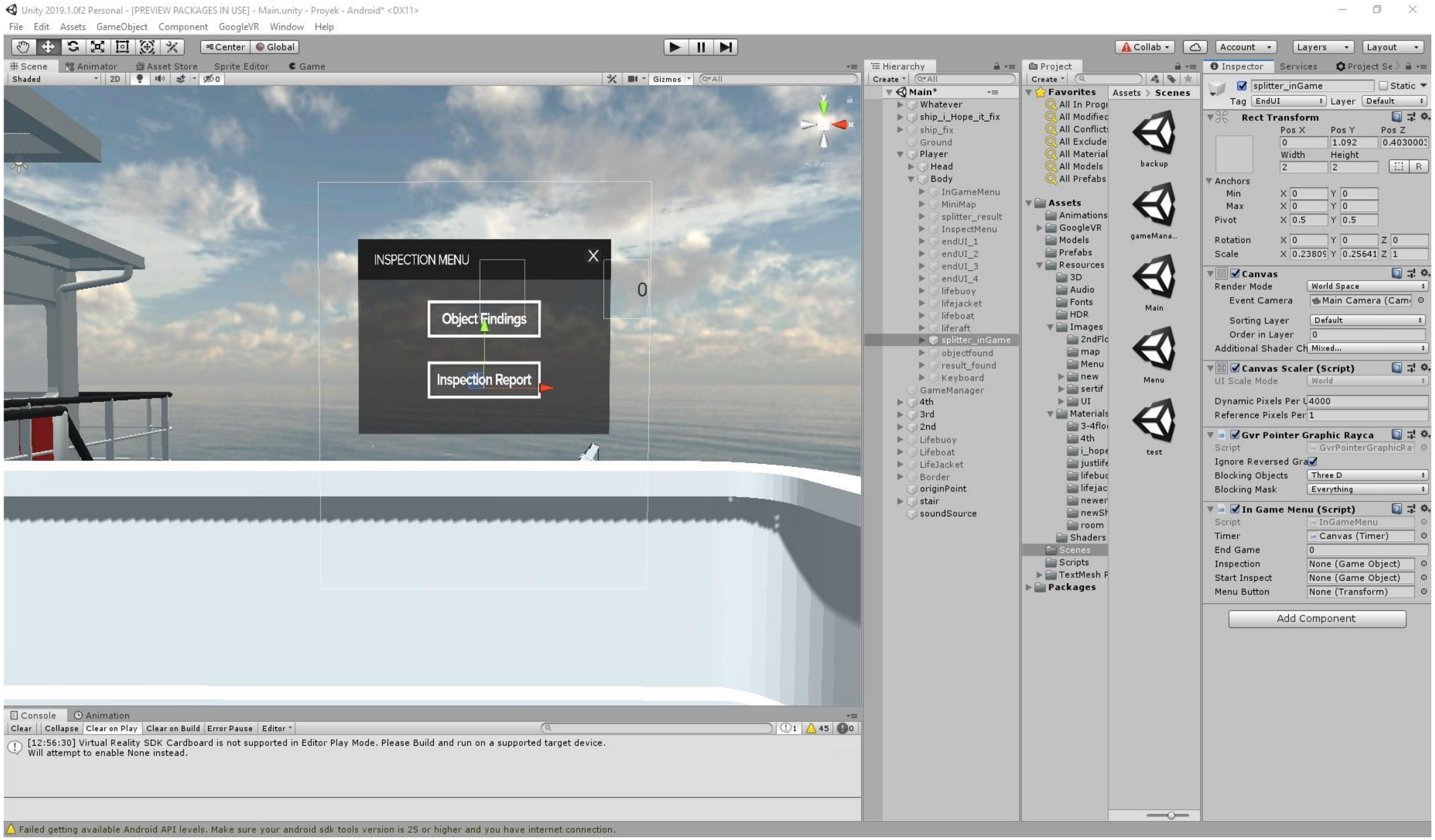

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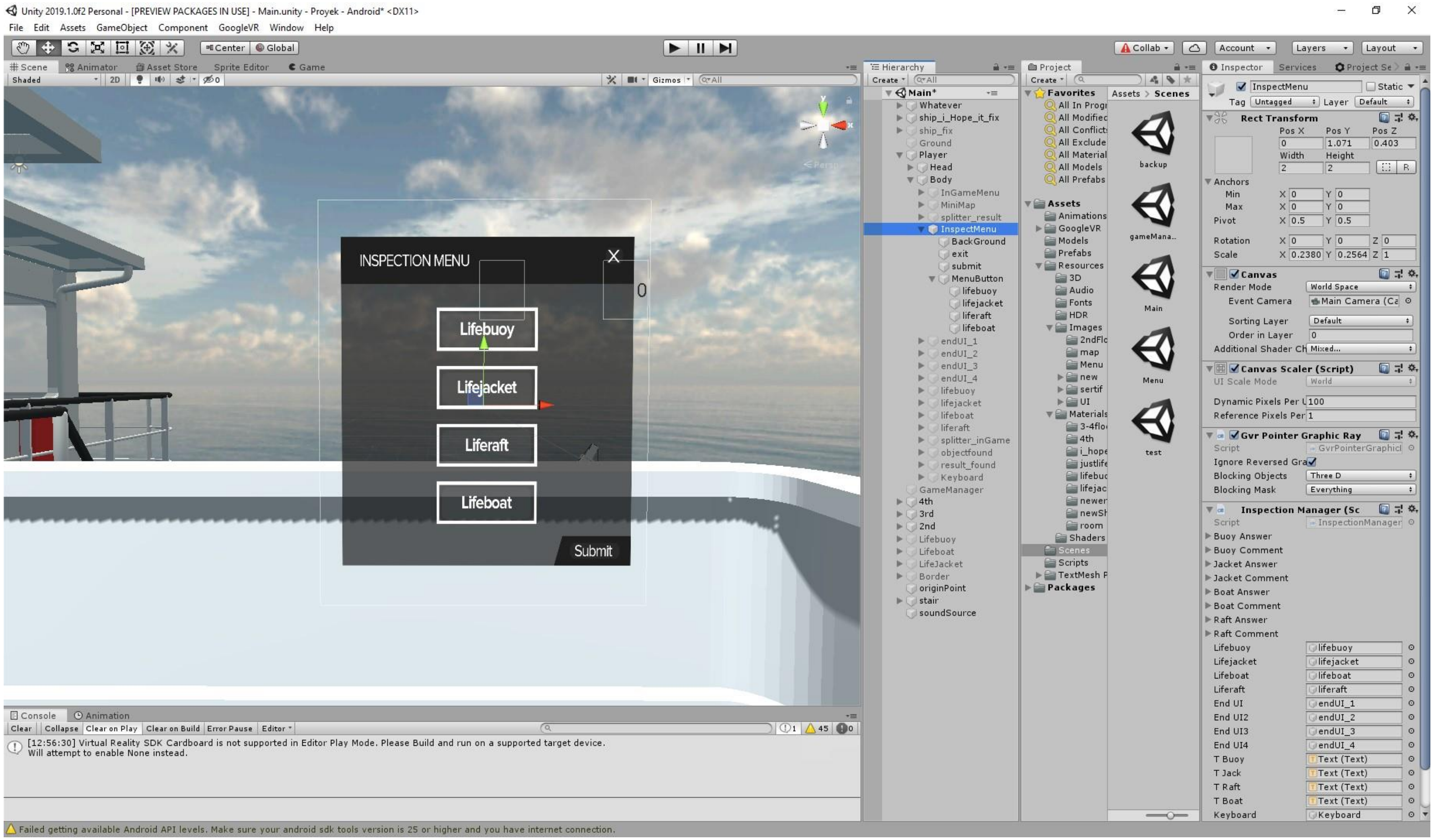

