Developing a Horror Game with Game Development Life Cycle Method using Unity Game Engine

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***Abstract*—Video games are entertainment media that are available on various devices from mobile devices to personal computers and gaming consoles. Video games are also played by various age groups, from children to adults, with their respective genres. The rapid development of the gaming industry opens many job opportunities in various fields and is expected to reach USD 583.96 billion market value by the end of 2030. Video games can also be used for learning and training particular knowledge packed as entertainment media or usually known as serious games. In this study, we developed a game called "Malam Kliwon," as a media for entertainment that also helps improve players' focus and decision-making. Our paper proposes a method for developing games that combine Game Development Life Cycle (GDLC), Black Box Testing, and User Experience Testing (UEQ). GDLC consists of six stages: Initiation, Pre-production, Production, Testing, Beta, and Release. The "Malam Kliwon" application is developed using the Unity game engine and Blender for game asset creation. Based on the Black Box Testing, all features are implemented correctly as shown by 100% successful test results. Furthermore, our application achieved positive scores in almost all aspects of UEQ, including attractiveness (1,660), perspicuity (1,750), efficiency (1,905), dependability (1,310), stimulation (1,220), and Novelty (0,520).**

Keywords—game development, video game, unity, game development life cycle

I. Introduction

Video Games are an entertainment medium that can be played on various devices such as consoles, computers, and mobile phones. Video games are also played by various age groups, from children to adults, with their respective genres. Based on data from Grand View Research, the development of the global video game industry is expected to reach US$ 583.69 billion by the end of 2030 [1].

In addition to the vast business potential, video games can also be used as a medium for entertainment (Entertainment Game) and training (Serious Game). An Entertainment Game or entertainment game is a game that is designed as an entertainment medium for players where players can focus on the entertainment aspects of the game [2]. Entertainment games are designed to provide experiences for players from several aspects, such as Game Mechanics, Game Graphics, Game soundtracks, and Stories from the game. Entertainment games can also be used as training media or also commonly referred to as Serious Games. A serious game is developed for training, marketing, simulation, and educational media designed to run on a computer or video game console [2]. According to Corti (2006) [3], game-based learning/serious game "is all about leveraging the power of computer games to captivate and engage end-users for a specific purpose, such as to develop new knowledge and skills" [3]. Video Games in the Horror genre are very suitable for a game to test the player's abilities as well as a medium for entertainment.

In this research, we propose a method for developing an interactive software or game by combining the Game Development Life Cycle (GDLC), Black Box Testing, and User Experience Questionnaire (UEQ) to help the developers in the Testing and Beta phase to test the playability of the game and to help the developer to determine the quality of the game with UEQ. To demonstrate our method, we developed an entertaining game that also can challenge the player's focus and decision-making. GDLC methodology was first proposed by Rido Ramadan and Yani Widyani [4], which consists of six stages: Initiation, Pre-Production, Production, Testing, Beta, and Release. We chose this method since GDLC can be applied to various types of games. To improve this method in the Testing phase we utilized the Black Box Testing method to test the game whether there is no game-breaking bug that can cause the game cannot be run and progress through. This testing also validated all of the planned features that could be run as expected results from the Game Design Document. And in the Beta phase, we also used UEQ to measure the user experience and the quality of the game, where the results can be used as a development decision to determine which step to take to improve the quality of the game that has been developed. This research focuses on developing a Windows PC-based game that aims as a medium for entertainment and challenge for its users.

II. Literature Review

A video game, or computer game, is a media where the user provides input to the controller to perform an action to complete a task or achieve a goal displayed on the screen [11]. A Serious Game is a game developed to be used as a medium for training, marketing, simulation, and education that is designed to run on a computer or video game console [2]. Entertainment Game is a game designed as an entertainment media for players where players can focus on the entertainment aspects of the game [2]. Entertainment games are designed to provide players with experiences from several aspects, such as Game Mechanics, Game Graphics, Game Soundtrack, and the Game's Story. Game Development, commonly known as Gamedev, is a game development process from the concept stage to the final product involving input from one or more game designers, project managers, artists, programmers, testers, and others [7,9]. Game

Development Life Cycle or GDLC is a game development process from the initial stage to the release stage, which is pre-production, Production, Testing, Beta, and Release [4].

