



**AN ANALYTICAL FRAMEWORK FOR EVALUATION
OF PROCEDURAL CONTENT GENERATION IN
VIDEO GAMES**

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Thesis for the Master's Program in Design Studies

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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ABSTRACT

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This thesis analyzes the influences of procedural content generation (PCG) on player satisfaction in order to bring in new perspectives to game developers. The study aims to achieve this by analyzing literature, critic and user reviews of selected video games. In addition, a sample chart to evaluate video games with the found metrics is proposed. Focusing on key aspects of player preferences and experiences arising from a comparison between games that use and do not use PCG. For comparison, ten video games are chosen (five on using, five on not using PCG). The results indicate that video games that use PCG have the potential to be both better and worse than the games that do not use PCG. On the other hand, video games that do use PCG do not score any higher than ones that do not use. The study suggests that game developers should strive for a balance between procedurally generated and manually designed elements to maximize player satisfaction. The methodology involved qualitative analysis of user reviews, providing insights into subjective player experiences while acknowledging potential biases. These results underscore the importance of thoughtful PCG implementation and offer practical guidance for future game design. This study

concludes with recommendations for further research, particularly in examining different PCG algorithms and their effects on long-term player engagement. The work contributes to a better overall understanding of how PCG plays a crucial role in enhancing game design, offering valuable perspectives to developers who aim to leverage its capabilities more effectively.

Keywords: Game Design, Video Games, Procedural Content Generation, Game Content, User Experience.

ÖZET

VİDEO OYUNLARINDA PROSEDÜREL İÇERİK ÜRETİMİNİN DEĞERLENDİRMESİNE YÖNELİK ANALİTİK BİR ÇERÇEVE

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Bu tez, literatürü, örnek oyunların eleştirilen ve kullanıcı incelemelerini analiz ederek video oyunlarında prosedürel içerik üretiminin (PCG) oyuncu memnuniyeti üzerindeki etkilerini analiz ederek oyun geliştiricilere yeni bakış açıları kazandırmayı hedefler. Ayrıca, bulunan metriklerle video oyunlarını değerlendirmek için bir örnek table önerilir. PCG kullanan ve kullanmayan oyunlar arasındaki bir karşılaştırmadan kaynaklanan oyuncu tercihlerinin ve deneyimlerinin temel yönlerine odaklanır. Karşılaştırma için on video oyunu seçildi (beşi PCG kullanan, beşi PCG kullanmayan). Sonuçlarda ise, PCG kullanan video oyunlarının PCG kullanmayan oyunlardan hem daha iyi hem de daha kötü olma potansiyeline sahip olduğunu göstermektedir. Önerilen örnek tablonun puanlamasına göre, PCG kullanan video oyunları, kullanmayanlardan daha yüksek puan almadığı görülüyor. Bu sebeple, oyun geliştiricilerin, oyuncu memnuniyetini en üst düzeye çıkarmak için prosedürel olarak üretilen ve elle tasarlanmış öğeler arasında bir denge kurmaya çalışmaları gerektiğini önermektedir. Metodoloji, olası önyargıları kabul ederken öznel oyuncu

deneyimlerine ilişkin içgörüler sağlayan kullanıcı incelemelerinin nitel analizini içeriyordu. Bu sonuçlar, dikkatli PCG uygulamasının önemini vurgular ve gelecekteki oyun tasarımı için pratik rehberlik sunar. Bu çalışma, özellikle farklı PCG algoritmalarını ve uzun vadeli oyuncu etkileşimi üzerindeki etkilerini incelemek için daha fazla araştırma önerileriyle sonuçlanmaktadır. Bu araştırma, PCG yöntemlerinin oyun tasarımını geliştirmede nasıl önemli bir rol oynadığına dair daha iyi bir anlayışa katkıda bulunarak, PCG ile yapılabilecekleri daha etkili bir şekilde kullanmayı amaçlayan geliştiricilere değerli bakış açıları sunmaktadır.

Anahtar Kelimeler: Oyun Tasarımı, Video Oyunları, Prosedürel İçerik Üretimi, Kullanıcı Deneyimi.

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LIST OF ABBREVIATIONS

2D	Two Dimensional
3D	Three Dimensional
AAA	Games with high-budget and high-profile
AI	Artificial Intelligence
GAN	Generative Adversarial Networks
ML	Machine Learning
NPC	Non-Player Character
PC	Personal Computer
PCG	Procedural Content Generation
PRNG	Pseudo-Random Number Generators
RPG	Role-Playing Games

CHAPTER 1: INTRODUCTION

Throughout the history of video game development, many tools have been used, including procedural content generation (PCG). This tool is generally an algorithm that takes on the role of a designer and produces content such as trees, textures, buildings, cities, and even maps. By using PCG in games, content generation becomes automated. To have a clear meaning, the term content here means objects, creatures, and environments that the player can see and interact with. This automated generation is used in two different ways, one is using PCG methods while the player is playing the game – online, and the other is during the development of the video game or right before starting the game – offline (Shaker et al., 2016). These different ways are used in many aspects of different games. Since the late 1970s and early 1980s, PCG has been used in various games from many genres. Some examples of PCG usage are *Rogue (1980)* and *Elite (1984)*. About 40 years later, in 2024, PCG is still used to generate content up to the point of the entire game world.

As the founder of Hello Games explains (How No Man’s Sky Infinite Universe Actually Works - IGN First, 2015), *No Man’s Sky (2016)* uses online procedural generation for generating flowers, terrain, creatures, and even planets. The generation of these contents is done simultaneously, meaning that the game generates all these contents as it is played. This simultaneous generation gives each player a unique experience in the game that uses PCG. Finding a specific object (which can be a natural resource) might take longer for player A, while player B reaches it in the first few minutes of their playtime. Also, there is another time for this generation to be made, which is during the development process or right before entering the game world. This could be the case for many games that are in the sandbox genre. For instance, *Minecraft (2009)* uses both of these online and offline methods. First, it generates a certain area right after pressing the “Create New World” button for the player to start interacting with the world. As the player moves from their starting point (spawn location), the game continuously generates new places, creatures, resources, and even new biomes. Therefore, it uses offline and online PCG to create each game world.

Simply put, PCG is not a usual random content generator. This tool generates content

that did not exist previously, but it does so according to rules set by the developers. Also, what to generate or the variety of content to be generated is given by the developer. Depending on the methods used, the generated content, the process of generation, and the uses of these generations change. In addition, these points also depend on the genre of the game that is developed. Not all types of procedural content generation methods may be applicable or efficient to use for all genres of games.

In this thesis, how procedural content generators work is explained, the benefits of using PCG are shown, the methods of PCG are explained, and the differences between games that use and do not use procedural content generation are researched to answer the question, “What is the focus of the players in PCG and non-PCG games?”. To answer this question, the current video game market has been researched. With the help of online reviews by critics and users, the points of users for each category have been determined. The research is limited to current 3D video games such as Minecraft (2011), No Man’s Sky (2016), Elden Ring (2022), and Horizon Zero Dawn (2020).

In this study, a literature study is used to discover the history of PCG, how PCG has been implemented in video games so far, and gather data on the uses of PCG. This analysis will provide insight into the evolution of PCG over the years, and what has been researched so far. Also, by analyzing the online user reviews on some games that use and do not use PCG, an insight has been gathered on customer expectations. By utilizing this insight, a qualitative evaluation system for video games is proposed. This proposal aims to compare chosen video games in order to see whether users are satisfied with the products they receive.

1.1. Research Question(s)

Based on the data gathered during the study, the research questions for the thesis are determined as:

Question 1: How is procedural content generation currently used in video game development?

Question 2: Is it possible to make better (e.g. more fun and/or more replayable) games

by using procedural content generation?

Question 3: What do the players of PCG and non-PCG games focus on the products they consume and do these games satisfy their expectations?

1.2. Hypothesis

Video games that use procedural generation can be efficient in many ways, from requiring fewer development times to requiring less storage space on the device of the consumer. By being efficient as such, the video games with PCG provide the same, - if not more- satisfaction to the consumers with Non-PCG games.

1.3. Methodology

By examining the existing literature on procedural content generation (PCG), this thesis delves into various aspects, including its definition, functionalities, applications, and potential avenues for enhancement. Furthermore, a concise historical overview of PCG is provided to contextualize its development and evolution over time. The primary objective of this thesis is to extract valuable insights from current games that effectively employ PCG and subsequently formulate a comprehensive roadmap for future game development utilizing this technology. Given the multitude of methods available for implementing PCG, this research selects and analyzes a diverse range of games that utilize PCG in distinct and innovative ways, ensuring a broad spectrum of approaches and techniques are covered. Through this comprehensive analysis, the thesis aims to contribute to the academic understanding of PCG and offer practical guidelines for its future application in game design.

The market research is done by analyzing the existing user reviews online in order to understand the differences and whether they work on games or not, as well as to find common points between games that use and do not use PCG. By creating a list of common keywords that are related to game design used in these reviews, it is assumed that the players of these games focus on and look for the keywords related to game elements. Therefore, improving these aspects in future games may highly influence the success of the upcoming productions. This thesis focuses on finding out these key points based on user reviews and creating a “checklist” for game developers to keep

in mind. However, this “checklist” is not the only way to make a good game, a shift in the trends of the time, new ways to play video games, and changes in customer expectations may heavily influence the game development progress.

During this process of gathering user reviews, an online data gathering tool was used. Only reviews of PC users were selected due to the broader game selection. After the extraction of these reviews, some of them were discarded. The reason behind this was that some comments were empty, random, unrelated to the subject, or contained only random punctuation. In addition, some comments were not written in English, so online translation was used to check whether those comments were related to the subject or not. The ones that are related were included and used as research data. Also, some comments were unable to be retrieved due to the limitations of the tool used. Those comments are contained in spoiler boxes and the tool used to retrieve the reviews was unable to extract them. Additionally, if the review had repetitive words/comments in the same box more than three times, those were redacted to only one and the rest of the review was considered spam comment. Out of all these critic and user reviews, only game design related ones were chosen for the purpose of this study.

1.4. Aims & Scope of Research

The research aims to determine how procedural content generation (PCG) can or does aid designers during the process of video game design. As the research comes to an end, it will be concluded how PCG is or/and can be a useful tool, how it contributes to the video game development process (e.g., improving efficiency, decreasing the cost of development, and/or making a game with high replayability). By drawing the limits of research within 3D and commercial video games, differences and similarities between the ones that use and the ones that do not use PCG will show the changes between consumer expectations and satisfaction.

CHAPTER 2: PROCEDURAL CONTENT GENERATION AND GAME CONTENT

2.1. Game Content Definition For This Research

The content of the video game is an important part of the game in terms of keeping players engaged in the created game worlds. Many items within the game can be considered as “content”. However, in this research, the game engine itself as well as non-player character (NPC) behavior are not regarded as content. The majority of elements in video games are referred to as content, which includes the levels, maps, game rules, textures, buildings, items, missions, music, weapons, vehicles, and characters.

