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# ANALYSIS OF VIRTUAL REALITY-BASED WAREHOUSE SIMULATION APPLICATIONS USING THE GAME USER EXPERIENCE SATISFACTION SCALE METHOD

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## Article Info

### Article history:

Received Oct 12<sup>th</sup>, 2022

Revised Nov 20<sup>th</sup>, 2022

Accepted Dec 26<sup>th</sup>, 2022

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### Keyword:

Warehouse Simulation  
3D Simulation App  
User Satisfaction  
Game User Experience  
Satisfaction Scale (GUESS)

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## ABSTRACT

In the world of simulation, there are many issues related to how to make a simulation interesting and make users want to use it again. One of them is user satisfaction. User satisfaction is the extent to which players feel satisfied when using an application. The warehouse simulation application is an application that is based on three dimensions and can only be run using virtual reality technology. This application aims to simulate how the activities of a picker in the warehouse. This research was conducted to determine the level of user satisfaction when using the warehouse simulation application. The research was conducted using the Game User Experience Satisfaction Scale (GUESS) method which has nine subscales, namely usability, narratives, play engrossment, enjoyment, creative freedom, audio aesthetics, personal gratification, social connectivity, and visual aesthetics. Data collection was carried out by distributing questionnaires through online media. Respondents in this study were 30 students of the Batam State Polytechnic International Trade Logistics study program. The analysis method uses a descriptive quantitative method. The results of the analysis show that of the nine subscales of user satisfaction with the Warehouse simulation application, four subscales are below average, namely enjoyment, audio aesthetics, personal gratification, and social connectivity. From these results, what needs to be improved is the addition of audio and UI that gives appreciation to users to increase personal gratification, changing the color concept in each scene so that users do not feel bored with the application.

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## 1. INTRODUCTION

Logistics is a series of processes that include planning, implementation, and supervision of a process of moving goods from the initial place to the destination. So that every role in the logistics system cannot be underestimated. Supply Chain Management, for example, is the management of various activities in order to obtain raw materials, continue transformation activities so that they become products in process, then become finished products and continue with delivery to consumers through a distribution system [1] An important part of a warehouse is a picker, who is tasked with searching for goods that have been ordered by consumers [2]. The coordination occurs not only within the company but also in all activities. The goal is to make the management of raw material inventory needs more effective and efficient [3].

Technological sophistication in today's world has developed rapidly, one of which is virtual reality technology. Virtual reality is the appearance of three-dimensional images that are generated by computers, and

look real with the help of certain tools [4]. Virtual reality is a computer-generated simulation of a three-dimensional environment, which seems very real to the person trying out the technology [5]. However, the use of virtual reality has a positive impact on learning interest and ease of understanding learning materials [6]. The use of virtual reality technology is a technological development that makes virtual products that will resemble the products we want [7]. There are four elements in VR, namely the virtual world, immersion, sensory feedback, and interactivity [8].

With the rapid development of computers and technology, virtual reality is one of the breakthroughs that can be taken as an example of the combination of computers and technological developments [9]. So there is a request from one of the clients to make a warehouse simulation application. The application is a simulation that does the work of a picker in a warehouse. A simulation application is a computer program that functions to mimic the behavior of certain real systems aimed at training and games [10]. The warehouse simulation application is a three-dimensional VR-based application that simulates how the warehousing process, such as picking up goods to be distributed. According to Darmawan, (2018) simulation application is software that aims to make it easier for each user to learn something in order to interact virtually and away from all risks [11]. This application was made by the author and the team during their internship at DigiArs Production House Polibatam.

In making virtual reality-based applications, user experience is one of the important things. User experience in the application is how the user feels in playing and enjoying the application. The advantage of user experience is that there is an assessment of how user satisfaction with an information system is experienced by its users [12]. A friendly display can make users more comfortable exploring a product. In addition, simulation applications have also been widely used as learning simulation applications [13]. User satisfaction is also defined as all about what users say about interactions on a product. Usually, users will say that the product is easy to use, confusing, or can also exceed user expectations [14]. The measurement of user satisfaction in the study is not only in terms of usability/playability, but also from narratives, play engrossment, enjoyment, creative freedom, audio aesthetics, personal gratification, social connectivity, and visual aesthetics [15].