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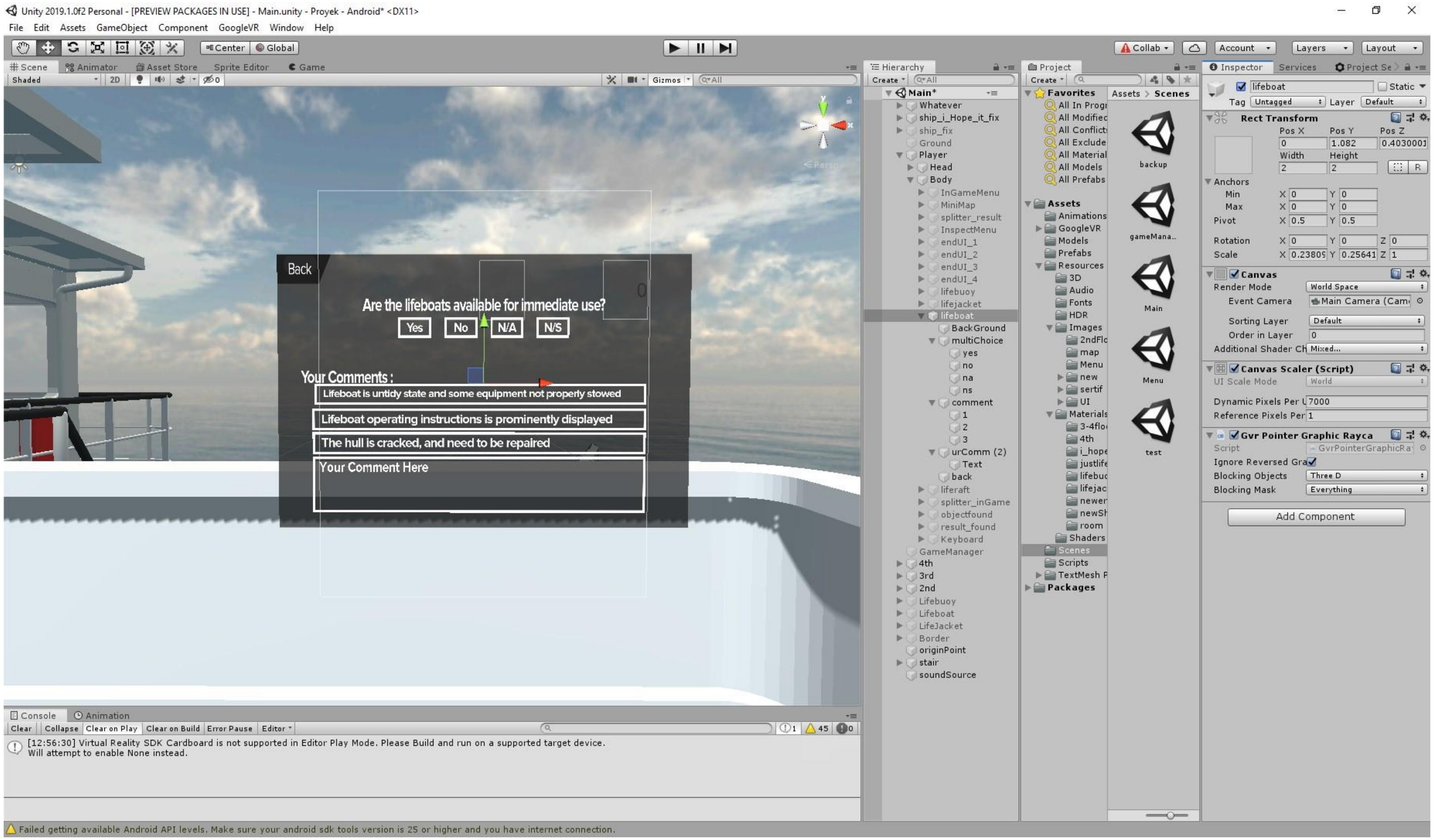

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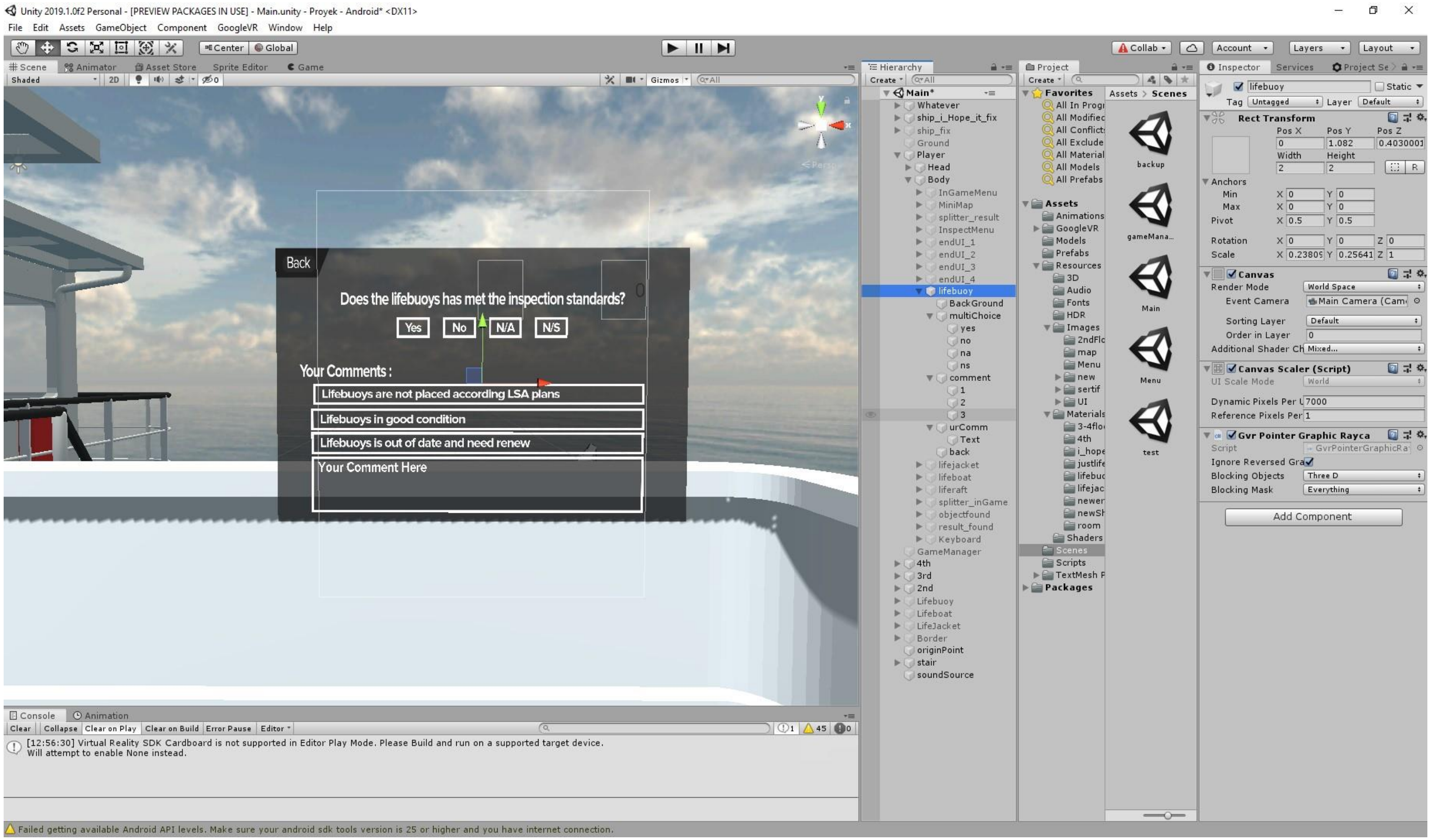

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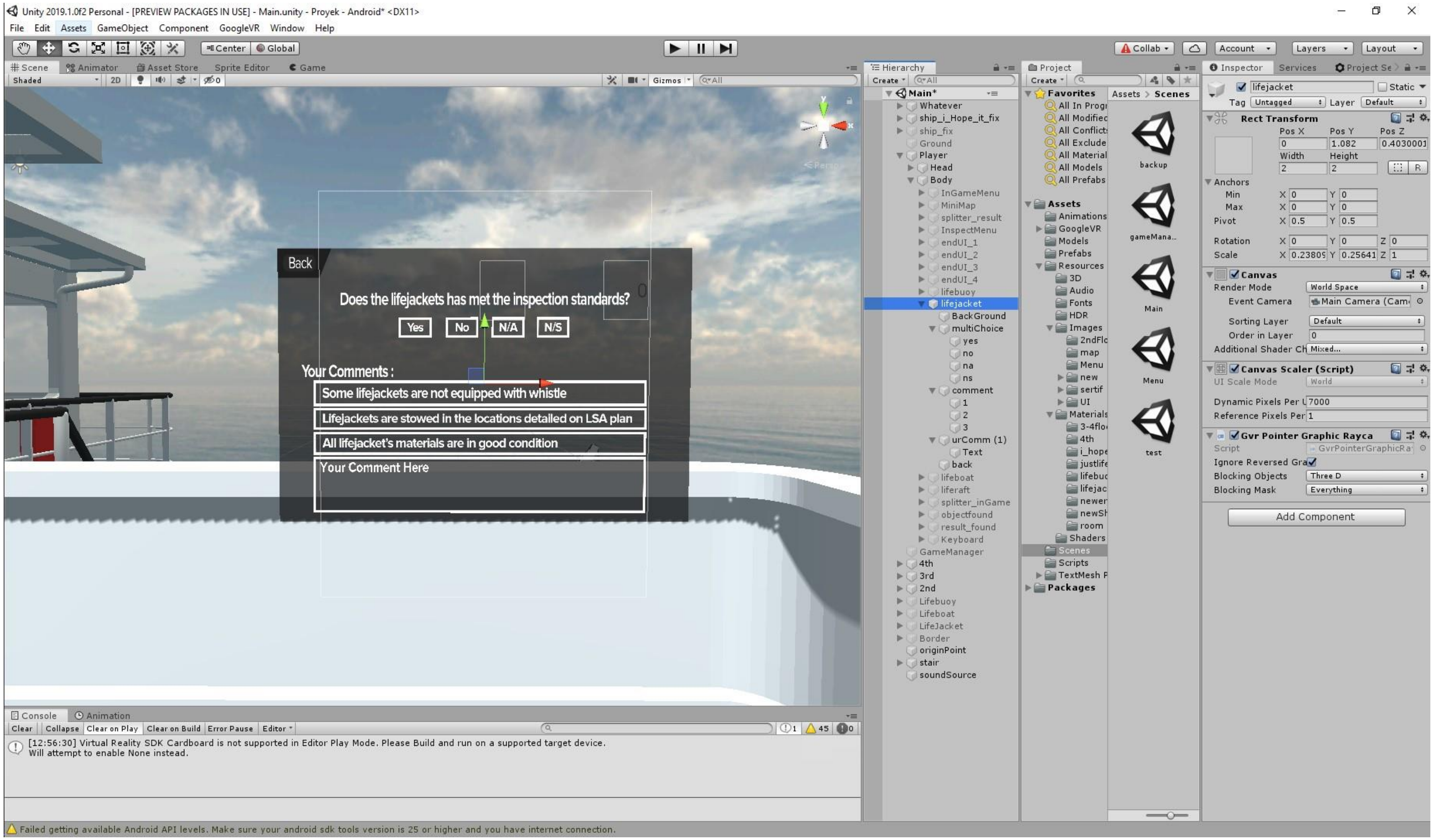