2.2. Definition of Procedural Content Generation

Procedural Content Generation (PCG) refers to the utilization of algorithms to automate the creation of media content. This encompasses a broad range of media traditionally authored by humans, including artistic forms like poetry, paintings, and music, as well as functional outputs like architectural drawings or films (Barriga, 2019).

In the context of video game content, PCG can be defined as automatically creating content for an entity, generally a game, using algorithms or other processes that can be very broad in respect of potential material about the entity under consideration because of their randomness. At the root of this process lies the concept of randomness: The application of PCG with the use of a limited set of parameters ensures the creation of a large number of unique game contents. The results of the use of PCG algorithms may comprise any number of components that influence gameplay, starting from maps, terrain, buildings, weapons, missions, characters, etc. (Amato, 2017).

6.Derived Content					
News & Broadcasts			Leaderboards		
5.Game Design					
System Design			World Design		
4.Game Scenarios					
Puzzles	Storyboards	Story		Levels	
3.Game Systems					
Ecosystems	Road Networks	Urban Environments		Entity Behavior	
2.Game Space					
Indoor Maps	Outdoor Maps			Bodies of Water	
1.Game Bits					
Textures	Sound	Vegetation	Buildings	Behavior	Fire, Water, Stone & Clouds

Figure 1. Game content classes and the elements that can be procedurally generated. (Source: Hendrikx et al., 2013)

At first glance, Fig. 1 might seem written in the wrong order, however, it is intentional due to the explanation by Hendrikx et. Al. (2013). They have created five main classes and one additional class for game content. *Game Bits*, *Game Space*, *Game Systems*, *Game Scenarios*, *Game Design*, and *Derived Content* are the classes. As can be seen in Fig. 1, these classes have elements that can be generated both manually and procedurally. The order of Figure 1 is important because everything starts from the

bottom. The elements at the bottom build the foundation of the rest of the taxonomy. As the game designer or developer starts to create/generate some content from the *Game Bits*, they begin to create/generate *Game Space*. Whether they are creating/generating a tree or furniture, they start to design the “bits” of the game. When a few pieces of furniture combined in a room and multiple rooms are generated, that starts the shape up as an *Indoor Map*, which is a part of the *Game Space*. When a few buildings are designed in outdoor areas with roads that the player sees and follows, this builds *Road Networks* and *Urban Environments*. Anything that these spaces tell/show to players is considered part of the story. To illustrate, if the game takes place in a post-apocalyptic world, abandoned buildings, broken down vehicles, and overgrown grass from the cracks in the roads can be seen. This environment tells the simple story of people who used to live in that town, but something bad happened. All of these are part of the *Game Scenario*. In order to tell the *Game Scenario*, developers/designers create the *World Design* according to the story, setting, and narrative style of the video game.

Derived Content is a little bit different. It is not directly in the game but anything that is related to the said game (Hendrikx et al., 2013). Livestreams, gameplay videos, tips and trick tutorials, the latest news about the game, and upcoming updates can be considered this sort of content. In addition, similar to how books are applied to cinema, lately some video games have their own television series. Some examples to these television series are *The Last of Us* (game - 2013, series -2023), *Fallout* (games - 1997-2021, series 2024), and *Arcane* (League of Legends game - 2009, series 2021). To sum up the *Derived Content*, it can be anything that is related to a game, whether it takes place in the same universe as the game does, tells the back story of the characters that players use and see, or simply is a version of the entire video game as a live-action series.

The reach of PCG can extend to more fundamental aspects of gameplay, potentially generating game mechanics and core rules (Barriga, 2019). In the early studies on this subject, the game content that is generated with PCG is classified as game bits, game space, game systems, game scenarios, game design, and derived content (Hendrikx et al., 2013). All this content generated with PCG, depending on the game and the

developer’s choice of what kind of game they want to make, can be generated with different methods. The main methods that are used in PCG for video games are *Traditional Methods*, *Search-based Methods*, and *Machine Learning*.

2.3. Methods of Procedural Content Generation

While using PCG in video games, there are multiple methods to do so. These methods are *Traditional Methods*, *Search-Based Methods*, and lastly, *Machine Learning Methods*. Each of these methods has different applications, and not all methods are applicable to every game genre. *Traditional Methods* include *Pseudo-Random Number Generators (PRNG)*, *Generative Grammars*, *Fractals*, and *Noise* to generate content for video games. *Search-based Methods* are divided into three sections, which are *The Space Representation*, *The Evaluation Function*, and *The Search Algorithm* (Barriga, 2019). Finally, *Machine Learning Methods* use external “Training Data” to process.

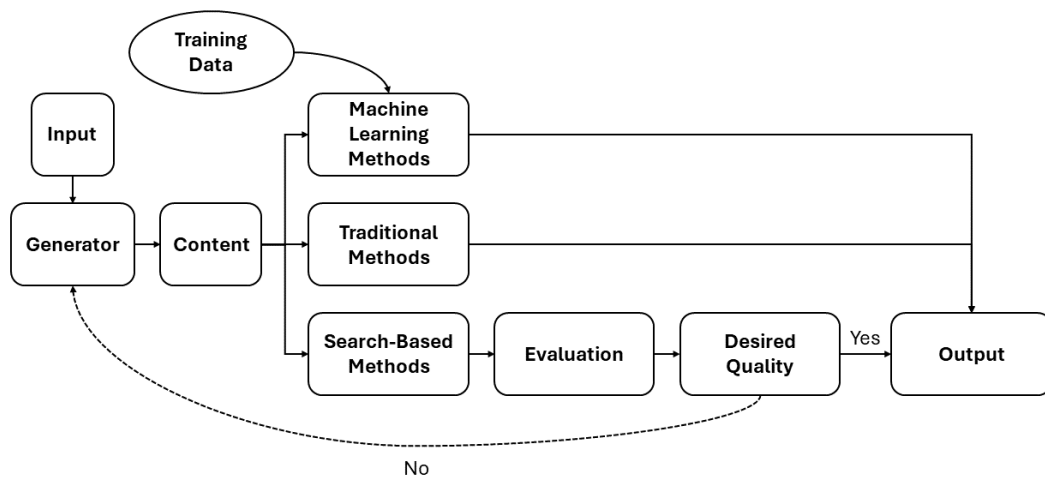


Figure 2. Procedural Content Generation Methods Workflow based on Zhang et al., (2022). (Source: Zhang et. al., 2022)

Fig. 2 displays the workflow of PCG methods. Even though all the methods have internally the same approach, the ones that specifically stand out are shown in Fig. 2. For instance, ML methods constantly evaluate the training data to reach a desired quality in the output but, this is in the nature of ML. Therefore, it is not separately shown in the figure.

2.3.1. Traditional Methods

Pseudo-Random Number Generators (PRNG), Generative Grammars, Fractals, and Noise, are examples of traditional methods of PCG. Each of these methods is used for different types of elements. The earliest retail video games that utilized pseudo-random number generators and other constructive techniques were dungeon and labyrinth generation games. The primary benefits of PRNG are speed and simplicity. When given the same seed, they are typically deterministic and produce the same content. They were initially employed as a data compression technique since each piece of material (often a level) could be represented by only one number: The seed that created it (Barriga, 2019).

Another method that is used for generating content for natural elements is generative grammar. Creating vegetation with generative grammar is arguably the most successful application of PCG in video games. There are many well-known tools (like SpeedTree), and both AAA games (a classification used within the video gaming industry to signify high-budget, high-profile games that are typically produced and distributed by large, well-known publishers (What are AAA Games?, n.d.) and small games frequently use them. This is an illustration of a technique that has been applied to other fields, such as architecture or film, through video games. The commercial use of grammar-based PCG could also be advantageous in the fields of city generation and level generation in platformers (Barriga, 2019). Since this method is used on a bigger scale objects such as vegetation, city generation, and level generation, when it produces good materials, it can save days of manual labor.

Lastly, the use of fractals and noise is similar to generative grammar in terms of the produced content field. They both generate content of natural elements such as vegetation textures, rocks, and mountain structures. The primary purpose of fractal and noise generation is to generate content that must mimic the effects of natural processes, such as the formation of mountains by geological procedures, or the textures of rocks or vegetation. Since the content produced by this class of algorithms has an organic feel, it is widely utilized in games with landscapes and to create textures for purposes other than games (Barriga, 2019). In short, some uses of traditional methods of PCG are dungeon and level generation, geological environments, and organic-looking

natural environments.

2.3.2. Search Based Methods

Search-based methods are classified as “*generate-and-test methods, i.e., they generate content and then evaluate it. However, rather than accepting or rejecting it, they score it*” (Barriga, 2019). These methods generally include three different sections: *the space representation, the evaluation function, and the search algorithm* (Barriga, 2019; Zhang et al., 2022). The use of each search-based method can be considered as trying to find results for the design process of the video game with contents of the required quality. As this process keeps going, better results will surface by eliminating the bad results until reaching the point of said quality. The more questions asked, the better the answers become; therefore, the results of the method will improve as it keeps asking questions. The advantages of search-based PCG methods include flexibility, quality control, and creativity, while challenges include computational cost, designing suitable objective functions, and balancing exploration and exploitation (Togelius et al., 2011).

Table 1. Distinction of each search-based method (Source: Shaker et al., 2016)

The Search Algorithm	Very simple evolutionary algorithms that serve as the “engine”, frequently function satisfactorily, but occasionally there are significant advantages to employing more complex algorithms.
The Content Representation	This is an illustration of the objects that are wished to be created, such as missions, levels, or creatures.
The Evaluation Function	A function that maps an object—a single piece of content—to a number that represents the quality of the object is known as an evaluation function.

The table above (Table 1) is a brief description of the components forming the base of a search-based method, applied in game design to automate the process of creating content for a game. These components are essential to restrain the multiple dimensions of quality while satisfying the desired quality as well as suiting the very purpose and

stipulation of a particular game. Also, these components have distinct roles in the process that goes from driving the search for optimal configurations of content to defining what and how things can be generated and the quality of the content assessed.

2.3.2.1. The Search Algorithm

This serves as the search-based method's "engine." As it can be seen, quite basic evolutionary algorithms frequently function satisfactorily, but occasionally there are significant advantages to employing more complex algorithms that, for example, take limitations into consideration or are tailored for a specific content illustration.

2.3.2.2. The Content Representation

This is an illustration of the objects you wish to create, such as missions, stages, or kitties with wings. Anything from a graph to a string to an array of real numbers could be the content representation. Effective searchability is determined by the content representation, which also defines (and hence limits) the type of content that can be produced.

2.3.2.3. The Evaluation Function

A function that maps an artefact—a single piece of content—to a number that represents the artefact's quality is known as an evaluation function. An evaluation function's result could show something like how playable a level is, how complicated a quest is, or how cute a flying kitten is. Creating an assessment function that accurately gauges the feature of game quality that it is intended to gauge is frequently one of the more challenging parts of creating a search-based PCG technique.