In this study, the author's measured user satisfaction in the warehouse simulation application which is based on three-dimensional virtual reality. Measurement of user satisfaction in the warehouse simulation application is carried out to determine the level of user satisfaction, which can later be used as a reference for making a list of suggestions for improving the application.

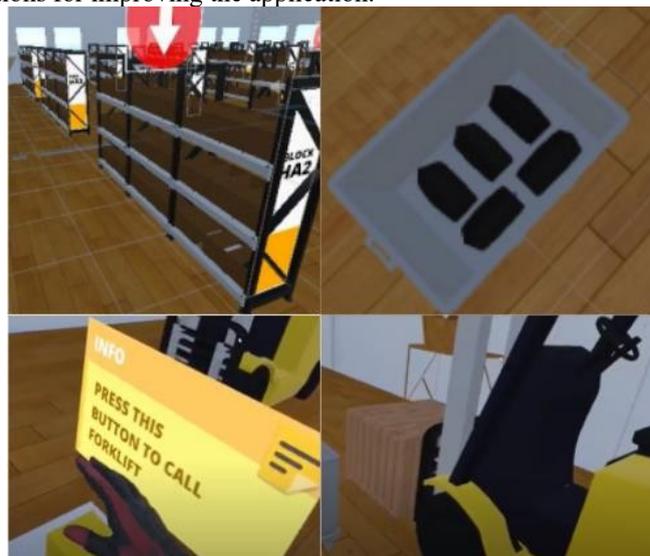


Image 1. Warehouse Simulation Application View

## 2. LITERATURE REVIEW

There are several previous studies on user satisfaction in games. A study entitled "The Development and Validation of the Game User Experience Satisfaction Scale (GUESS)" states that the GUESS technique can be applied to all types of video games to measure user satisfaction and gaming experience. These results are based on research to develop and validate a new instrument that will be used to measure player satisfaction. This was done because it is difficult to get quality feedback during playtesting if it is done without a measurement tool that can assess the satisfaction of playing a good game. This research was conducted on 450

video game titles across all popular genres by implementing a mixed method consisting of expert review, exploratory factor analysis (N = 629), confirmatory factor analysis (N = 729), questionnaire study, and item generation. The result of this study was that GUESS was shown to have content validity, internal consistency, and convergent and discriminant validity [14].

Then in a study entitled "Gaming on the Rift: How Virtual Reality Affects Game User Satisfaction," the study measured user satisfaction when playing virtual reality (VR) strategy games, data collection using a questionnaire with the Game User Satisfaction Scale (GUESS) model. The results of the study were satisfaction, enjoyment, engrossment, creativity, and sound and graphics quality increased overall when used with virtual reality (VR) tools [16].

### 3. RESEARCH METHOD

Analysis of user satisfaction in warehouse simulation applications using the Game User Satisfaction Scale (GUESS) evaluation model, because it can be applied to all types of video games and has complete measurement elements [15]. The research method in this analysis uses descriptive quantitative methods with data collection instruments in the form of questionnaires through online media. Figure 2 shows the research flow that will be carried out to measure user satisfaction with the GUESS method adapted from Shelstad, Smith & Chaparro's research [16].

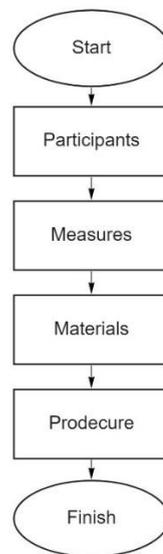


Image 2. The flow of Research Method GUESS

#### 3.1. Participants

In Roscoe's research, he gave advice for feasible sample size in a study to be between 30 and 500 respondents [17]. So that the respondents in the analysis of warehouse simulation applications were 30 students of the Batam State Polytechnic International Trade Logistics study program. Participants will be classified according to the category of the length of time needed to get used to using virtual reality devices in a week. Gamers have four groups, namely Non-Gamers, Infrequent gamers, Regular gamers, and Frequent gamers [18].

#### 3.2. Measures

Measurement of user satisfaction using the Game User Experience Satisfaction Scale (GUESS). GUESS consists of 55 questions, but in this study, the authors used GUESS-18 which is a shortened version of GUESS which has 55 questions. The GUESS-18 has 18 question items that assess nine aspects of user satisfaction while playing. GUESS-18 is used because it shows very good suitability. This method is a short, practical, yet comprehensive measure of user satisfaction. The following is a description of the nine subscales in the GUESS method [15]:

1) Usability/Playability

Usability/ Playability is how an application is easy to play with a clear goal and has minimal cognitive interference from the user interface and controller.