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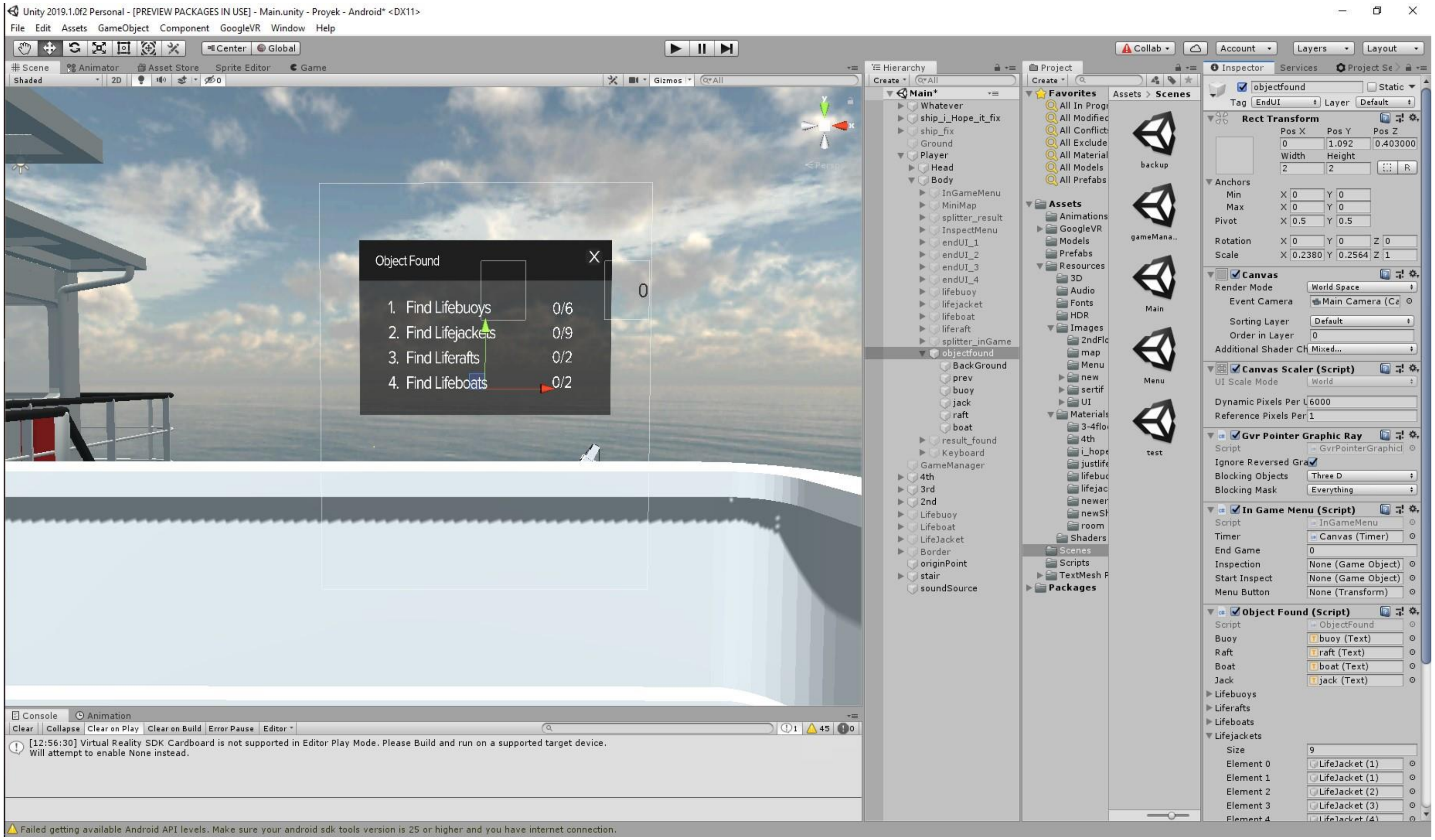

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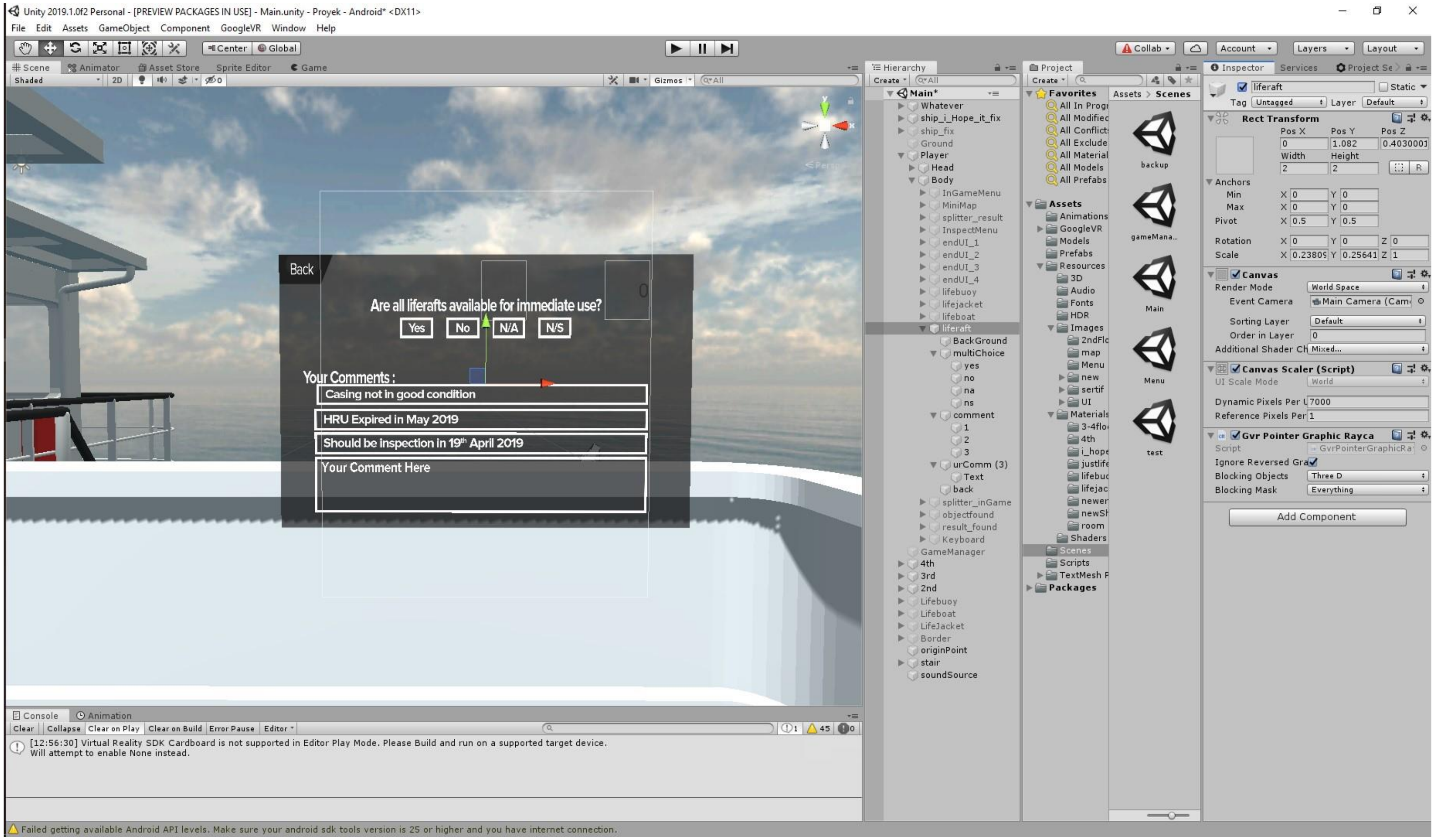