2.3.3. Machine Learning Methods

Machine learning techniques employ training data to produce mathematical models, which are then utilized for answering inquiries regarding either the same data set (such as clustering problems) or a different one (such as classification problems). *Generative Adversarial Networks* (GANs) (Goodfellow et al., 2014), *Autoencoders* (Jain et al., n.d.), *Markov Models* (Snodgrass and Ontañón, 2017), and *Recurrent Neural Networks* (Summerville and Mateas, 2016) are the most well-known machine learning (ML) approaches that have emerged recently for the successful production of new game

elements (Barriga, 2019). The neural networks can be divided even further into sequences, grids, and graphs (Zhang et al., 2022). Different game genres use different data structures. While Role-Playing Games (RPGs) use grids, 2D platformer games use sequences (Barriga, 2019). These different uses are based on the dynamics of each game genre.

Table 2. ML Use in Video Games Generated Through PCG based on Barriga (2019) (Source: Barriga 2019)

Sequence	<ul style="list-style-type: none"> - Super Mario Bros. - Loderunner, - Kid Icarus
Grid	<ul style="list-style-type: none"> - Super Mario Bros. - Kid Icarus - StarCraft II
Graph	<ul style="list-style-type: none"> - Super Mario Bros. - Generic Interactive Fiction

The table above (Table 2) provides a detailed categorization of various games and the underlying structures utilized in ML methods of PCG. Each structure tailored to different game types and design requirements. For each structure, a selection of example games presented and an in-depth explanation of how the structure is applied in PCG offered, highlighting its significance in shaping the gameplay experience and facilitating content generation.

2.4. Taxonomy of Procedural Content Generation

As mentioned earlier, in previous research PCG classification was made and it was categorized as *Game Bits*, *Game Space*, *Game Systems*, *Game Scenarios*, and *Game Design* (Hendrikx et al., 2013). Each of these categories is a combination of the previous one, and they include many aspects from that category. To simply put:

- *Game Bits*, when seen separately, are the fundamental building blocks of the content of the game, that have no impact on how the player plays. These

include: textures, sound, vegetation, buildings, behavior, and fire, water, stone, and clouds.

- *Game Space*, is the environment in which the action takes place. This category includes both indoor and outdoor maps and bodies of water, which need elements from the previous category, *Game Bits* in order to be created.
- *Game Systems*, can be considered a part of *Game Space*. These systems include: ecosystems, road networks, urban environments, and entity behavior.
- *Game Scenarios*, are when events take place and these can happen in ways such as solving puzzles, creating storyboards, the story progress, and progressing between levels.
- *Game Design*, is basically what the game can do and what the player will achieve. This category includes system design and world design. (Amato, 2017, Hendrikx et al., 2013)

Procedural Content Generation Taxonomy

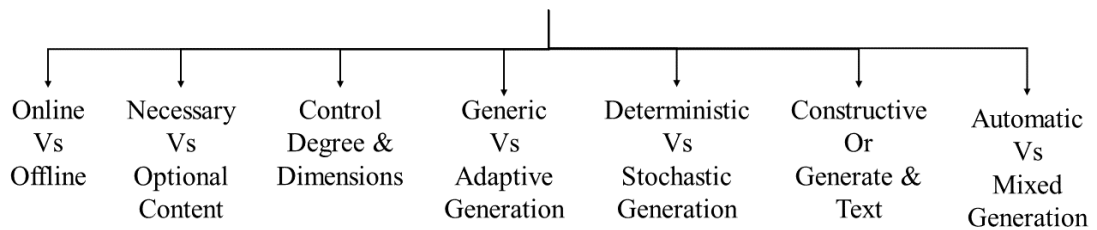


Figure 3. A revised version of PCG taxonomy based on Shaker et. al. (2016) (Source: Shaker et. al., 2016)

A revised version of PCG taxonomy is shown in Fig. 3, based on Shaker et al. (2016) which covers a broader perspective on procedural content generation. Each category of this taxonomy takes a look at the differences between types of content generated and generation methods. The categories of this revised taxonomy are:

- *Online vs. Offline Generation*, the offline content generation occurs during game development or before entering the game, while online content generation occurs during game play. When a player opens a door in a building, for instance, the game instantly creates the interior, including the rooms, walls,

decorations, etc. This is an example of online PCG. When an algorithm generates a structure's basic interior layout and a designer makes necessary modifications before the game is finished, that is an example of offline PCG. It is obvious that the online PCG needs to live up to the fundamental standards for producing worthwhile content: both the speed and the quality requirements of the content must be met.

- *Necessary vs Optional Content*, for players to advance in the game, some necessary content is essential. Crossable dungeons, beatable monsters, and the main rules of the game are considered examples of necessary game content. Anything that is not directly related to the progress of the player through the game is considered optional content. The length of the dungeon, types of weapons to use, and the amount of weapons can be classified as optional content.
- *Control Degree and Dimensions*, is differentiation dependent upon the generation algorithm type and parameterization strategy employed. The algorithm can operate as a multi-dimensional vector with the parameters that define the characteristics of the material to be generated, or it can operate as a simple algorithm that accepts a randomly generated integer as an input. When creating a dungeon, the algorithm can take into account many input factors, such as the quantity of chambers, corridors, branching factors, and so on. The generated content can be tailored and managed to a greater extent with higher control levels.
- *Generic vs. Adaptive Generation*, in contrast to adaptive content generation, which analyzes player interactions with the game and creates content based on past behavior of the player, generic content generation refers to the PCG paradigm, where content is generated without taking player behavior into account.
- *Deterministic vs. Stochastic Generation*, has to do with how random the building process is. Deterministic algorithms (such as the Rogue dungeon generation method) can be designed to either produce the same content with the same input parameters or different content even with the same input parameters.
- *Constructive or Generate-and-test*, as is often the case with roguelike games,

constructive PCG generates the content in a single run. Contrarily, generate-and-test approaches repeatedly generate and test in a loop until a workable solution is produced within the expected requirements. (Amato, 2017, Shaker et al., 2016)

- *Automatic vs Mixed Generation*, game designers have had little input with PCG; they typically adjust the parameters of the algorithm to direct and control the creation of material, but the primary goal of PCG is still to generate an endless variety of enjoyable content. Nonetheless, a novel and intriguing paradigm has surfaced, emphasizing the integration of designer and/or player feedback throughout the design procedure. In this mixed-initiative model, the algorithm and a human designer work together to produce the intended content. (Shaker et al., 2016)

Both of these taxonomies draw attention to important parts of procedural content generation and how it is applied in video games. While some of them are directly related to the generated content, some of them are related to the applications and methods of PCG.

2.5. History of Procedural Content Generation

The main reason behind the development of procedural content generation was actually compressing data. It was used as a method of data compression from the very beginning of its life (Amato, 2017). In the early eighties, storage spaces were quite limited. Therefore, in order to make a big game, the developers needed to find a way to downsize the game files. For example, PCG was utilized in *The Sentinel* (1985) to construct 10,000 distinct levels that were compressed into 48 and 64 kilobytes. Each landscape is created using a procedural generation method that starts with a tiny data packet: the eight-digit code that appears after a preceding landscape is finished. Given the generation technique, the number of landscapes was decided upon arbitrarily in order to give players a nice experience without overwhelming them with an impossible aim (Amato, 2017). Another game that uses PCG is *Rogue* (1980). This game uses PCG in order to create random levels whenever a new game begins (Shaker et al., 2016). Also, *Elite* (1985) created a universe with 256 solar systems and 8 galaxies per universe by using PCG. There are one to twelve planets in each solar system, each with

a space station in orbit, a name, a landscape, commodity prices, and regional details. Owing to the limited power of 8-bit processors, these planets were created with PCG (Amato, 2017).

As new products were released, such as CD-ROMs, it became possible to include more content in the games. The need for PCG was shifted from saving space to automatic content generation. Until *Diablo* (1996), was developed, PCG was used to generate materials for games such as trees, vegetation, and environments, raising the content of a game in an effort that was not achievable by manual labor and increasing the replayability aspect of the game (Aversa, 2015). With the release of *Diablo* (1996), which is a part of rogue-like game genre, PCG started to be used for generating random dungeons and random items. Simply put, dungeons are the levels that the game takes place in, and items are the treasures that players find in these levels. Still on the date, this random treasure generation is used in many games in similar genres, and in some games, the rarity and power of the item are shown by using different colors or tags, such as rare, uncommon, epic, or legendary.

Since the establishment of commercial PCG design tools in 1996, PCG has been used for more than just space, role-playing, and rogue-like games. This ushered in the PCG era that we see today. Procedural content generation is based on the premise that game content is produced by computers following a predetermined process rather than by hand by human creators (Hendrikx et al., 2013). Currently, however, level content is designed using PCG approaches, which aids in the creation of game content more quickly and frequently goes unnoticed by the player as a design technique. Procedural approaches, when applied more heavily, offer an option to content creators in terms of creating game environments quickly and efficiently. The creation of game levels and the world as the game is being played or loaded is one example of how PCG techniques are used intensely: In this instance, PCG instantiates all of the game's elements, including trees, monsters, characters, riches, and various other materials. These methods are used in games such as *Elite* (1985), *Diablo* (1996), *Minecraft* (2009), and *Spelunky* (2008) (Togelius et al., 2013). In addition to these games, any game that creates game levels or items for players randomly can be considered a game using procedural content generation. More recently, *No Man's Sky* (2016), *Lethal Company*

(2023), Astroneer (2019), and Valheim (2021) can be considered to be games with PCG due to the elements of randomness.

2.6. Applications of Procedural Content Generation in Video Games

As mentioned earlier, there is more than one method to use procedural content generation when making a video game. Depending on the type of game, these methods could be applicable for generating as small as the textures of roads or as large as the entire game world. However, the use of procedural content generation is tricky, relying entirely on the capabilities of PCG with an unbalanced game could result in a failed attempt as well as drawing a bad image for the company. Of course, if the game is balanced and the dependence on the PCG is relatively low, then the game could be a huge success. In order to create games where a PCG algorithm is a crucial component of the game design, advancements are needed in both PCG and game design. In PCG, the variables of the PCG algorithm must be meaningfully dependent on player actions. The algorithm must be more dependable and controlled than the majority of existing algorithms (Togelius et al., 2013). Although using procedural content generation (PCG) may seem like a good way for creators to save money and time, there are drawbacks. The main ones are that the game's replayability and content quality depend on its use of procedural environments.

Table 3. Games that use PCG, the good and bad aspects of their uses based on Pereira de Araujo and Souto (2017) (Source: Pereira de Araujo and Souto, 2017)

Games That Use PCG	Usage of PCG	The Good	The Bad
Diablo	Map Generation	- Increased replayability , - More variations and fresh difficulties for experienced players.	- Lack of landmarks (as the map relies on pre-designated locations).
Minecraft	World Generation	- Promotes replayability , - Limitless exploration .	- Lack of goals , - Gameplay depends on the player.