2) Narratives

Narratives are aspects of an app's story (events and characters) that can be used to capture player interest and shape emotions.

- 3) Play Engrossment  
Play Engrossment is the extent to which the application can attract the player's attention when used and the interest in the application that makes the player want to use it again.
- 4) Enjoyment  
Enjoyment is what players feel when playing, whether they feel happy or bored with the application.
- 5) Creative Freedom  
Creative Freedom is the extent to which the app can spark the player's creativity and curiosity and freely express the player's individuality.
- 6) Audio Aesthetics  
Audio Aesthetics are the audio aspects of the app (sound effects) and how much the audio can enrich the user experience.
- 7) Personal Gratification  
Personal Gratification is the motivational aspect of the app that encourages the user's sense of achievement, desire to succeed, and to keep playing.
- 8) Social Connectivity  
Social Connectivity is the extent to which the application facilitates relationships between users so that users can interact with each other in the application.
- 9) Visual Aesthetics  
Visual Aesthetics is about how the appearance or graphics of the application are attractive to users so that users will feel relaxed while playing.

GUESS-18 is rated on a 7-point Likert scale (1 = Strongly Disagree and 7 = Strongly Agree). Subscale scores will be calculated by averaging the items in the scale. The overall score is calculated by summing the average score of each subscale [16]. In this study, the authors distributed the questionnaire twice. The first questionnaire is a classification questionnaire to filter respondents according to the category of gaming time spent in a week. The second questionnaire is an assessment that refers to GUESS-18. The average assessment for each subscale on the research variable uses the calculation of the scale range. The following is the formula for calculating the scale range [17]:

$$RS = \frac{m-n}{b}$$

Description:

RS = Scale Range

M = Maximum number of scale points in the questionnaire

n = Minimum number of scale points in the questionnaire

b = Number of scale points in the questionnaire

$$RS = \frac{7-1}{7} = 0,85$$

Based on the calculations carried out above, the assessment is obtained in the form of an average index in table 1.

No	Index Value	Category
1	1 – 1,85	Strongly Disagree
2	1.86 – 2.71	Disagree
3	2.72 – 3.57	Sometimes Disagree
4	3.58 – 4.43	Between Agree and Disagree
5	4.44 – 5.29	Sometimes Agree
6	5.30 – 6.15	Agree
7	6.16 - 7	Strongly Agree

### 3.3. Materials

The materials used as material for this research are three-dimensional warehouse simulation applications that can only be played using virtual reality tools. When using the application, the player will simulate taking goods according to the list on the order list of goods. When taking the wrong item, a UI display will appear that the item is not included in the list of items. After the player has successfully collected all the items in accordance with the order list, then the player scans each item. Then after all items are successfully scanned, then all items will be carried by a forklift for distribution.

### 3.4. Procedures

There are several procedures for user satisfaction research on warehouse simulation applications :

- 1) Distributed questionnaires through online media to classify participants based on the length of time they played games during the week.
- 2) Selecting respondents based on time categories, namely 1-4 hours, 5-9 hours, and 10-19 hours.
- 3) Informing all respondents of the time or date for respondents to test the simulation application.
- 4) Participants play the warehouse simulation application and then fill out the questionnaire directly after using the application.
- 5) Processing the test result data that has been obtained from the questionnaire, the data is processed to get the average of each factor in the test.
- 6) Recapitulating the test result data, at this stage displaying the average value of each GUESS subscale. This value will later be used to determine which part of the user satisfaction of the warehouse simulation application needs to be improved.
- 7) Analyse the test results which will be a reference for improving and increasing user satisfaction with the object of research and provide reasons why it should improve and increase factors that are considered unsatisfactory.
- 8) Provide conclusions and suggestions after conducting the tests that have been carried out. Conclusions are obtained from the results of data analysis. Suggestions contain a list of improvements for user satisfaction in warehouse simulation applications that refer to the GUESS method.