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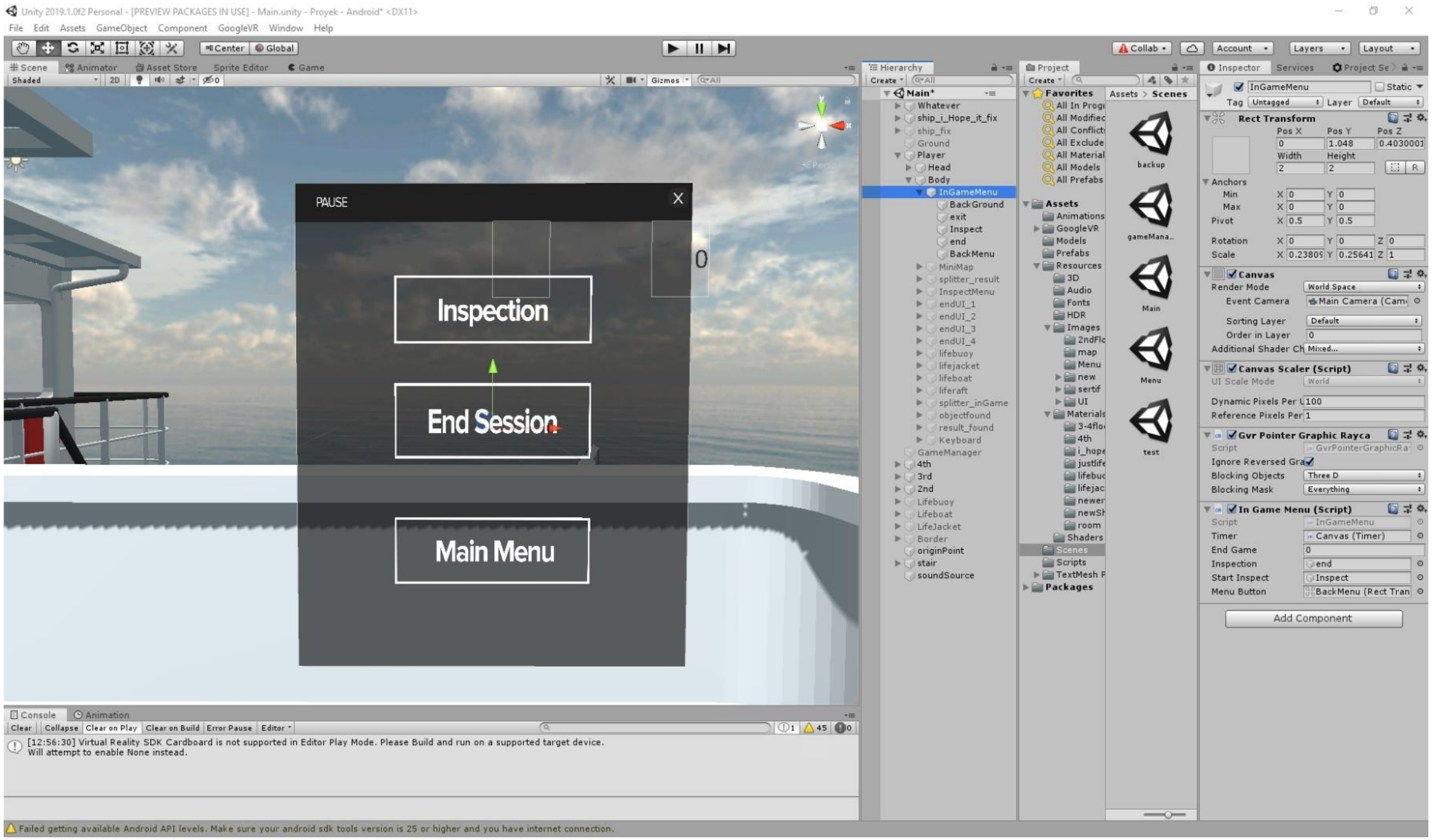

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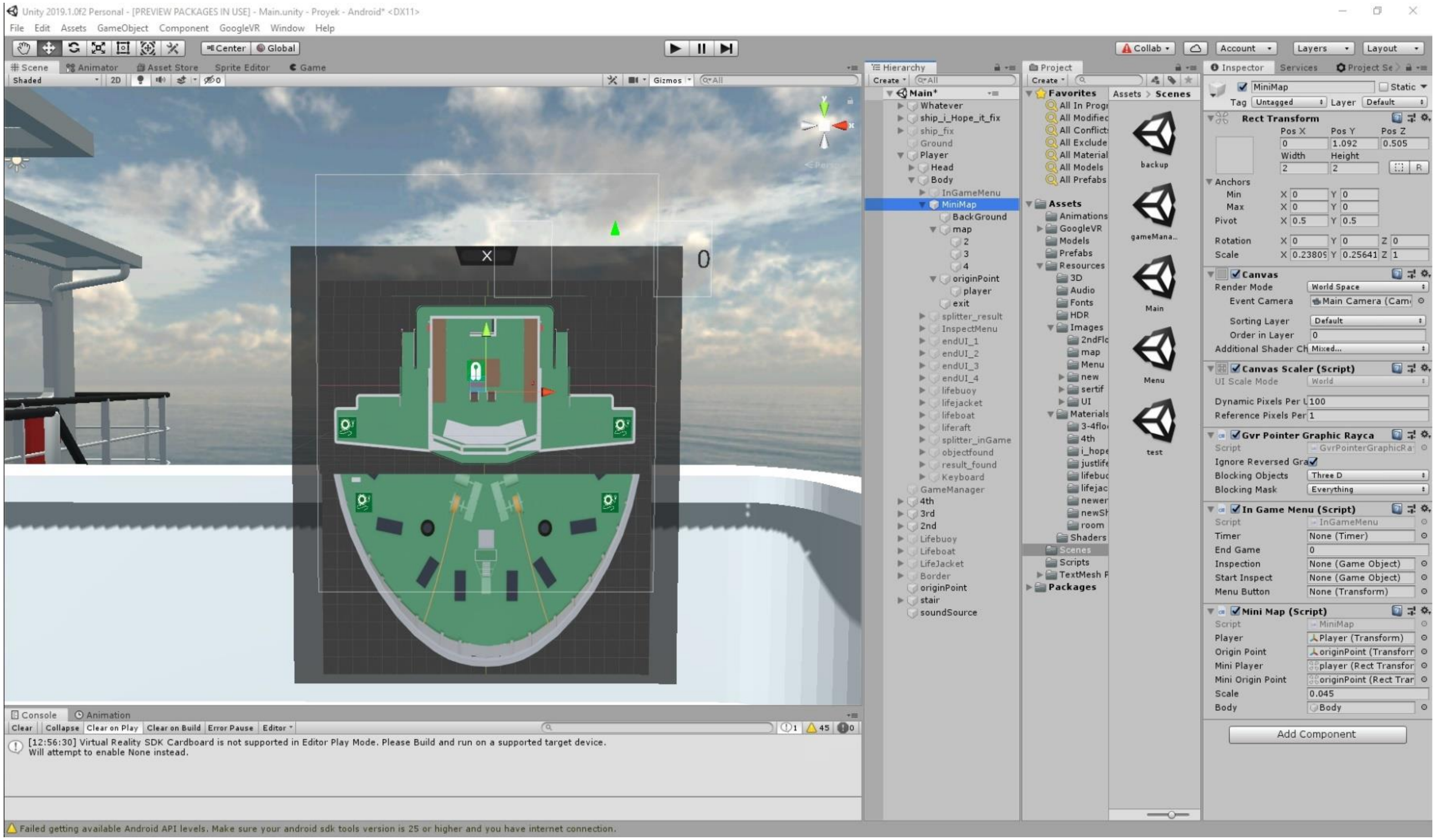

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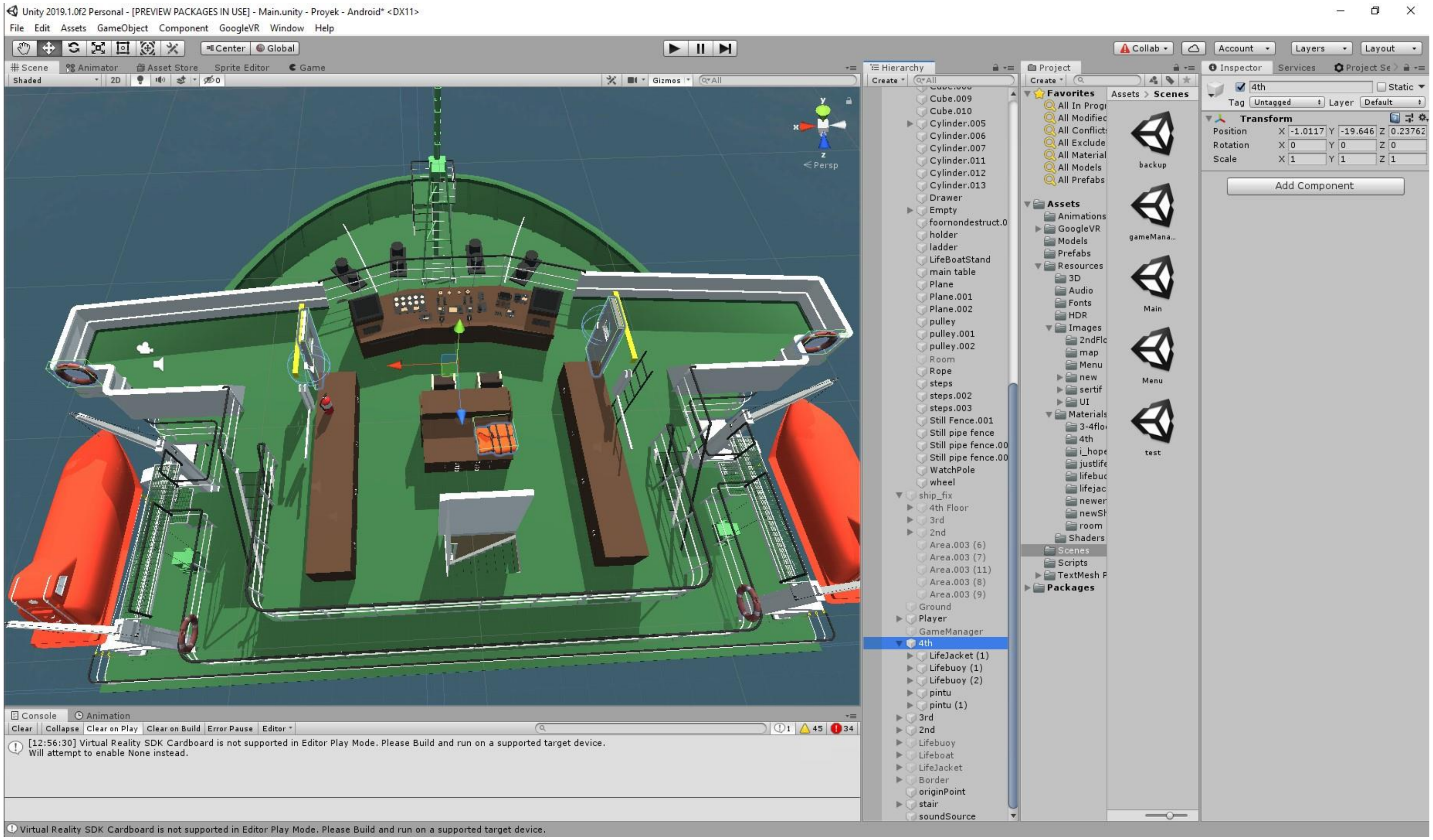