3D Modeling is a process of creating a digital three-dimensional representation of an object by manipulating polygons, edges, and vertices in a three-dimensional space simulation. 3D Modeling can be used in various fields, such as game development, animation, film, simulation, architecture, and product design. Some examples of 3D modeling software are Autodesk Maya, Autodesk 3ds Max, Blender, SketchUp, AutoCAD, and ZBrush [10]. Blender is an open-source 3D Modeling Software developed by The Blender Foundation with version 1.0 released in January 1995 and became open source on October 13, 2002, with GNU General Public License (GPL). Blender supports the entire pipeline of 3D Modeling, rigging, animation, simulation, rendering, compositing, motion tracking, video editing, and game development. Blender is a cross-platform software that can be run on Windows, Linux, and Macintosh [6]. Substance 3D Painter is an industry-standard 3D painting software used to texture 3D objects [12].

Game Engine is a software framework designed to create and develop a video game. Developers use Game Engine to develop games on consoles, mobile devices, and personal computers [7,8]. Unity is an all-purpose game engine developed by Unity Technologies that was first introduced at Apple's Worldwide Developers Conference in 2005. Unity is a cross-platform game engine that allows developers to create 2D and 3D games on various platforms with Unity. Unity uses the C# programming language with drag-and-drop functionality [5]. A game asset is a term given to an asset used in the game development process. The form of game assets can be characters, objects, sound effects, maps, programs, text, stories, technology, and other intellectual property used to develop a game [7,8].

III. Methodology

A. Game Development Life Cycle

Game Development Life Cycle, or shortly GDLC, is a game development process from the initial stage to the release stage, divided into several stages: pre-production, production, testing, beta, and release, as shown in Fig. 1.

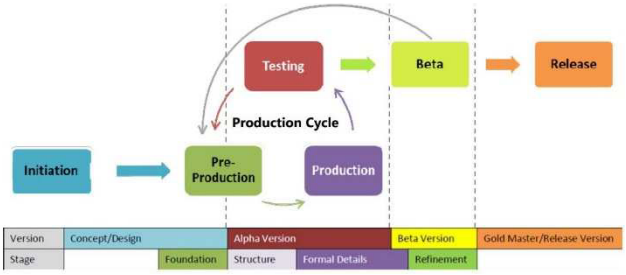

Fig. 1. Game Development Life Cycle diagram [4].

1) Initiation: Initiation is the first stage in the Game Development Life Cycle methodology, where the rough and earliest concepts of the game are created at this stage. The output of this stage is the game's concept and a description of the game to be developed [4].

2) Pre-production: Pre-production is the second stage in the Game Development Life Cycle methodology, where this stage focuses on creating and improving the game design and making game prototypes [4]. The output of this stage is a game design document (GDD) which contains game descriptions, game mechanics, genres, stories, level designs, UI, and game assets that need to be developed. After the GDD is made, a prototype will be made to test the game design and the overall idea or concept of the game. At this stage, the prototypes made are Foundation and Structure. The Foundation is the prototype for creating a mock-up of core gameplay and game capabilities. The Structure is an enhanced version of the Foundation. The Structure is used to display the core gameplay of the developed game and its core mechanics, such as game rules and logic. Pre-production ends when all revisions and changes to the game design are approved and documented in the GDD [4].

3) Production: Production is the third stage in the Game Development Life Cycle methodology, which is the main process of all processes; where this stage focuses on creating game assets and the source code of the game and integrating the two. Prototypes at this stage are formal details and refinement. Formal Details is an enhanced version of Structure with more game assets and mechanics in this version. Formal Details focuses on balancing the game's difficulty, adding new features, improving overall performance, and fixing bugs. Refinement is a prototype that is ready to use where at this stage, the quality improvement focuses on making the game fun, challenging, and easy to understand [4].

4) Testing: Testing is the fourth stage in the Game Development Life Cycle methodology, where usability and playability testing of the game is held. Testing at this stage uses prototypes from the previous stage, using the Formal Details prototype and the Refinement prototype. Formal Detail Testing is conducted to test the features and difficulty level of the game through playtesting. Refinement Testing is a test to determine whether the game is tedious, difficult, challenging, et cetera. The outputs of this stage are bug reports, change requests, and development decisions, where these results will determine whether the game is ready to enter the next stage (Beta) or still need to make improvements or changes to the game [4].