Table 3 (Continued). Games that use PCG, the good and bad aspects of their uses based on Pereira de Araujo and Souto (2017) (Source: Pereira de Araujo and Souto, 2017)

The Eldor Scrolls V: Skyrim	Quest Generation	- Procedural sidequests that enhance exploration .	- Infinite quests do not change the game environment.
No Man's Sky	World/Planet Generation	- Promotes exploration (18 quintillion planets that were generated procedurally)	- Lack of variety on procedurally generated planets.

Each video game that is in Table 3 has a different purpose for using PCG. Additionally, the usage provides a different “good” and “bad” side to that video game. When used for world generation in Minecraft, it increases replayability and exploration, also decreases the goals and sense of direction for the player in terms of gameplay actions to take.

Usage of Procedural Content Generation

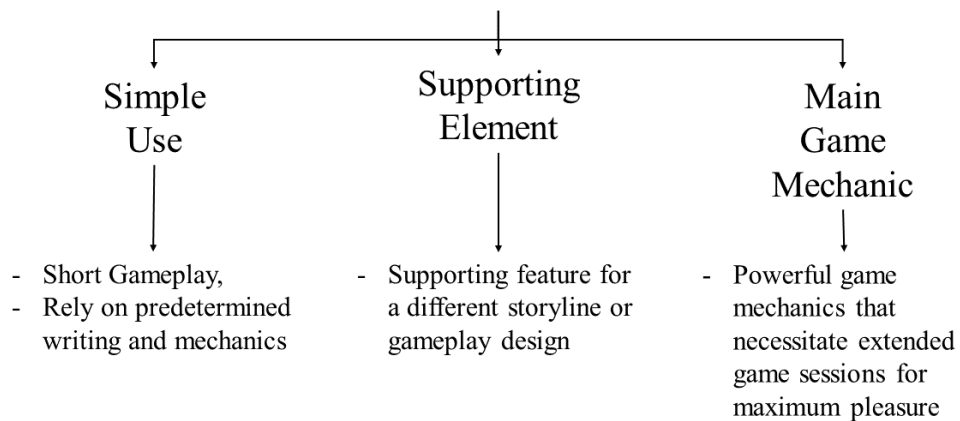


Figure 4. Uses of PCG and the intended results based on Pereira de Araujo and Souto (2017) (Source: Pereira de Araujo and Souto, 2017)

These use cases of PCG can be categorized as *simple use*, *supporting element*, and *main game mechanic* (Fig. 4). These three categories show the importance of PCG in the game that uses it. As in each category, the amount of reliance on PCG increases. In *simple use*, PCG generates smaller portions of the video game when compared to

the role of *supporting element*. Meanwhile, if PCG is used as *main game mechanic*, the video game relies heavily on PCG.

2.6.1. PCG as Simple Use

Generating game elements by hand or via procedural content generation (PCG) is a decision that developers frequently have to make. Assets, stories, characters, and maps are carefully designed when little to no PCG is employed; this produces unique pieces that enable fine-tuning of combinations, relationships, and game balance. However, as Hendrikx et. al. (2013) point out, this strategy necessitates a significant investment of time and money in production. Therefore, in order to produce a game that is almost flawless given the limitations of the game, smaller studios may need to shorten the experience and emphasize the strong points of the core game design, such as a compelling story or well-balanced mechanics. In addition, PCG can be utilized throughout the development phase to generate content, which is a suitable substitute for content creation that is done on-the-go depending on player behavior. Instead of depending on preset "seeds," PCG allows developers to use preset templates as a foundation to create large-scale game environments or non-playable characters. Rather than starting from zero, this method lets developers build atop the created material, saving time during the early stages of design (Pereira de Araujo and Souto, 2017). An example of player behavior here can be the direction that a player moves in Minecraft. The game renders set distances in order to optimize the performance of the game. If the player is moving towards the north, then the southern parts of the map are not rendered, and nothing occurs when the player is far from those locations.

2.6.2. PCG as Supporting Element

As demonstrated by "Skyrim" and its "Radiant Quest System," PCG can be a useful tool for extending gameplay and enjoyment past the beginning of the adventure. Additionally, as demonstrated by "Diablo," extensive PCG use is recommended as long as it does not take away from the opportunities the game offers. The best of both worlds can be achieved by keeping the main plot and game universe apart, allowing writers to focus on more complicated game content or plot while still providing players with an "endless" area or experience where they can practice or just enjoy the gameplay more when they are not focused on the main plot - whether for greater

enjoyment or for "late-game" performance (Pereira de Araujo and Souto, 2017).

2.6.3. PCG as Main Game Mechanic

The quality of the fundamental gameplay mechanisms becomes crucial in games where the user experience is anchored by randomly generated content. It is up to these mechanics to keep players interested and engaged when there is less emphasis on writing. Because of this dependence on PCG, careful balance and fine-tuning modifications are required to guarantee a smooth and enjoyable gameplay experience during the anticipated duration of gameplay (Pereira de Araujo and Souto, 2017). It is imperative for developers to meticulously design systems that can adjust to the constantly shifting environments and obstacles produced by the algorithm, providing users with a feeling of advancement, exploration, and proficiency. Furthermore, achieving a careful balance between randomness and structure is necessary for the successful integration of procedural generation with fundamental gaming features, providing a varied and well-rounded experience that is both fair and challenging. Because of this, the effectiveness of procedurally generated material depends not just on the novelty and diversity it offers, but also on the fundamental stability of the gameplay systems that underpin it.

CHAPTER 3: CRITICS AND USER REVIEWS OF GAMES USING AND NOT USING PROCEDURAL CONTENT GENERATION

In order to have a deep understanding, five games were chosen for both games that use and do not use PCG games. Some of the games were closer to date, and some were over 10 years old. PCG games are selected in relation to the literature review. Some were selected because of their unique use of PCG and some were chosen because they were repeatedly mentioned in the previous research. Non-PCG games, on the other hand, were chosen more randomly. Some were chosen because they were recent and some were selected because they earned the “Game of the Year” title. The reason behind this choice was to see whether the expectations of players changed or not and how the developments went over the years. A few of the games in the research were first released as early access. This stage of the game is not a finished product; therefore, it cannot be reviewed as one. So, the solution for this situation was to select only the reviews after the games were fully released or had their “1.0 update”. This would mean that the game had reached a certain point and that the majority of the basics of the game were finished being developed. Also, most of the games are released on more than one game console and PC. However, for the consistency of the research, only PC releases of the selected games were chosen.

The progress of the study started with obtaining reviews from the website. The “Instant Data Scraper” extension was used for exporting the reviews from the Metacritic website. After gathering the reviews, each one of the reviews was analyzed, and the ones in different languages (e.g., Russian, Italian, Japanese, etc.) were translated to English by using machine translation. The successfully translated ones are included in the study; however, machine translation has its limitations. The ones that could not be translated were eliminated. Also, the tool used to obtain reviews had its own limitations as well. Some reviews on the website are marked as “Spoiler Alert”, which is to protect readers who have not fully played the game from unwanted information they will come across in the future. “Instant Data Scraper” was not able to overcome the restrictions of these comment boxes and could not gather the information behind them; therefore, all reviews that included potential spoilers were eliminated. However,

tables for each game were created in descending order of the frequency of their usage. Following the outputs, tables for each game are created, and all the tables are gathered together to draw a conclusion for the research. From that point on, the repeating words from the reviews are considered the metrics of the study. However, it would be difficult to draw a conclusion from all the metrics for this research; therefore, an elimination was necessary in order to achieve more accurate data.

Table 4. List of keywords used as metrics after the analysis.

Metrics	
Bugs	Used as “Bugs/Issues”
Issues	
Combat	
Experience	
Explore	Used as “Explore/Exploration”
Exploration	
Enjoy	Used as “Fun/Enjoyable”
Enjoyable	
Fun	
Gameplay	Used as “Gameplay/Mechanic”
Mechanic	
Graphics	
Level	
Quests	Used as “Quests/Missions”
Missions	
RPG	
Story	Used as “Story/Narrative”
Narrative	
World	

During this elimination, some of the fundamental terms of game design (Adams, 2014) and PCG (Aversa, 2015) fields were chosen. In addition to these, some metrics were also kept due to being common in most - if not all - games. Similar metrics were combined together (e.g. “enjoy”, “enjoyable” and “fun”, “bugs” and “issues”, “story” and “narrative”, etc.) to project a more accurate result as well. Also, if a certain game/genre specific metric has exceeded a certain frequency, that metric is kept as well. Table 4 presents a full list regarding the transformation of these keywords into the metrics of the research.

The refined code for the metric/keyword extraction tool (developed by the Author):

```
stop_words = [
    "the", "a", "an", "and", "you", "don't", "is", "to", "be", "in", "on",
    "that", "which", "this", "but", "or", "at", "by", "for", "as", "with", "of",
    "have", "it", "about", "from", "get", "say", "make", "can", "more"
]

def analyze_keywords(text):
    """
    Analyzes text and returns game design keywords used 3+ times with their
    frequency, sorted by frequency (descending).
    Args:
        text: The text string to analyze (can be user input).
    Returns:
        A dictionary containing game design keywords used 3+ times (keys) and
        their frequency (values), sorted by frequency (descending).
    """
    processed_text = text.lower()
    for char in "!@#%&^&*()-=+{ }[];:\\"":
        processed_text = processed_text.replace(char, "")
    words = processed_text.split()
    word_counts = {}
    for word in words:
        if word not in stop_words:
```

```

    if word in word_counts:
        word_counts[word] += 1
    else:
        word_counts[word] = 1

filtered_words = {}
for word, count in word_counts.items():
    if count >= 3 and word in game_design_keywords:
        filtered_words[word] = count

sorted_words = dict(sorted(filtered_words.items(), key=lambda item: item[1],
reverse=True))
return sorted_words

# Get user input
user_text = input("Enter your text to analyze: ")

# Analyze and display results
keywords = analyze_keywords(user_text)

print("Game Design Keywords used 3+ times (descending frequency):")
for word, count in keywords.items():
    print(f"{word}: {count}")

```

3.2. *Review Analysis of PCG Games*

As can be seen in Table 4 different games from different release dates were selected for the study. The reason behind choosing games from different times was to see if the user expectations changed over time or stayed the same. Also, the games that were released previously had potentially more reviews. More reviews could mean broader angles to check and analyze in the study. This approach was used for both PCG and Non-PCG games and five games were selected for both categories.

Table 5. Numbers of Total and Eligible User Reviews on Video Games That Use Procedural Content Generation

PCG Games		
Game	Number of All User Reviews	Eligible User Reviews
Astroneer (2019)	64	63
Deep Rock Galactic (2018)	159	154
No Man's Sky (2016)	851	832
Minecraft (2011)	2069	1991
The Elder Scrolls V: Skyrim (2011)	2699	2608

The chosen video games that use PCG for the study are shown in Table 5 with total and eligible user reviews. As the games got older, the number of reviews increased. Also, it can be seen that as the number of total reviews increases, the ratio of eligible comments decreases.