## 4. ANALYSIS RESULTS AND DISCUSSION

### 4.1 Participant Demographics

The average age of the participants was 18-25 years old who were students of the International Trade Logistics study program of Batam State Polytechnic. In determining the demographics of participants, researchers classify according to the length of time spent playing games [18]. The author's purpose in classifying respondents is to find out the extent to which users get used to using virtual reality devices. So that the respondents in the infrequent gamer category were 26 people, regular gamers were 3 people, and frequent gamers were 1 person.

### 4.2 Results

The results of the overall score on the warehouse simulation application are  $M = 48.9$  and  $SD = 9.1$ . This shows that respondents agree that the warehouse simulation application is quite satisfying. Analysis of the warehouse simulation application with the highest subscale level is usability and narratives ( $M = 6.27$  and  $SD = 0.74$ ), this shows that the application is easy to understand so that it can improve the playing experience for the better and the story aspect of the application is interesting for players. While the lowest subscale level is social connectivity ( $M = 3.75$  and  $SD = 1.78$ ) this value indicates that players cannot socialize or interact with application users. The overall GUESS subscale score can be seen in table 2 and figure 4:

Table 2. GUESS Subscale Score

No	Subscale	Mean	Standard Deviation
1	Usability	6,27	0,65
2	Narratives	6,06	0,74
3	Play Engrossment	5,72	1,37
4	Enjoyment	4,82	0,93
5	Creative Freedom	5,78	0,75
6	Audio Aesthetics	5,22	1,54
7	Personal Gratification	5,13	0,78
8	Social Connectivity	3,75	1,78
9	Visual Aesthetics	5,63	1,06
<b>Grand Total GUESS</b>		<b>48,4</b>	<b>9,1</b>

### Mean of GUESS Subscales

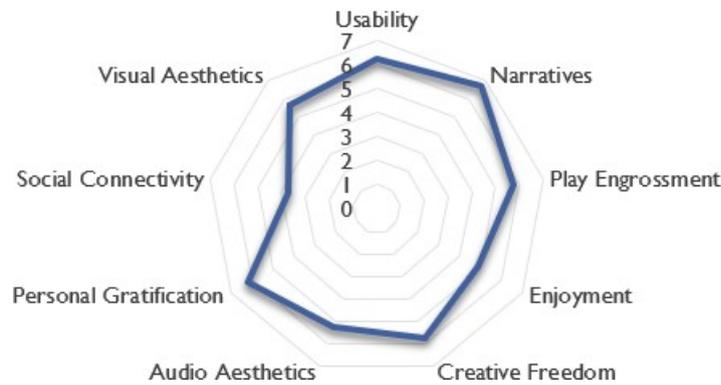


Image 4. GUESS Subscale Radar Diagram

Table 2 and Figure 4 show the mean value of each subscale, four subscales have mean values above 5.5, namely usability, narratives, play engrossment, creative freedom, and visual aesthetics. This shows that respondents are satisfied with the components in the five subscales:

1) Usability

On the usability subscale, it has an average value of 6.27 and it can be concluded based on the indicators and usability subscales that the warehouse simulation application has controls that are easy for users to understand and an interface that is easy for users to navigate, such as each menu scene.

2) Narratives

In the narratives subscale, it has an average value of 6.06 and it can be concluded based on the indicators and the narratives subscale that the warehouse simulation application has aspects of the story that can be used to capture the interest and shape the emotions of its users.

3) Play Engrossment

The play engrossment subscale has an average value of 5.72 and it can be concluded based on the indicators and play engrossment subscales that the warehouse simulation application has an interesting storyline for its users so that it makes players want to complete each stage in the application.

4) Creative Freedom

The creative freedom subscale has an average value of 5.78 and it can be concluded based on the indicators and creative freedom subscales that the warehouse simulation application has several activities such as taking items according to the list and scanning each item.

5) Visual Aesthetics

The visual aesthetics subscale has an average value of 5.63 and it can be concluded based on the indicators and visual aesthetics subscales that the warehouse simulation application has a display or graphics contained in the application that is attractive to players so that it makes players enjoy each scene.

There are four subscales that have a mean value below 5.5, namely enjoyment, audio aesthetics, personal gratification, and social connectivity, which means that these four subscales can be taken into consideration in making suggestions for improvement to increase user satisfaction in the warehouse simulation application.