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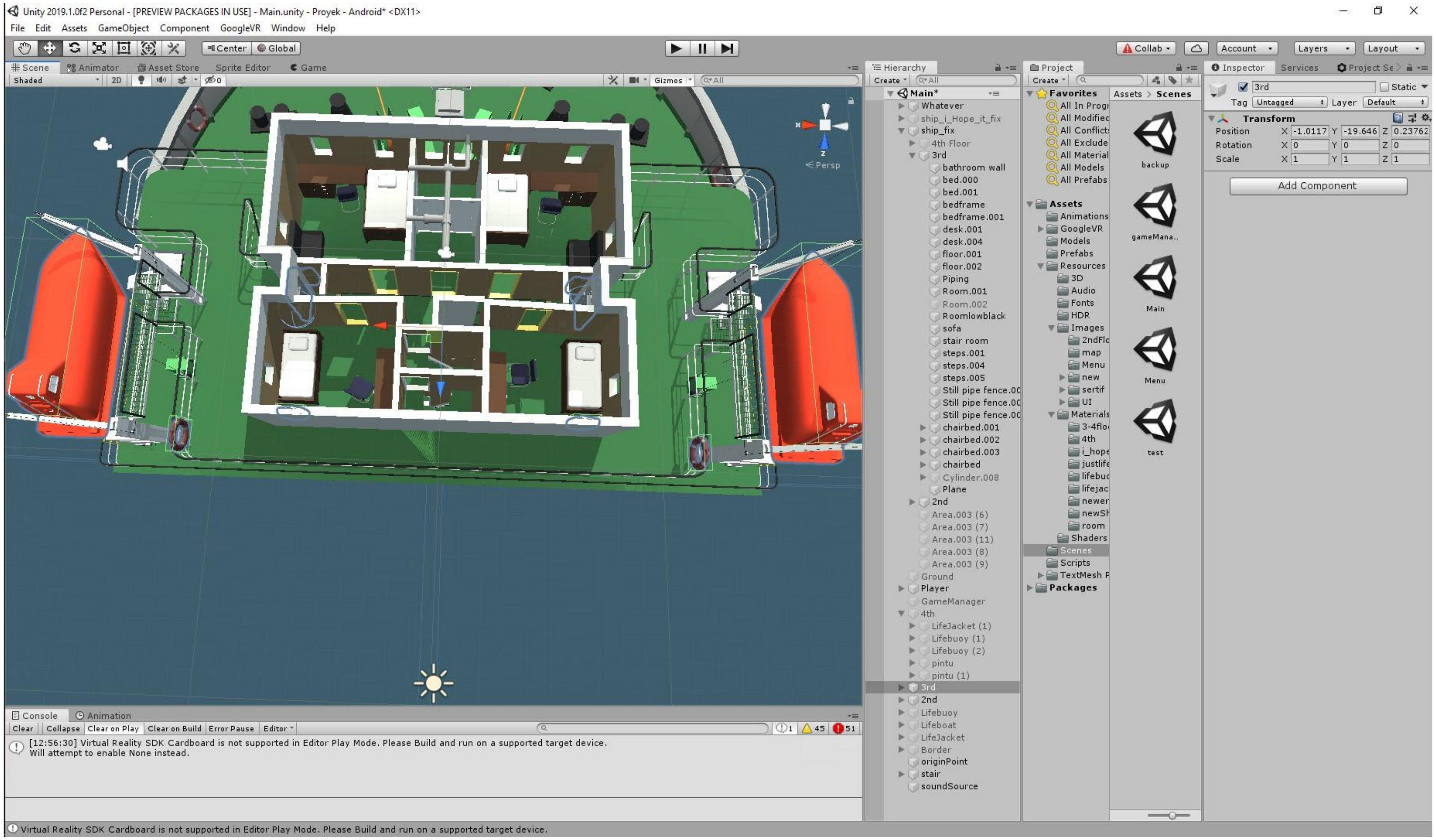

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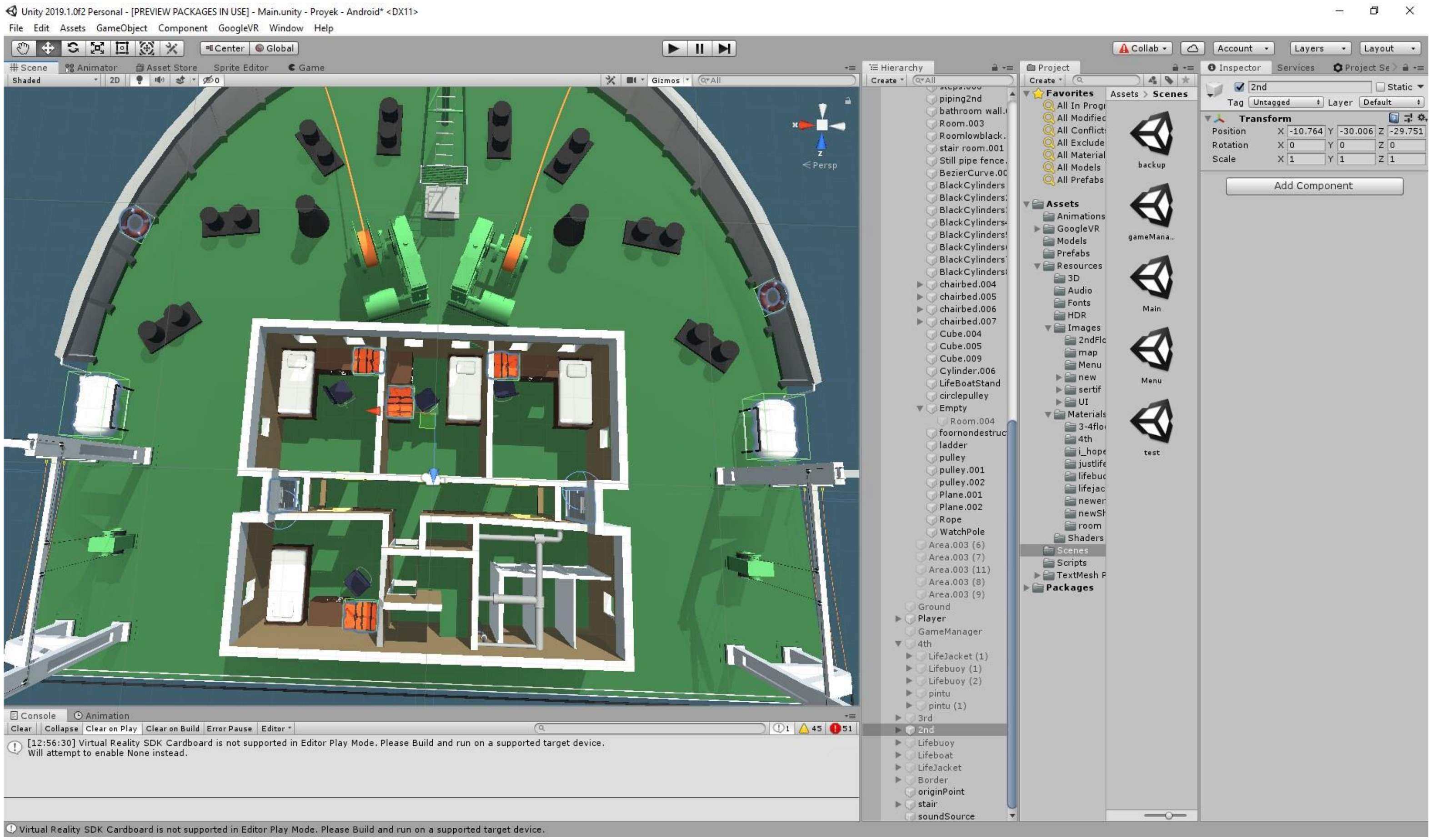