3.3. *Astroneer (2019)*

System Era Softworks is the developer of the open-world sandbox adventure game *Astroneer* (2019). The game was released as early access in 2016 and fully released in 2019. In the game, players assume the role of astronauts exploring the farthest reaches of space in this 25th-century game, which is set in space and features a variety of procedurally created planets with distinct settings and obstacles. The game's low-poly visual style combined with vivid, stylized images creates a cozy, bright universe. Using a tool called the Terrain Tool, players can reshape landscapes, gather resources, and construct bases and vehicles to expand their capabilities and ensure survival. Procedural generation plays a key role in providing diverse and dynamic terrain, encouraging players to explore and adapt to ever-changing landscapes. Resource management is crucial, as collected materials "Replayability," essential tools and

modules. The game lets players create their own goals, whether it be creating intricate bases, traveling to far-off planets, or accomplishing other objectives, all while fostering creativity and exploration without enforcing rigid rules.

Table 6. All Critic and User Reviews of Astroneer (PC)

	User Reviews		Critic Reviews	
	Keywords	Frequency	Keywords	Frequency
1	Bugs/Issues	15	Survival	10
2	Fun/Enjoyable	14	Game	9
3	Exploration	14	Relaxing/Tranquil	8
4	Atmosphere	12	Exploration	7
5	Graphics	9	Crafting	7
6	Gameplay/Mechanics	8	Experience	7
7	Base Building	7	Space	5

Table 6. All Critic and User Reviews of Astroneer (PC) (Continued)

8	Survival	6	Enjoyable	5
9	Multiplayer	6	Charming	4
10	Repetitive	5	Repetitive	4
11	Tutorial	4	Solid	3
12	Content/Update	4		
13	Recommendation	4		

Since the game was released as early-access, it was not the complete product. Therefore, the research focuses on the part after the full release. The critic reviews are from 2019, which is when the game was fully released, and the user reviews of the game are in the timeframe of 2019 and 2023. It can be seen that in Table 6, it is shown that within there are 19 total critic reviews (Astroneer critic reviews, n.d.) that are considered as expert opinion in this research and all of the comments were eligible.

Repeating keywords indicate that consumers focus on such aspects while they play the video game. The top 5 of repeating keywords are “Survival”, “Game”, “Relaxing/Tranquil”, “Exploration”, and “Crafting” in these expert reviews. On the other hand, out of 64 user reviews (Astroneer user reviews, n.d.), 63 of them were eligible as of this study. The most used keywords are “Bugs/Issues”, “Fun/Enjoyable”, “Exploration”, “Atmosphere”, and “Graphics” by the players of the game. While both reviews have the same and similar keywords repeating, the frequency of their usage shows what each side focuses on while playing the game.

3.3.1. Critic Reviews

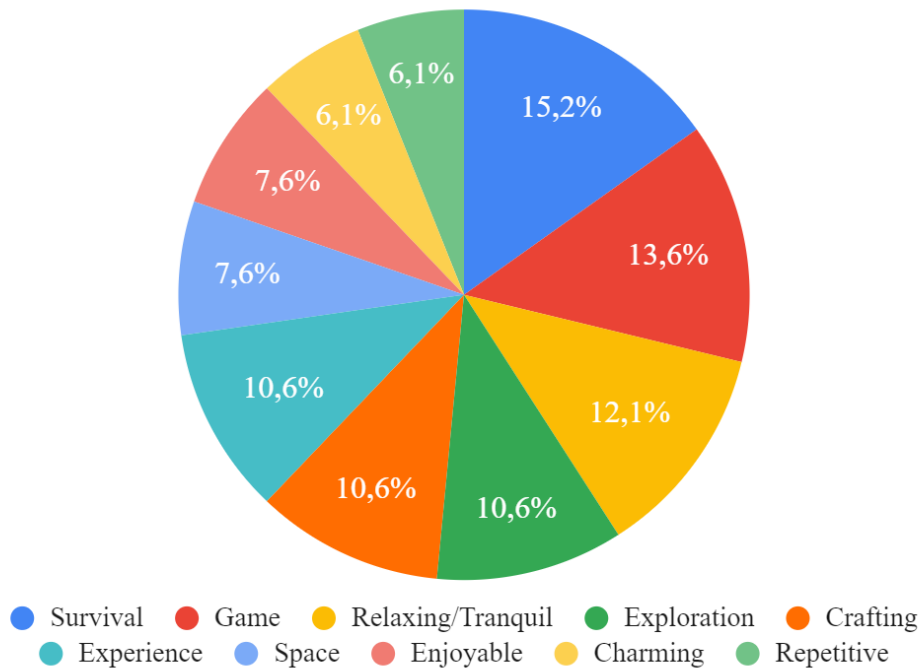


Figure 6. Critics Review Metrics of Astroneer (2019)

In Table 7 it is seen that some of the keywords from Table 6 are considered as metrics. Due to the elimination of the keywords, the first ten keywords from critic reviews are selected as metrics. In addition, Fig. 6 shows the distribution of the metrics in the form of percentages.

Table 7. Critic Review Metrics of Astroneer (2019)

Metrics	Frequency
Survival	10
Game	9
Relaxing/Tranquil	8
Exploration	7
Crafting	7
Experience	7
Space	5
Enjoyable	5
Charming	4
Repetitive	4

The first ten keywords from Table 6 are chosen as the metrics for the study. Out of 19 critic reviews (Astroneer critic reviews, n.d.) the critic review metrics for Astroneer (2019) are “Survival”, “Game”, “Relaxing/Tranquil”, “Exploration”, “Crafting”, “Experience”, “Space”, “Enjoyable”, “Charming”, and “Repetitive”. While “Survival” takes the lead with 15,2%, “Exploration”, “Crafting”, and “Experience” have the same frequency with 10,6%. The rest of the distribution of critic review metrics can be seen in Fig. 6 in more detail.

3.3.2. User Reviews

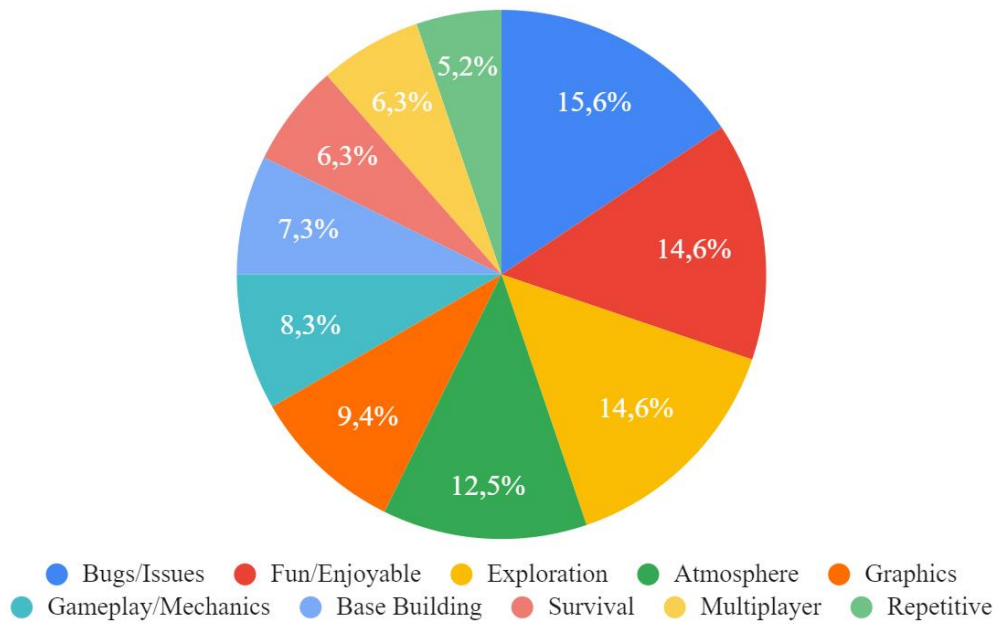


Figure 7. User Review Metrics of Astroneer (2019)

Table 8 displays the metrics for user reviews of Astroneer (2019). These metrics are chosen from the first ten user review keywords in Table 6. The breakdown of each metric can be seen in Fig. 7. This chart provides a visual sense of the table that lists these metrics.

Table 8. Astroneer (2019) User Review Metrics Overview

Metrics	Frequency
Bugs/Issues	15
Fun/Enjoyable	14
Exploration	14
Atmosphere	12
Graphics	9
Gameplay/Mechanics	8
Base Building	7
Survival	6
Multiplayer	6
Repetitive	5

Out of 63 eligible user reviews (Astroneer user reviews, n.d.), the selected metrics are

“Bugs/Issues”, “Fun/Enjoyable”, “Exploration”, “Atmosphere”, “Graphics”, “Gameplay/Mechanics”, “Base Building”, “Survival”, “Multiplayer”, and “Repetitive”. The distribution of the metrics is, “Bugs/Issues” is at the top with 15,6%, “Fun/Enjoyable” and “Exploration” share the second position with 14,6%, and the breakdown of the other metrics can be seen in Fig. 2. This distribution of metrics shows that the players/users of the game focus on “Bugs/Issues” but this point is slightly higher than “Fun/Enjoyable” and “Exploration”. In addition, the players did not miss the points of “Atmosphere”, “Graphics”, “Gameplay/Mechanics”, “Survival”, “Multiplayer”, and “Repetitive”. By having more metrics than the critics, it is seen that the players have more aspects on which they focus while playing the game.

3.4. *Deep Rock Galactic (2020)*

Developed by Ghost Ship Games, *Deep Rock Galactic* (2020) was released as an early access game in 2018, and the full release came out in 2020. The game is a cooperative first-person shooter that is well-known for its use of procedural content generation. In this future environment, players take on the role of dwarf miners and start out on missions within the planet Hoxxes IV's hazardous, alien-infested caves. Every mission is set in a randomly created cave system with different layouts, hazards, and resource distributions each time, making every game an entirely new experience. Vibrant bioluminescent components mixed with the game's gloomy, atmospheric graphics create an immersive and captivating underground world. Players must cooperate to mine precious minerals, defend against extraterrestrial animals, and accomplish mission goals while armed with specialized tools and weaponry. Players must modify their tactics since the procedural generation guarantees a variety of unforeseen cave structures.

Table 9. All Critic and User Reviews of Deep Rock Galactic (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	Co-op/ Multiplayer	82	Co-op/ Multiplayer	23	16	Graphics	8
2	Rock	57	Game	10	17	Atmosphere	8
3	Fun/ Enjoyable	55	Deep Rock Galactic	9	18	Great	8
4	Gameplay/ Mechanics	54	Great	6	19	Good	8
5	Community	30	Play	5	20	Dwarves	7
6	Exploration	17	Friends	5	21	Experience	6
7	Game	16	Fun	4	22	Mission	6
8	Deep Rock	14	Excellent	4	23	Content	6
9	Replayability	14	Gameplay	4	24	Humor	6
10	Play	10	Experience	4	25	Immersion	5
11	Classes	10	Missions	3	26	Variety	4
12	Friends	9	Variety	3	27	Performance	4
13	Best	9	Shooter	3	28	Developer	4
14	Progression	8	Space	3	29	Communication	3
15	Challenging	8					

There were a total of 21 critic reviews and 159 user reviews for Deep Rock Galactic. However, only 154 of those user reviews were eligible for the research. As shown in the Table 9, the most common keywords among the critics are “Co-op”, “Game”, “Multiplayer”, “Great”, and “Deep Rock Galactic” - which is the name of the game. On the other side, the most common keywords in the user reviews are “Co-op”, “Rock”, “Gameplay/Mechanics”, “Fun”, and “Community”. By having the same keyword in the top keywords, it can be said that developers have created a common

point between the critics and the players.