5) Beta: Beta is the fifth stage in the Game Development Life Cycle methodology. In this stage, the developer will call a third party to test the game, where the testers will play the game to find bugs and provide feedback to the developer. The output of this stage is bug reports and user feedback [4].

6) Release: Release is the last stage of the Game Development Life Cycle methodology, where at this stage, the game is ready to be released to the public [4].

B. Black Box Testing

Black Box Testing is a software testing method that aims to test the functional requirements of software where the tester only needs to know the input and output; where the tester does not have to know how the inner system works [13][14].

C. User Experience Questionnaire

A User Experience Questionnaire is a method of testing the user experience of a product. The user Experience Questionnaire aims to test the attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty of a product; where participants will fill out a questionnaire

containing 26 questions. Each answer uses a scale from -3 to +3, where -3 is the most negative, 0 is neutral, and +3 is the most positive. Values above +1 represent a positive user response, and values below -1 represent a negative response. Test results showing values from -0.8 to 0.8 describe neutral evaluation results, values above 0.8 describe positive evaluation results, and values below -0.8 describe negative results [15]. The result is gathered from the tester's response to the 26 questions, where each question belongs to a specific scale. The answers from the tester will be summed and averaged based on the scale. Then the answers from each examiner will be summed up and averaged to get the value of a scale.

IV. Result & Evaluation

After developing the game through stages, the game will be tested with two methods which are Black Box Testing to test the functionality of the game to make sure all of the features that have been made can run according to the requirement and User Experience Questionnaire to test the experience where 50 testers will play the game and give feedback to the game.

A. Game Asset

Game assets in this game are 3D models of objects that exist in the real world. This game's assets were created using Blender and Substance 3D Painter. The render results of the game assets can be seen in Fig. 2, Fig.3, and Fig. 4.

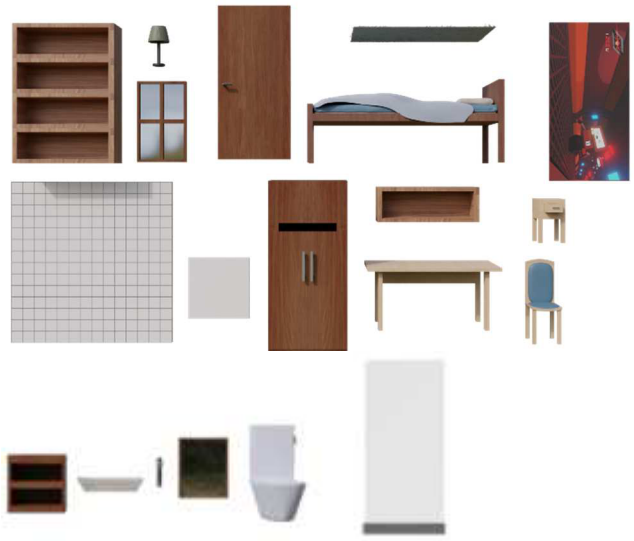

Fig. 2. Render results of the 3D models developed for the game that is used in the Slamet's Room and Toilet areas of the game.

Fig. 3. Render results of the 3D models developed for the game that are used in Slamet's Uncle Room area of the game.

Fig. 4. Render result of the 3D models for collectible and usable items where the player can use and interact with it.

B. Gameplay and UI

This game tells a story about a guy named Slamet who is visiting his uncle's house during his holiday. During his stay, Slamet's uncle needed to visit a friend in another village and left Slamet alone to look at the house. During the night, Slamet woke up from his sleep and got a voice message from his uncle saying that he couldn't get home because he had other things to do. After listening to the message, Slamet can't go back to sleep, and strange things start happening in the house.

At the top left of the gameplay, three parameters display the player's Hit Point or HP, Stamina, and Oxygen. HP is a value that determines how much the player can receive a hit from the enemy before losing. If the player's HP reaches 0, then the player will lose and be directed to the Main Menu. Stamina is a value that determines how long the player can run where; if the Stamina reaches 0, then the player will not be able to run. Oxygen is a value that determines how long the player can hide from enemy pursuit; where if the value reaches 0, then the player will lose and be directed to the Main menu. The top right shows the in-game time and the number of items the player has collected. The bottom left shows the key that's been collected by the player. The bottom right shows the items that the player currently has. An example for the gameplay's UI can be seen in Fig. 5, Fig. 6, Fig. 7, and Fig. 8.