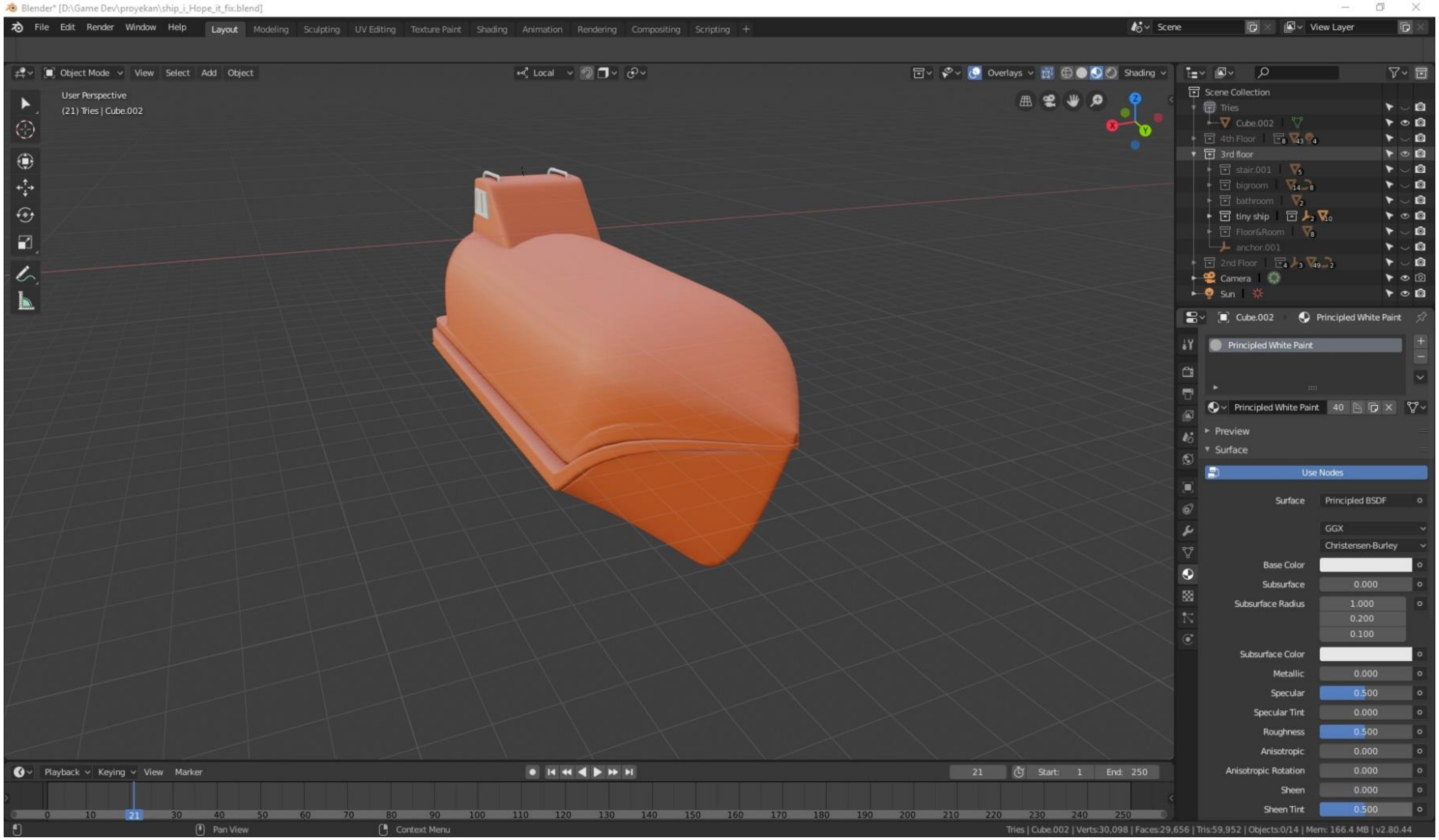
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3rd floor
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bigroom
bathroom
tiny ship
Floor&Room
anchor.001
2nd Floor
Camera
Sun
Cube.002
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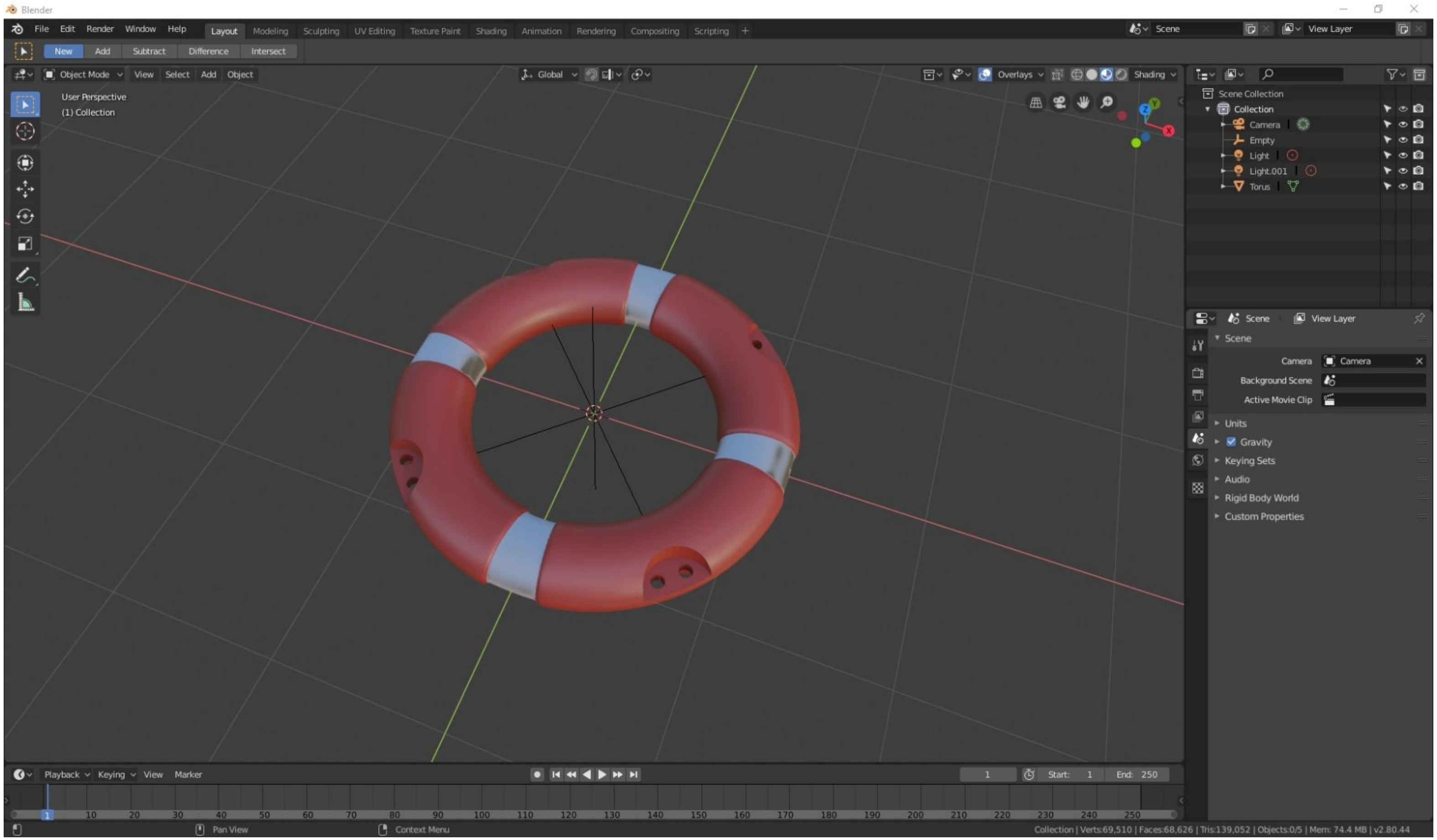
Design Virtual Reality Simulation from Unity 3D Software