3.4.1. Critic Reviews

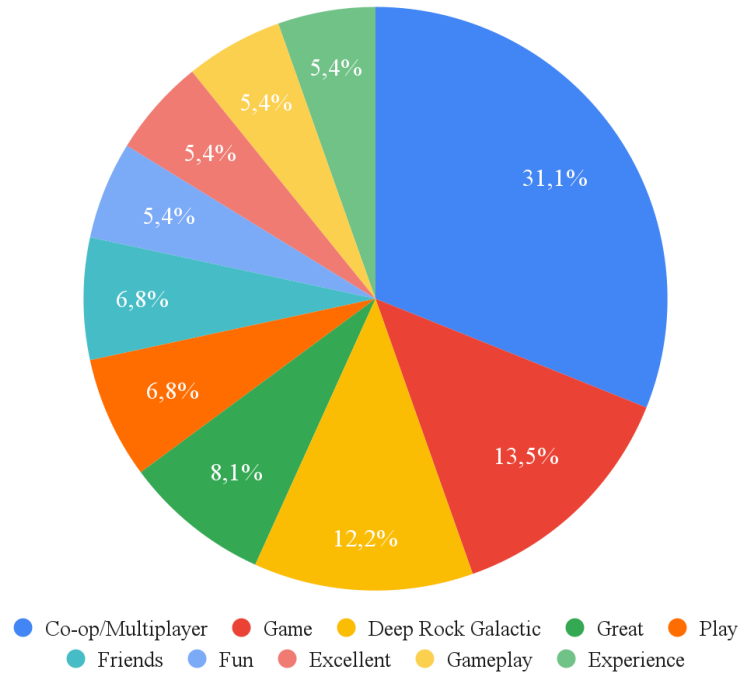


Figure 8. Critic Review Metrics of Deep Rock Galactic (2020)

While all the repeating keywords can be seen in Table 9, after the analysis, the ones in the first ten rows are selected. While Table 10 shows the final metrics for the critic reviews of Deep Rock Galactic (2020) with a detailed number of frequencies, Fig. 8 presents the allocation of those metrics visually.

Table 10. Deep Rock Galactic (2020) Critic Review Metrics Overview

Metrics	Frequency
Co-op/Multiplayer	82
Rock	57
Fun/Enjoyable	55
Gameplay/Mechanics	54
Community	30
Exploration	17
Game	16

Table 10 (Continued). Deep Rock Galactic (2020) Critic Review Metrics Overview

Deep Rock	14
Replayability	14
Play	10

Following the elimination of keywords, the decided metrics for the study are selected. Out of 21 critics opinions (Deep Rock Galactic critic reviews, n.d.) the metrics for *Deep Rock Galactic* (2020) are “Co-op/Multiplayer”, “Rock”, “Fun/Enjoyable”, “GameplayMechanics”, “Community”, “Exploration”, “Game”, “Deep Rock”, “Replayability”, and “Play”. While “Co-op/Multiplayer” takes the lead with 31,1%, “Game” follows with 13,5%. In Fig. 8, percentages can be seen in more detail.

3.4.2. User Reviews

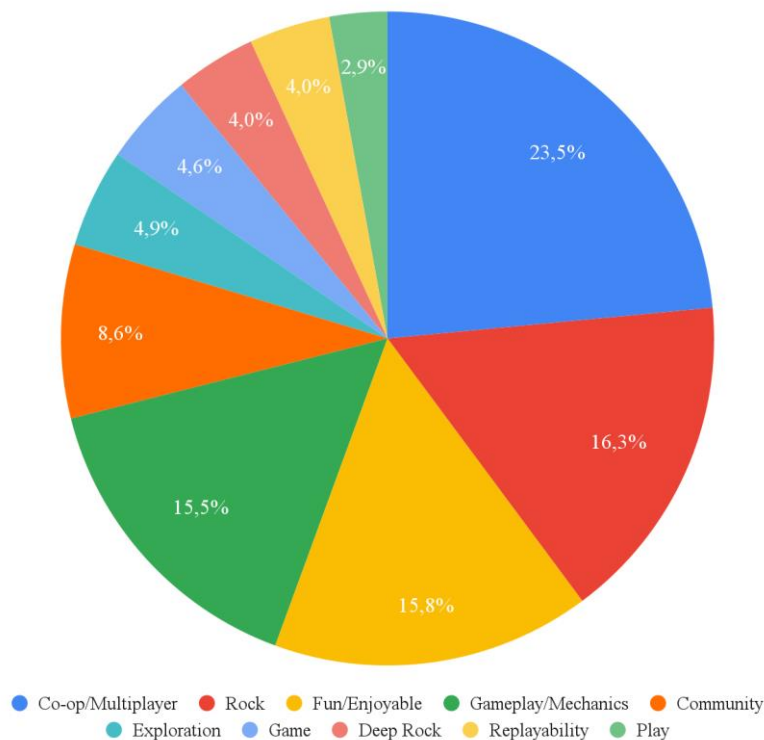


Figure 9. User Review Metrics of Deep Rock Galactic (2020)

Following the study, only the keywords associated with game design were chosen, even though Table 8 displays all of the recurring terms. Fig. 9 provides a visual representation of the metrics' distribution, while Table 11 displays the final metrics

for the user reviews of Deep Rock Galactic (2020) along with a full frequency breakdown.

Table 11. Deep Rock Galactic (2020) User Review Metrics Overview

Keywords	Frequency
Graphics	8
Atmosphere	8
Great	8
Good	8
Dwarves	7
Experience	6
Mission	6
Content	6
Humor	6
Immersion	5

In the meantime, out of 154 eligible user reviews (Deep Rock Galactic user reviews, n.d.), the selected user metrics are “Co-op”, “Rock”, “Gameplay/Mechanics”, “Fun”, “Community”, “Exploration”, “Game”, “Deep Rock”, “Replayability”, and “Multiplayer”. The frequency of these metrics can be seen in Table 11. The distribution of the metrics is, “Co-op” is at the top with 22,1%, “Rock”, follows with 17,5%, and “Gameplay/Mechanics” is at third place with 16,6%. The rest of the metrics are shown in Fig. 9 in more detail with their percentages. This distribution shows that the players/users of the game mainly focus on “Co-op” aspect. Also, “Rock” is slightly higher on the list than “Gameplay/Mechanics”.

3.5. *No Man’s Sky (2016)*

The open-world exploration game No Man's Sky (2016), created by Hello Games, is renowned for its audacious breadth and use of procedural content creation. Players can explore an endless number of planets in this procedurally generated cosmos, each with its own distinct ecosystems, landscapes, and wildlife. Because each planet is unique due to procedural generation, there are countless options for exploration and a variety of landscapes.

Table 12. All Critic and User Reviews of No Man's Sky (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	Game	1960	Game	16	26	PC	24
2	Planet(s)	298	Sky	15	27	Survival	23
3	Space	157	No	14	28	Resources	22
4	Exploration	147	Exploration/ Discovery	12	29	Crafting	22
5	Update(s)	135	Experience	6	30	Generated	21
6	Ship	93	Universe	5	31	Bug(s)	20
7	Gameplay	82	Space	5	32	Base(s)	16
8	Content	67	Beautiful	4	33	Sandbox	16
9	Developers /Dev(s)	58	Procedural Generation	4	34	Controls	13
10	Play	56	Ambition	4	35	Animals	11
11	System	53	Scale	3	36	Combat	9
12	Story	50	Technical	3	37	Patch(es)	9
13	Release	50	Gameplay	3	38	World	9
14	Building	43	Repetitive	3	39	Character	8
15	Multiplayer	43	Criticized	3	40	NEXT	8
16	Universe	42	Flaws	3	41	Species	5
17	Inventory	41	Mixed	3	42	Atlas	5
18	Mechanics	40	Enjoyable	3	43	Customization	4
19	Graphics	38	Mechanics	3	44	AI	4
20	Features	38	Reviewers	3	45	Difficulty	4
21	Mission(s)/ Quest(s)	36	Systems	3	46	Level	4
22	Procedural	32			47	Feedback	4
23	Player(s)	31			48	Fixed	4
24	Galaxy	26			49	Trading	4
25	Design	24			50	Crashes	4

All of the keywords for No Man's Sky (2016) can be found in Table 12. The first ten of these keywords are chosen as the metrics for the study and analyzed further in the following sections.

Hello Games developed the massive open-world exploration game No Man's Sky (2016), which is well-known for utilizing procedural content generation extensively. In an infinite universe, players set out to explore countless planets, each procedurally generated to offer distinct environments, animals, and landscapes. The technology of procedural generation guarantees that each planet is unique, possessing its own terrain, flora, fauna, and environmental conditions, offering countless exploration opportunities. Each discovery seems fresh and thrilling because of the game's vivid, varied graphic style, which perfectly conveys the vastness and diversity of space.

3.5.1. Critic Reviews

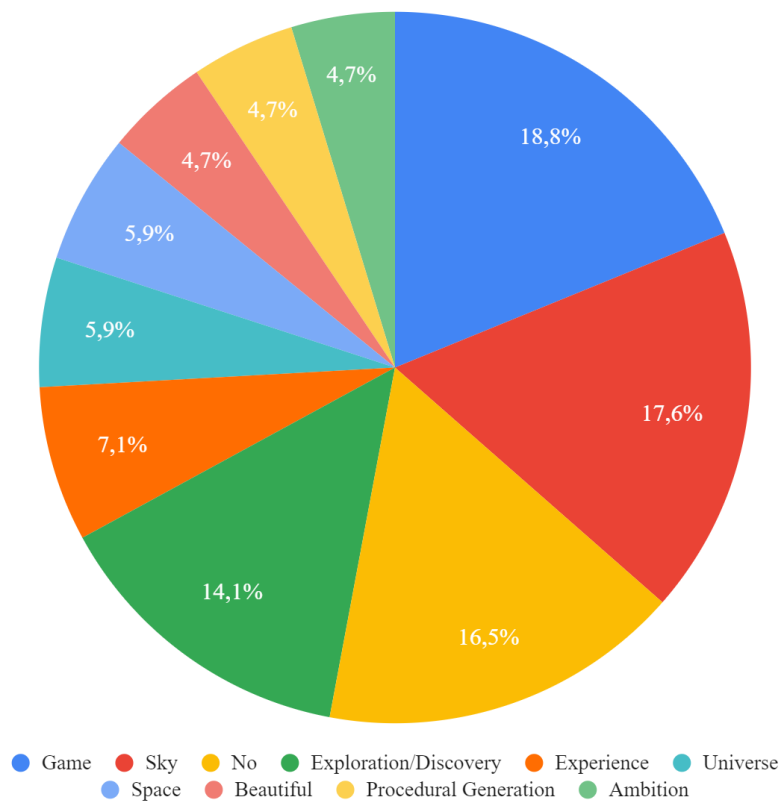


Figure 10. Critic Review Metrics of No Man's Sky (2016)

After the analysis, all of the recurring keywords are visible in Table 11, but only those that are associated with game design are chosen. Fig. 10 displays the final stats for the critic evaluations of No Man's Sky (2016) in a visual format, while Table 13 displays

precise figures of the metrics.