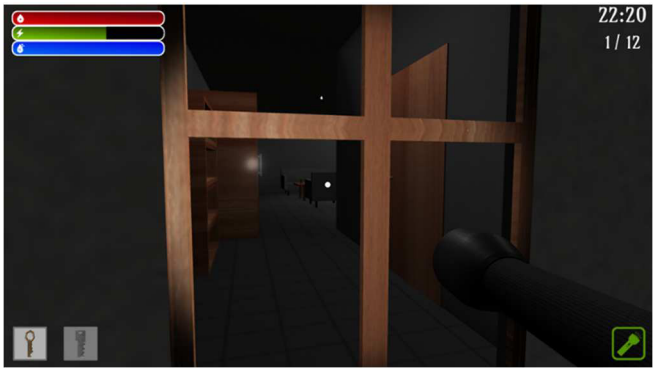

Fig. 5. In-game screenshot with the flashlight in use.

A text will appear on an object where the player can interact with the game object, as shown in Fig. 6, Fig. 7, and Fig. 8.

Fig. 6. In-game screenshot with a collectible item where the player can grab an item.

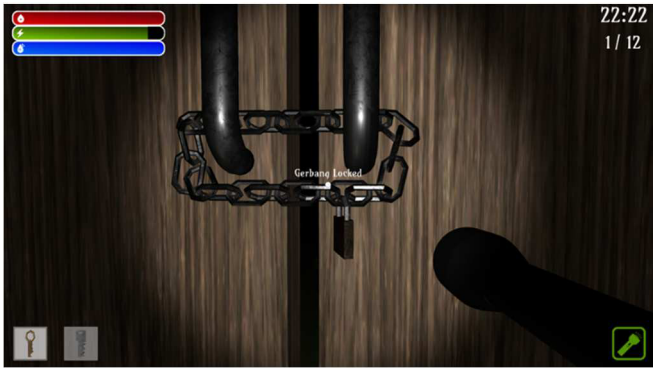

Fig. 7. In-game screenshot with an interactable object where the player can interact with the object to progress through the game.

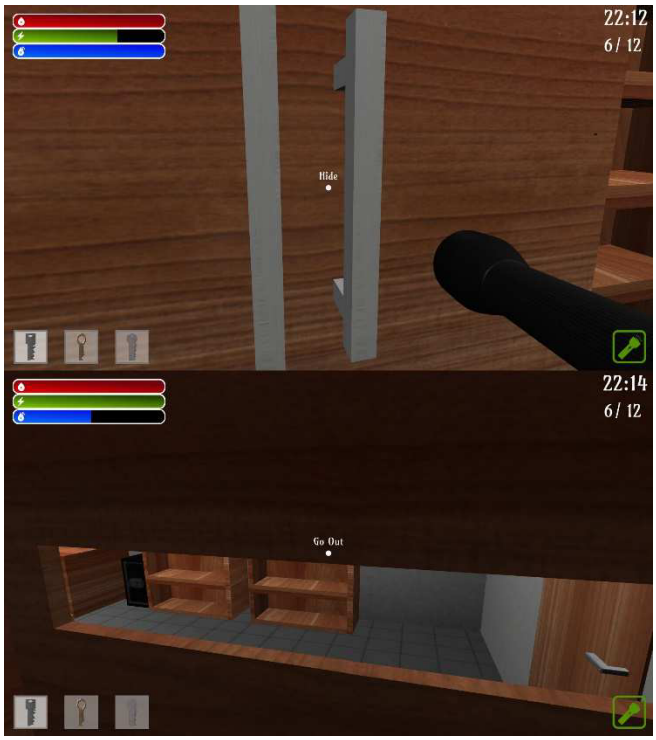

Fig. 8. In-game screenshot with an interactable object where the player can hide and go out of hiding.

C. Black Box Testing Results

In Black Box Testing, all of the features in the game will be tested to ensure that all features can run as expected without problems.