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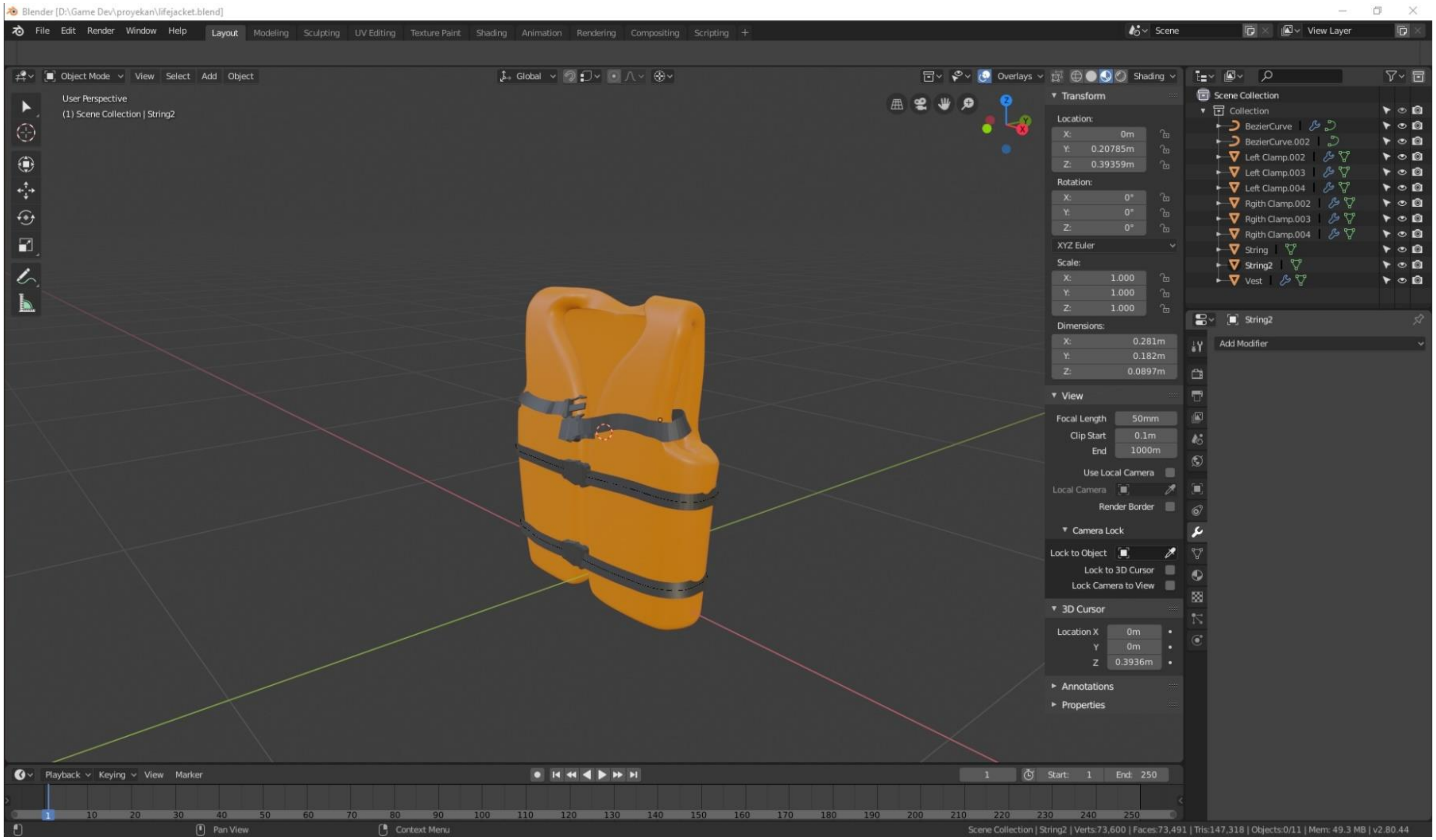

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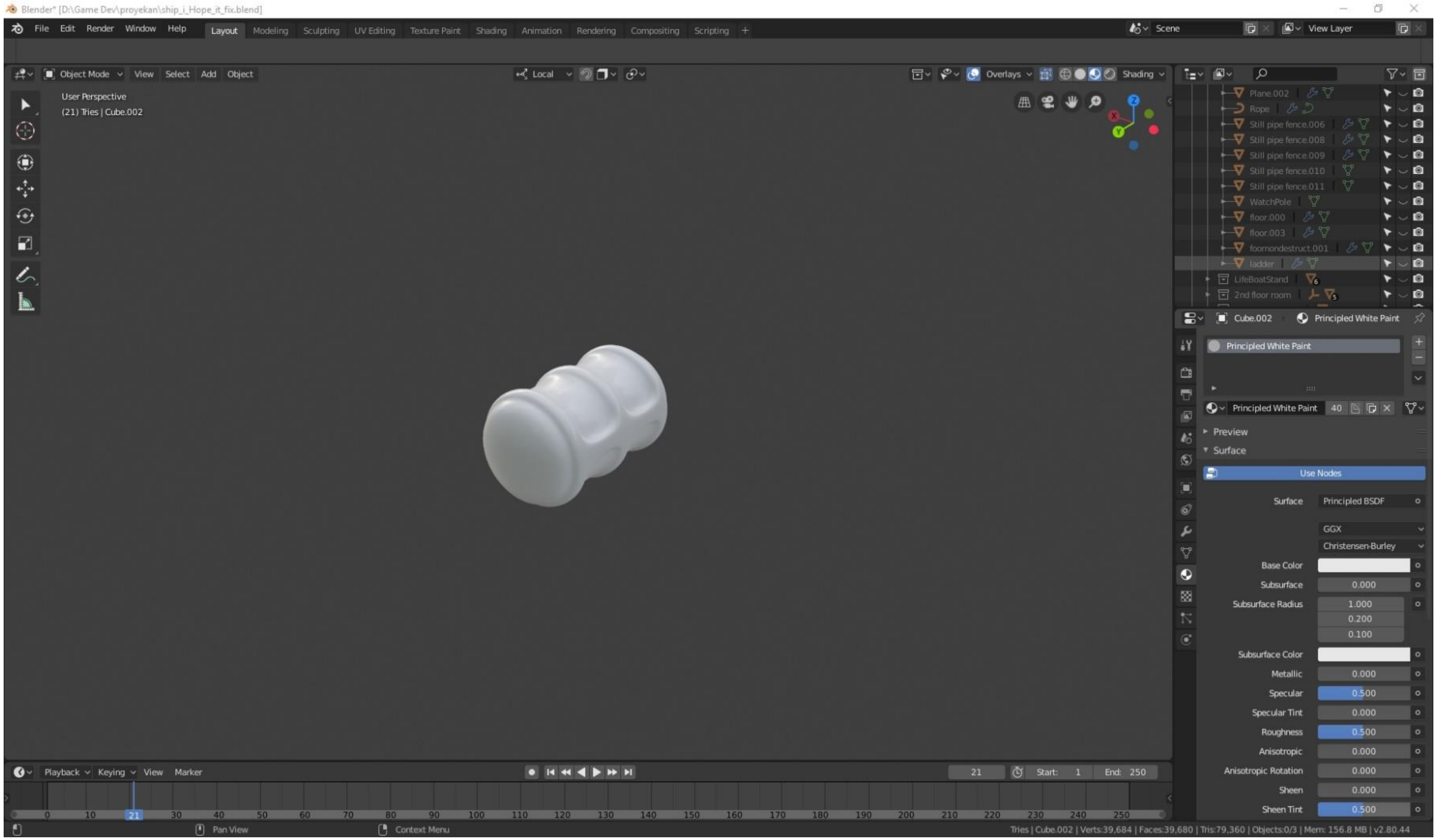
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floor.003
foornondestruct.001
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LifeBoatStand
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Cube.002
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Christensen-Burley
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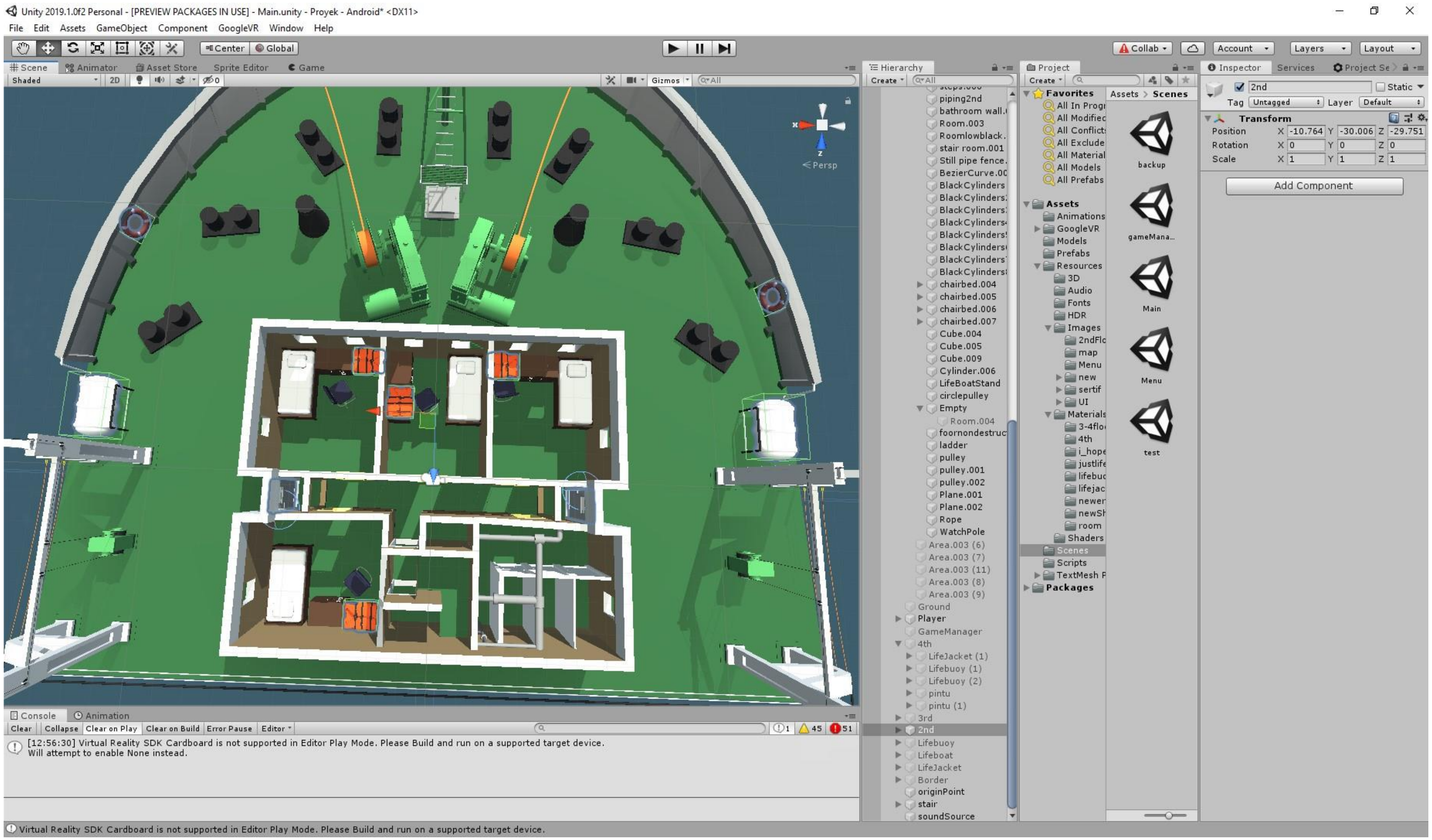