Table 13. No Man’s Sky (2016) Critic Review Metrics Overview

Metrics	Frequency
Game	16
Sky	15
No	14
Exploration/Discovery	12
Experience	6
Universe	5
Space	5
Beautiful	4
Procedural Generation	4
Ambition	4

By eliminating the keywords, the remaining ones are selected as metrics for the study. Out of 20 critics opinions (No Man’s Sky critic reviews, n.d.), in Table 13 and Fig. 10 the metrics for *No Man’s Sky* (2016) are shown, “Game” 18,8% and “Sky” 17,6%. In the list of metrics, “Universe”, “Space” and “Beautiful”, “Procedural Generation”, and “Ambition” share the same positions with 5,9% and 4,7%.

3.5.2. User Reviews

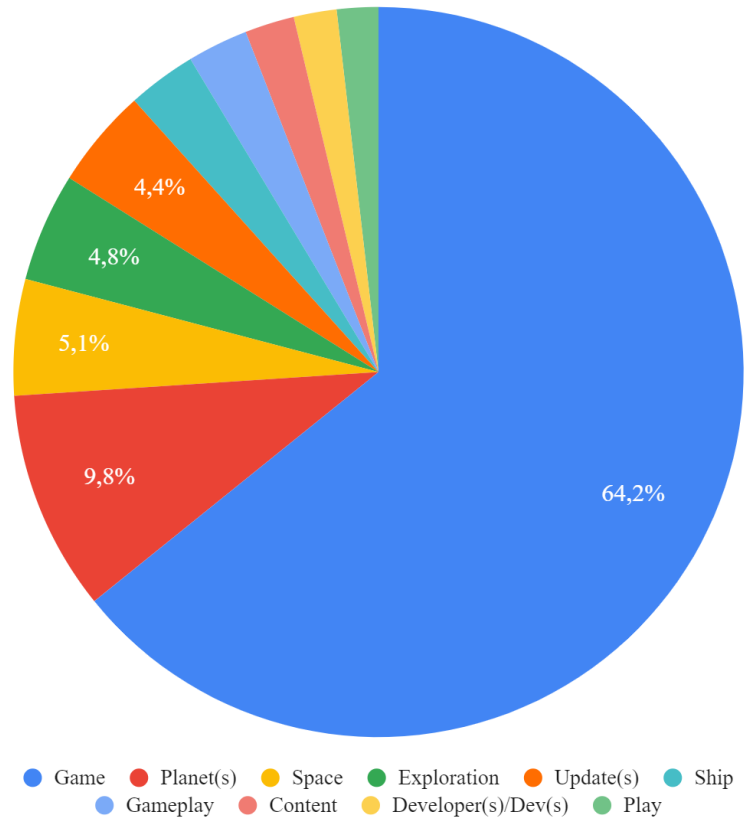


Figure 11. User Review Metrics of No Man's Sky (2016)

Following the analysis, Table 12 displays all of the repeated keywords; however, only those in the first ten rows are repeated the most and selected for the study. Table 14 shows the exact user review metrics, while Fig. 11 shows the final statistics for the user reviews of No Man's Sky (2016) visually.

Table 14. No Man's Sky (2016) User Review Metrics Overview

Metrics	Frequency
Game	1960
Planet(s)	298
Space	157
Exploration	147
Update(s)	135
Ship	93

Table 14 (Continued). No Man’s Sky (2016) User Review Metrics Overview

Gameplay	82
Content	67
Developer(s)/Dev(s)	58
Play	56

Also, between 832 eligible user reviews (No Man’s Sky user reviews, n.d.), the chosen user metrics are “Game” 64,2%, “Planet(s)” 9,8%, “Space” 5,1%, “Exploration” 4,8%, and the rest of the percentages can be seen in Fig. 11.

3.6. *Minecraft (2011)*

The sandbox game Minecraft (2011), created by Mojang Studios, is well-known for using a lot of procedural content generation. In this pixelated environment, players can construct buildings, go on exploration missions, gather materials, and make crafts. The large and varied randomly generated planets in the game have a variety of biomes, including mountains, deserts, woods, and oceans, each with its own distinct terrain, flora, and wildlife. Because of this randomization, each new game offers a unique setting and set of difficulties, which keeps gaming interesting and novel.

In Minecraft (2011), players have a choice between two modes: creative, which allows for limitless building and exploration, and survival, which requires them to guard against hostile mobs while keeping an eye on their health and hunger. Additionally, procedural generation is essential for building underground environments such as mineshafts, dungeons, and caverns, which enhance the game's sense of exploration and adventure.

Table 15. All Critic and User Reviews of Minecraft (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	Fun/ Enjoyable	861	Experience	7	17	Level	35
2	World	542	Explore/ Exploration	5	18	Elements	34

Table 15 (Continued). All Critic and User Reviews of Minecraft (PC)

3	Graphics	538	World	3	19	Variety	32
4	Survival	344	Generation	3	20	Generation	31
5	Gameplay/ Mechanics	296			21	Performance	22
6	Community	283			22	Atmosphere	21
7	Sandbox	253			23	Optimization	20
8	Content	173			24	Progress	16
9	Experience	166			25	Immersive/ Immersion	15
10	Explore/ Exploration	153			26	Physics	12
11	Bugs/Issues	144			27	Inventory	11
12	Story/ Narrative	127			28	Characters	8
13	Combat	105			29	Progression	7
14	Adventure	85			30	Quest(s)	7
15	Design	44			31	Puzzle	3
16	RPG	42					

Also, the multiplayer support enables players to collaborate or compete in shared worlds, fostering a vibrant community with countless custom maps, mods, and servers created by fans. Since its official release in 2011, "Minecraft" has continually evolved, with regular updates introducing new features, blocks, and gameplay mechanics, influenced by player feedback. The game's blend of creative freedom, survival elements, and procedurally generated content has made "Minecraft" a timeless classic and a beloved experience for players of all ages.

All of the keywords that were analyzed through the critic and user reviews can be seen in Table 15 with their frequencies. Out of these keywords, most repeating ten are chosen for the study and are further analyzed in the following sections.

3.6.1. Critic Reviews

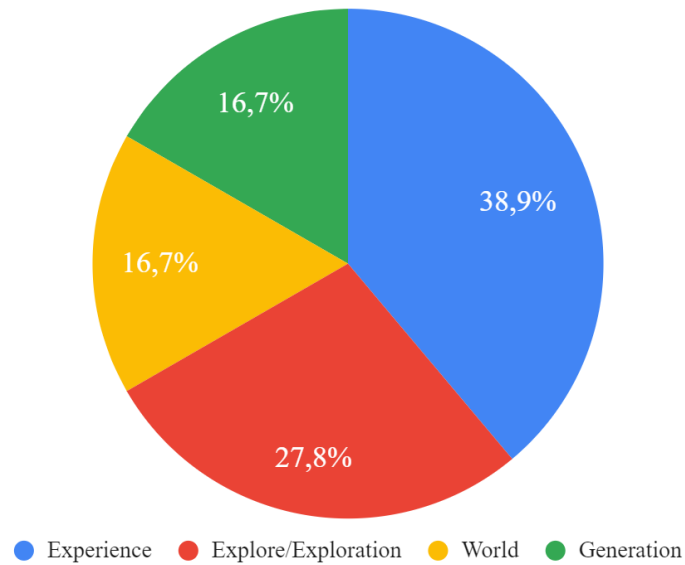


Figure. 12. Critic Review Metrics of Minecraft (2011)

Following the analysis, Table 16 displays all of the reoccurring keywords from the critic reviews and the final statistics for these reviews of Minecraft (2011) are presented visually in Fig. 12, while the exact metrics are shown in Table 16.

Table 16. Minecraft (2011) Critic Review Metrics Overview

Metrics	Frequency
Experience	7
Explore/Exploration	5
World	3
Generation	3

By eliminating and selecting metrics for the study, out of 33 critic opinions, (Minecraft critic reviews, n.d.), the metrics for Minecraft (2011) are “Experience” 38,9%, “Exploration” 27,8%, “World” 16,7, and “Generation” 16,7%, It can be seen that the critics of Minecraft (2011) focus mainly on “Experience” aspect of the game.

3.6.2. User Reviews

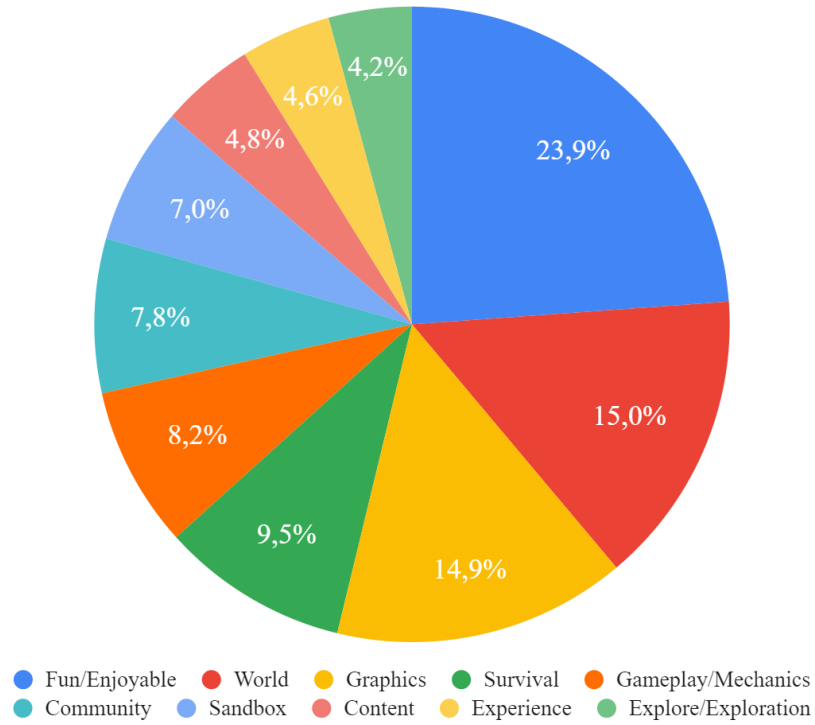


Figure 13. User Review Metrics of Minecraft (2011)

Table 17 provides exact metrics information with the frequencies included, while Fig. 13 presents the summary statistics for the user reviews of Minecraft (2011) in a visual manner after selecting those metrics from Table 15.