TABLE I. BLACK BOX TESTING RESULTS

No	Feature Type	Feature Name	Expected Results	Results
1	Menu	Start Game	Start the level	Succeed
2	Menu	Settings	Open the settings	Succeed
3	Menu	Exit	Close the program	Succeed
4	Option	Music	To adjust the music volume	Succeed
5	Option	Sound	To adjust the sound effect volume	Succeed
6	Option	Return to Menu	Return player to Main Menu	Succeed
7	Gameplay	Flashlight	It can be grabbed and used as a lighting	Succeed
8	Gameplay	Handphone	It can be grabbed and shows the in-game time	Succeed
9	Gameplay	Key	It can be grabbed and unlocks a door	Succeed
10	Gameplay	Door	Can be opened	Succeed
11	Gameplay	Quest Item	It can be grabbed and add a score	Succeed
12	Gameplay	Food	Restore Hit Points	Succeed
13	Gameplay	Hit Point	Run the level as long the Hit Point does not reach 0	Succeed
14	Gameplay	Stamina	Able to make player sprint as long the Stamina does not reach 0	Succeed
15	Gameplay	Oxygen	Able to make the player hide at a specific spot as long the Oxygen does not reach 0	Succeed
16	Gameplay	Patrolling Enemy	The AI enemy will patrol the level to look for the player	Succeed
17	Gameplay	Chasing Player	The AI enemy will start chasing the player when the player enters the detection range.	Succeed
18	Gameplay	Attacking Player	The AI enemy will start attacking the player when the player enters the attack range	Succeed
19	Gameplay	Game Over	Shows the game over screen when the Hit Point or Oxygen reaches 0	Succeed
20	Gameplay	In-Game Menu	To show the in-game menu	Succeed
21	Gameplay	Drop Item	Able to make the player drop an item the player currently uses	Succeed

From Table I, we can see that all of the functional requirements of the game are met and can run perfectly without a problem from start to finish.

D. User Experience Questionnaire Testing Results

This test uses the User Experience Questionnaire, where the tester will be given 26 questions to fill out. At this stage, 50 testers will be tasked with playing the game and providing feedback from the game by filling out a form. The process of selecting the candidate is done by sending a test invitation to a candidate who meets the requirements for the test: be aged between 16 and 30 years old, have the knowledge to operate a computer with a mouse and keyboard, and understand the basic controls of video games. To ensure the reliability of the questionnaire of the test, we use the Indonesian version of the UEQ and add some explanations to each question related to the feature and User Experience of the game. And to ensure the reliability of the result, we use one of UEQ's tools to detect inconsistencies in data; if a tester has more than two inconsistencies, their data will not be used in the final result.

After data was collected from the testers, the results of the test were as follows:

1) Attractiveness: the average score of attractiveness received an average score of 1.6, which indicates a positive result from the testers and illustrates that most of the testers liked the game they played and found it attractive.

2) Perspicuity: the average score of perspicuity received an average score of 1.7, which indicates a positive result from the tester and illustrates that most of the testers can easily understand the game and how to play it.

3) Efficiency: the average score of efficiency received an average score of 1.9, which indicates a positive result from the tester and illustrates that most of the testers can run the game without a problem or having performance issues during the test.

4) Dependability: the average score of dependability received an average score of 1.3, indicating a positive result from the tester and meeting most of the tester's expectations of the game.

5) Stimulation: the average score of stimulation received an average score of 1.2, which indicates a positive result from the testers and illustrates that most of the testers found the game interesting.

6) Novelty: the average score of novelty received an average score of 0.5, indicating neutral results from the tester and illustrating that some of the testers found the game conventional or inventive and conservative or innovative.

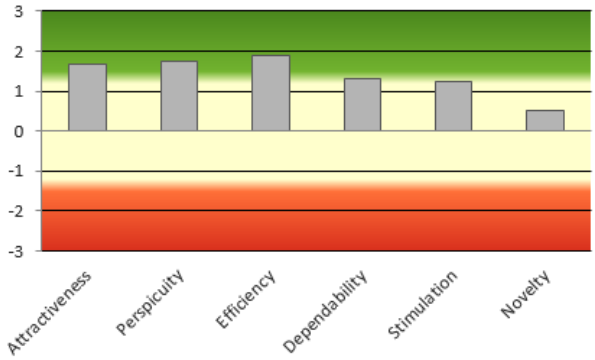

Fig. 9. Average score of the UEQ testing with a bar chart showing the average score from each scale.