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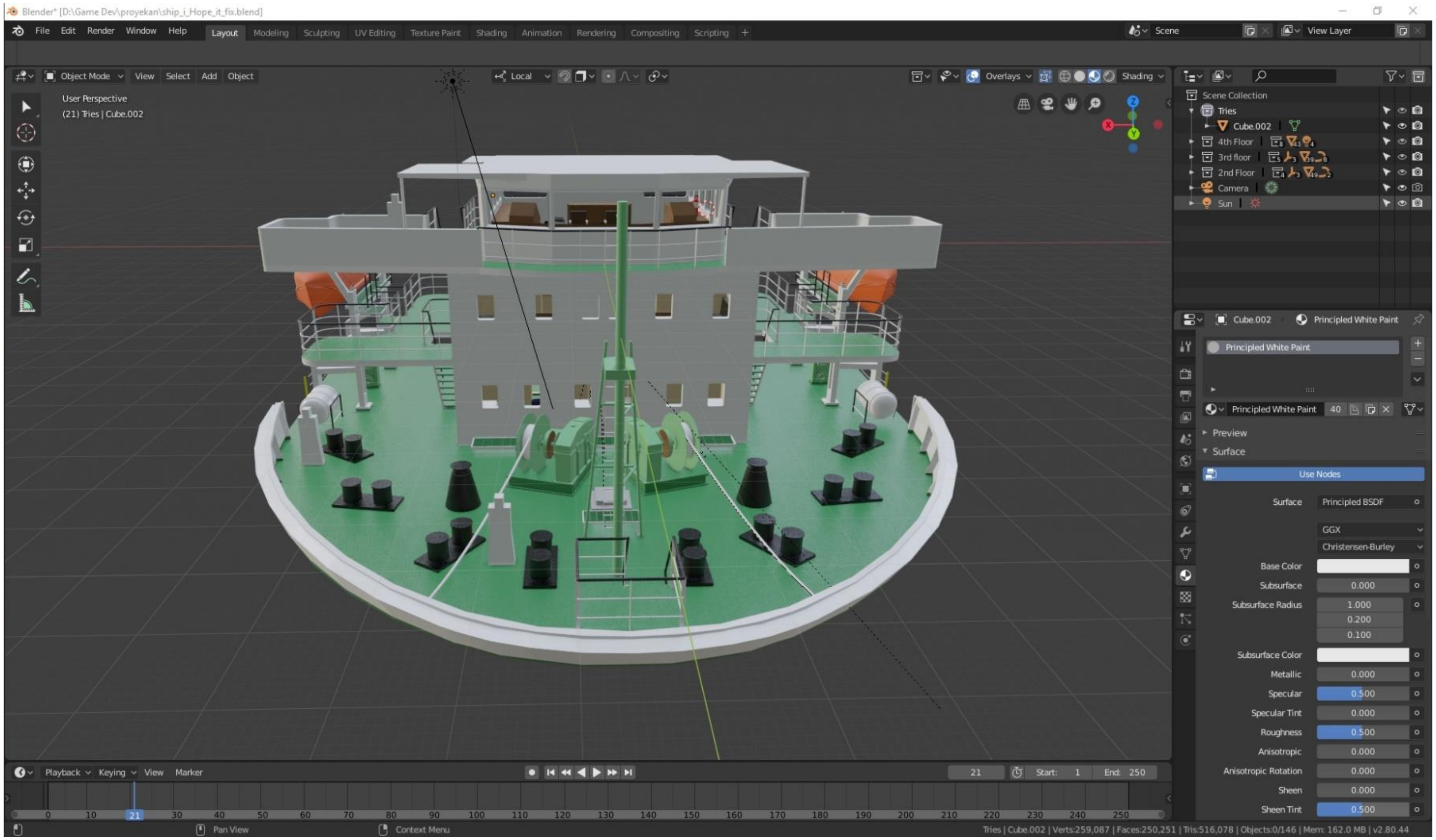

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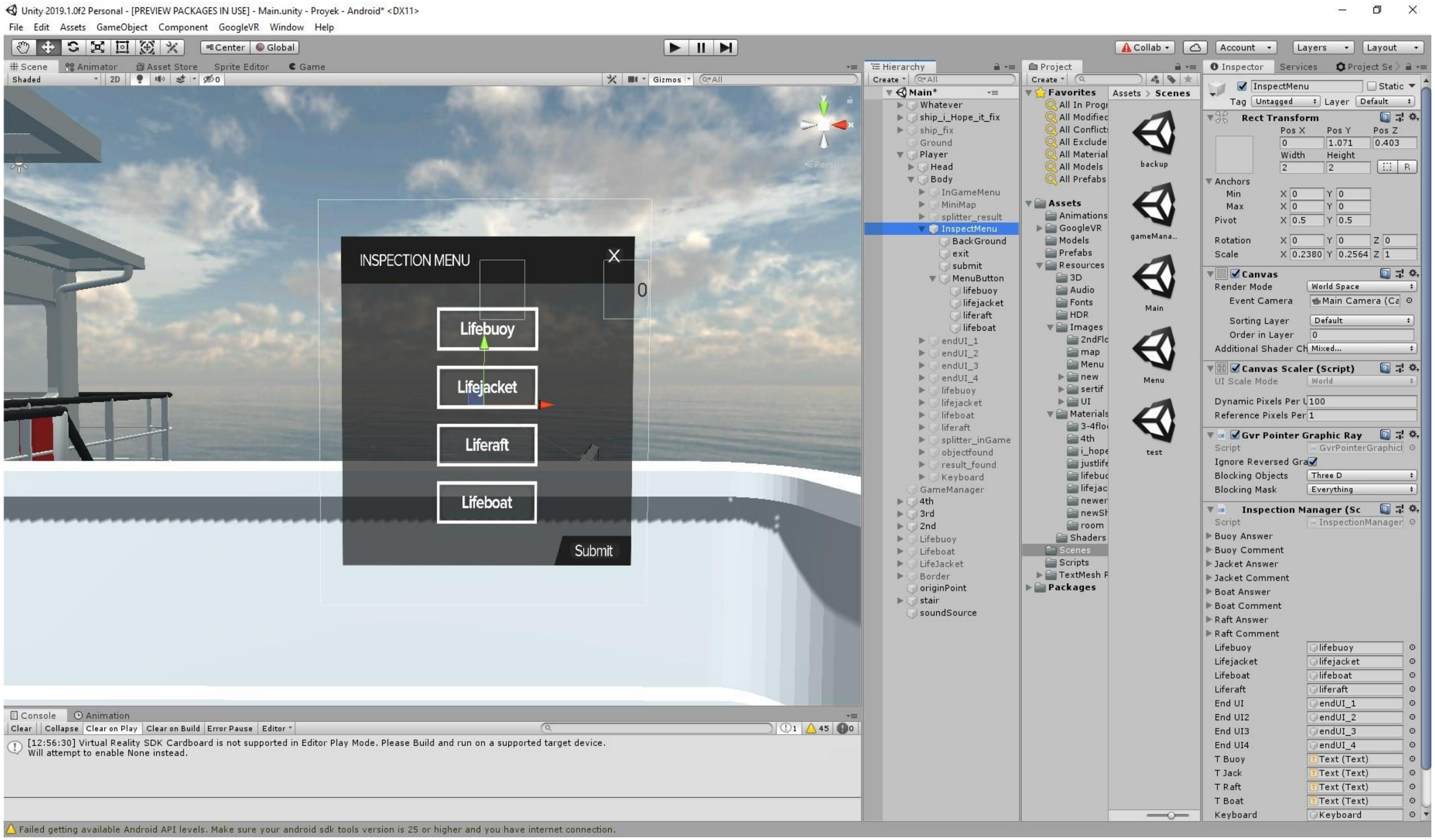

AUTHOR BIOGRAPHY

The author’s name is Rafiqi Zulfauzi Pribadi, born on 21 July 1996 in Bekasi, West Java. As the second child from three siblings. Derived from a simple family with a Father named Puguh Pribadi and Mother named Istikomah. However, fortunate to have a formal education at SDN Sekupang 02, he continued his study at SMP Nurul Muhajirin Sekupang, and SMAN 4 Batam. In 2015, author proceed to pursue bachelor degree at Department of Marine Engineering (Double Degree Program with Hochschule Wismar), Department of Marine Engineering, Institut Teknologi Sepuluh Nopember Surabaya specializes in Ship Maintenance and Operation field. During the study period, Author did activities in campus organizations such as: HIMASISKAL ITS (2016-2018), JMMI ITS (2016 - 2018). The Author also joined in event organizer such as Coordinator Permission and Security Division of Marine Icon 2017.

Rafiqi Zulfauzi Pribadi

rafiqizulfauzii@gmail.com

Motto : “Bring benefit to all people”