1) Enjoyment

In the application, users quickly feel bored, because of the color concept in the room theme and the absence of audio as musical accompaniment. So it would be better if each scene changed the theme color to be different and added audio back sound so that users do not feel bored.

2) Audio Aesthetics

The warehouse simulation application does not have much audio applied to each activity that will be carried out by its users. The application only applies audio effects only to the forklift running and when scanning goods. So that it will add more to the user experience in the future if the audio effect is applied to every activity that will be carried out by the player.

3) Personal Gratification

In the warehouse simulation application, the personal gratification subscale has an average of below 5.5 so the improvement in this subscale is by adding audio and UI such as congratulations to users after completing each scene.

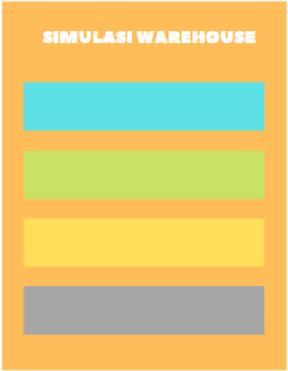
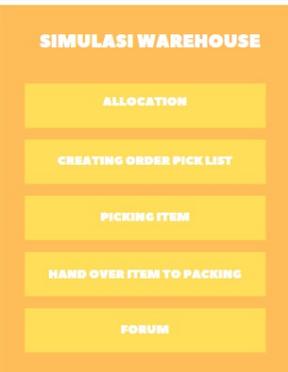
4) Social Connectivity

The warehouse simulation application does not have multiplayer and chat facilities or features the application, this is the cause of social relationships between players being absent so that players cannot interact with each other when the simulation application is used.

### 4.3. Improvement Recommendations

The four subscales previously described will be taken into consideration in making a list of improvement recommendations to increase user satisfaction in the warehouse simulation application. The final stage of the analysis of the simulation application is in the form of suggestions for improvement of the four subscales that have scores below the average. Based on the results of the analysis, a list of recommendations for improvements to the warehouse simulation application is obtained in table 3.

Tabel 3. Tabel Rekomendasi Perbaikan

No	Subskala	Improvement Recommendations	Illustration
1	Enjoyment	<ul style="list-style-type: none"> <li>Changed the theme colors in each scene and added audio accompaniment.</li> </ul>	
2	Audio Aesthetics	<ul style="list-style-type: none"> <li>Adding an audio effect to the bag of goods so that every time the player touches and places it, it will make a sound.</li> </ul>	
3	Personal Gratification	<ul style="list-style-type: none"> <li>Provide audio and UI such as congratulations to the user after completing each scene.</li> </ul>	
4	Social Connectivity	<ul style="list-style-type: none"> <li>Adding a forum menu in the application, where the menu is located on the main menu. The purpose of the forum menu is so that each user can communicate with other users.</li> </ul>	

## 5. CONCLUSION

Based on the results of the analysis using the Game User Experience Satisfaction Scale (GUESS) method in the warehouse simulation application, the results were obtained from 9 subscales that have an average value below 5.5, namely enjoyment, audio aesthetics, and personal gratification, social connectivity. The factor that causes the lack of value in the enjoyment subscale is that it is too boring for users in each scene. In the audio aesthetics subscale is the lack of audio that should be applied to each activity, in order to add to the player's experience. In the personal gratification subscale, each scene of the warehouse simulation application is less challenging so that users easily feel bored. In the social connectivity subscale, the warehouse simulation application does not have multiplayer and chat features so players cannot interact with anyone when running the application. The recommended list of improvements for enjoyment is to add mini-games such as composing words related to the warehouse. In audio aesthetics, add audio to each activity, such as bags of goods. For personal gratification, provide simple rewards such as audio applause at the end of each scene. In social connectivity, namely adding a forum menu for communication between users.

Based on the results of user satisfaction analysis using a questionnaire distributed through online media with the GUESS model, the lowest subscale average value of 3.75 and the highest subscale of 6.27 were obtained. Overall, the average value of GUESS user satisfaction is 48.4 so the simulation application falls into the category of simulation applications that are quite satisfying.

## ACKNOWLEDGEMENTS

The author would like to thank all those who have participated and provided support in carrying out the process of analyzing user satisfaction in warehouse simulation applications using the Game User Satisfaction Scale (GUESS) method so that this research can be put into writing.

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