TABLE II. UEQ RESULTS

UEQ Scales	Mean	Variance
Attractiveness	1,660	0,79
Perspicuity	1,750	1,10
Efficiency	1,905	1,01
Dependability	1,310	0,58
Stimulation	1,220	0,93
Novelty	0,520	1,24

From Table II and Fig. 9, we can see that the average results from most of the scales show positive results and show neutral results on the Novelty scale with an average score of 0,520.

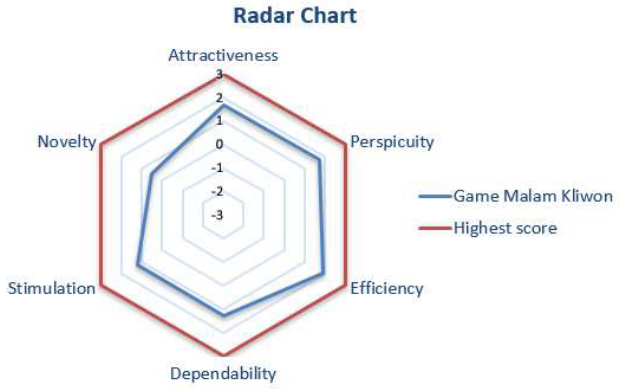

Fig. 10. A radar chart of the UEQ results that shows the UEQ statistics of the game.

The results were then revisualized with a radar chart to help us visualize which aspects of the game needed improvement and compare the results with other games, as shown in Fig. 10. The result can also be grouped into pragmatic quality (perspicuity, efficiency, and dependability), which describes a task-related quality aspect, and hedonic quality (stimulation, novelty), which describes a non-task-related quality aspect, as shown in Table III and Fig. 11.

TABLE III. PRAGMATIC AND HEDONIC QUALITY

Pragmatic and Hedonic Quality	
Attractiveness	1,66
Pragmatic Quality	1,66
Hedonic Quality	0,87

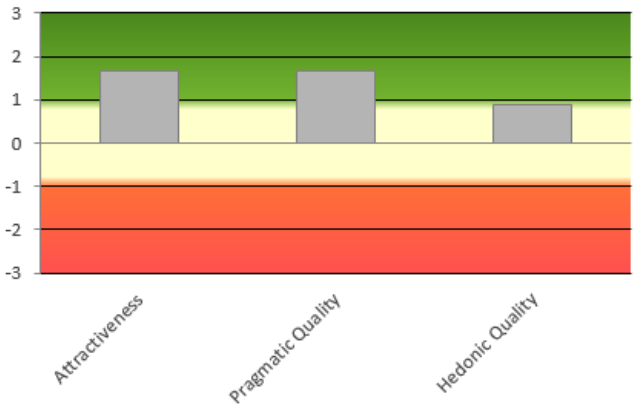

Fig. 11. Pragmatic and Hedonic Quality with a bar chart showing the average score from each scale.

V. CONCLUSION AND FUTURE WORKS

Based on the research results, the Game Development Life Cycle is a game development method that is very suitable for developing all kinds of games, from educational games to entertainment games. The Black Box Testing method is used in the Testing phase of the GDLC to help the developer test the functional requirements of the game and make sure it can be played from start to finish without any trouble. From the result of this test, the Black Box Testing method works perfectly where all of the functional requirements of the game are met and run without problem. The UEQ is used in the Beta phase of the GDLC to help the developer determine the user experience of the game. The UEQ results from the game developed in this research are Attractiveness (1,660),

Perspicuity (1,750), Efficiency (1,905), Dependability (1,310), Stimulation (1,220), and Novelty (0,520). With the Game Development Life Cycle, developers can develop games that are entertaining but can also train players in certain aspects. Furthermore, combined with the Black Box Testing method and the User Experience Questionnaire, developers can easily find bugs and errors in their programs, which helps the developer determine the pragmatic and hedonic quality of the program they develop and helps them decide what the best development decision is for the program.

To improve the results of this research, we would like to try to increase the sample size and change the parameters of the participants so they're not limited to the age of 16–30 years old but more open to other age groups, and we would like to use other genres of games besides horror games so we can see the results of this research from another perspective and type of game.

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