Table 17. Minecraft (2011) User Review Metrics Overview

Metrics	Frequency
Fun/Enjoyable	861
World	542
Graphics	538
Survival	344
Gameplay/Mechanics	296
Community	283
Sandbox	253
Content	173
Experience	166
Explore/Exploration	153

Additionally, between 1991 eligible user reviews (Minecraft user reviews, n.d.), the chosen user metrics are “Fun/Enjoyable” 23,9%, “World” 15%, and “Graphics” 14,9%. The distribution of metrics is shown in the Fig. 13 while a detailed list is presented in Table 17. By looking at the distribution of metrics, it can be said that the players of *Minecraft* (2011) mainly focus on the “Fun/Enjoyable” aspect of the game.

3.7. *The Elder Scrolls V: Skyrim (2011)*

The Elder Scrolls V: Skyrim (2011) is an open-world action role-playing game developed by Bethesda Game Studios. Set in the richly detailed fantasy world of Tamriel, specifically the northern province of Skyrim, the game immerses players in a land teeming with diverse landscapes, cities, and dungeons. While Skyrim's world is largely handcrafted, it employs procedural content generation to enhance certain aspects, such as terrain features and the placement of random encounters and loot, ensuring that each player's experience feels unique.

Players assume the role of the Dragonborn, a hero prophesied to save the world from the returning dragons. The game offers an expansive main quest, numerous side quests, and a deep lore that players can explore at their own pace. Skyrim's open-world design allows for immense freedom, letting players choose their path, be it as a warrior, mage, thief, or a blend of various skill sets. Combat, exploration, and character progression are central to the gameplay. Players can customize their character with a wide array of skills, abilities, and equipment, adapting their playstyle to suit their preferences. The world of Skyrim is filled with dynamic weather, day-night cycles, and a variety of NPCs, each with their own routines and stories, creating a living, breathing environment.

Table 18. All Critic and User Reviews of The Elder Scrolls V: Skyrim (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	Quest(s)/ Mission(s)	1498	Gameplay	13	16	Community	227
2	World	1333	Exploration	10	17	Design	115
3	Graphics	845	Atmosphere	8	18	Atmosphere	94
4	Bugs/Issues	840	Graphics	6	19	Inventory	93
5	Story/ Narrative	840	Freedom	6	20	Variety	93
6	Fun/Enjoyable	768	Immersion	3	21	Adventure	76
7	Combat	658	Role- playing	3	22	Progress/ Progression	69
8	RPG	626	Bugs/Issues	3	23	Elements	68
9	Gameplay/ Mechanic	506			24	Sandbox	59
10	Level	370			25	Physics	39
11	Characters	351			26	Animation	38
12	Experience	337			27	Performance	29
13	Explore/ Exploration	335			28	Generation	26
14	Content	269			29	Optimization	6
15	Immersive/ Immersion	240					

Since its release in 2011, *The Elder Scrolls V: Skyrim* has received critical acclaim for its depth, immersive world, and modding community, which has significantly extended the game's lifespan by adding new content, features, and improvements. The combination of an intricately designed world, procedural elements, and player-driven narrative makes *The Elder Scrolls V: Skyrim* a landmark title in the role-playing game genre.

3.7.1. Critic Reviews

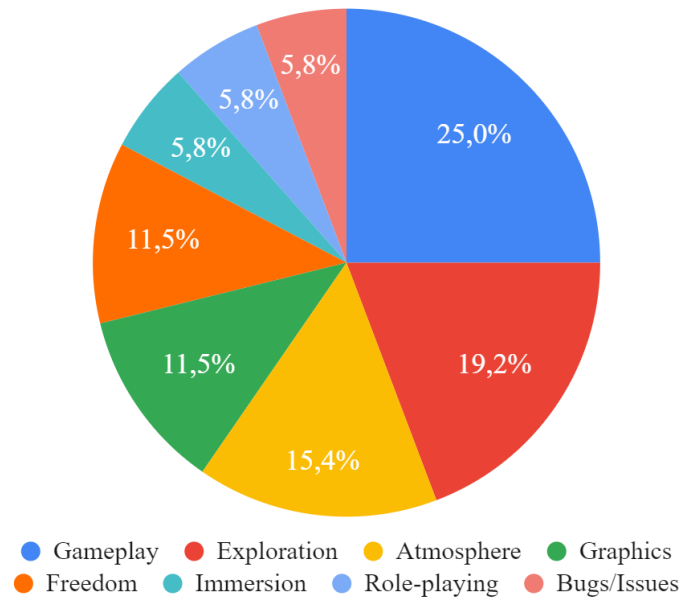


Figure 14. Critic Review Metrics of The Elder Scrolls V: Skyrim (2011)

While Table 18 shows all the repeating keywords from the reviews, Table 19 presents selected keywords that are used as metrics in the study with the number of repetition frequencies. Also, Fig. 14 presents those numbers visually, so it can emphasize the trends among those comments.

Table 19. The Elder Scrolls V: Skyrim (2011) Critic Review Metrics Overview

Metrics	Frequency
Gameplay	13
Exploration	10
Atmosphere	8
Graphics	6
Freedom	6
Immersion	3
Role-playing	3
Bugs/Issues	3

By eliminating and selecting metrics for the study, out of 32 critics opinions, (“The Elder Scrolls V,” n.d.), the metrics for The Elder Scrolls V: Skyrim (2011) are

“Gameplay” 25%, “Exploration” 19,2%, “Atmosphere” 15,4%, “Graphics” and “Freedom” 11,5%, “Immersion”, “Role-Playing”, and “Bugs/Issues” 5,8%. It is possible to say that the critics of The Elder Scrolls V: Skyrim (2011) focus mainly on the “Gameplay” aspect of the game.

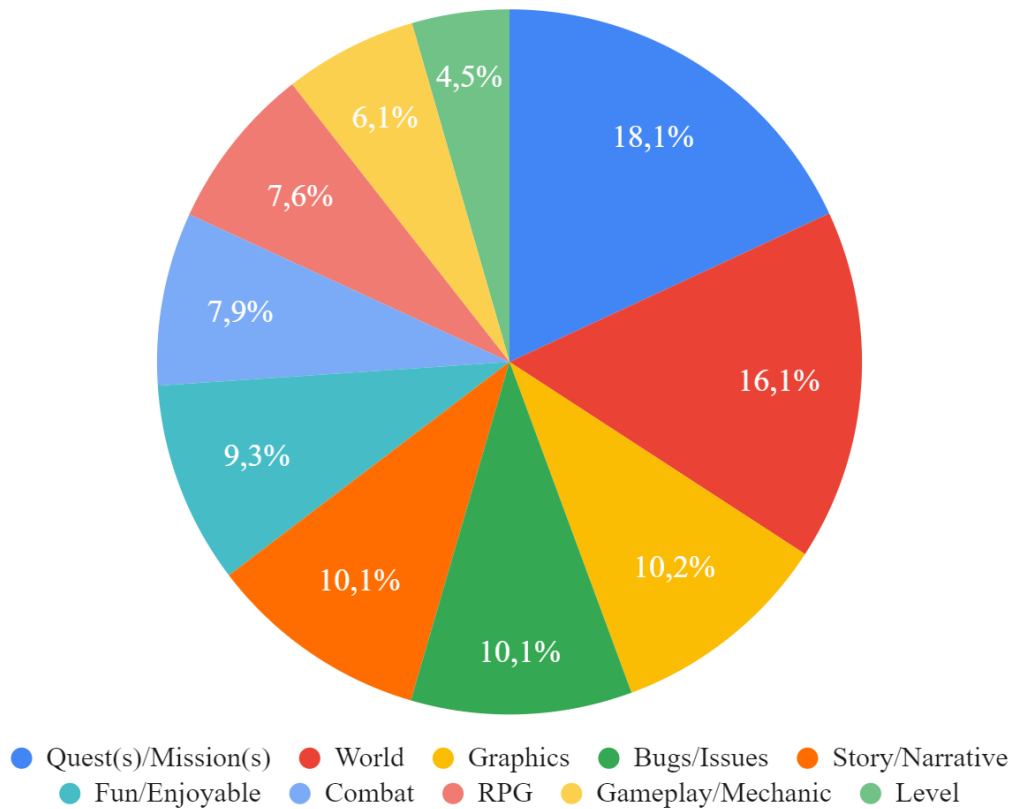


Figure 15. User Review Metrics of The Elder Scrolls V: Skyrim (2011)

Table 18 displays all of the reoccurring terms from the reviews; Table 20 lists specific keywords along with their frequency of occurrences that are used as metrics in the research. In order to highlight the trends in those remarks, Fig. 15 also visually displays those figures.

Table 20. The Elder Scrolls V: Skyrim (2011) User Review Metrics Overview

Metrics	Frequency
Quest(s)/Mission(s)	1498
World	1333
Graphics	845

Table 20 (Continued). The Elder Scrolls V: Skyrim (2011) User Review Metrics Overview

Bugs/Issues	840
Story/Narrative	840
Fun/Enjoyable	768
Combat	658
RPG	626
Gameplay/Mechanic	506
Level	370

Additionally, between 2608 eligible user reviews (The Elder Scrolls V: Skyrim user reviews, n.d.), the chosen user metrics are “Quest(s)/Mission(s)”, “World”, “Graphics”, “Bugs/Issues”, “Story/Narrative”, “Fun/Enjoyable”, “Combat”, “RPG”, “Gameplay/Mechanic”, and “Level”. By looking at the distribution of metrics, it can be said that the players of The Elder Scrolls V: Skyrim (2011) mainly focus on the “Quest(s)/Mission(s)” aspect of the game.

3.8. Review Analysis on Non-PCG Games

The same principles with PCG games were applicable to Non-PCG games while selecting the games and the reviews. However, Non-PCG games had a broader selection; therefore, five more recent games were selected. The chosen games, the number of total user reviews and the eligible ones can be seen in Table 21.

Table 21. Numbers of Total and Eligible User Reviews on Video Games That Do Not Use Procedural Content Generation

Non-PCG Games		
Game	Number of All User Reviews	Eligible User Reviews
Uncharted Legacy of Thieves (2022)	259	257
Control (2019)	421	414
Horizon Zero Dawn Complete Edition (2020)	416	406

Table 17 (Continued). Minecraft (2011) User Review Metrics Overview

Elden Ring (2022)	2286	2208
The Witcher 3: Wild Hunt (2015)	3002	2903

3.9. *Uncharted Legacy of Thieves (2022)*

The restored compilation of Naughty Dog, *Uncharted: Legacy of Thieves Collection* (2022), includes two highly regarded action-adventure games: *Uncharted 4: A Thief's End* and *Uncharted: The Lost Legacy*. With upgraded graphics, better performance, and other features tailored for contemporary gaming platforms, this collection takes the exciting adventures of Nathan Drake and Chloe Frazer to new heights.

Players continue Nathan Drake's journey in "*Uncharted 4: A Thief's End*," as he emerges from retirement to look for a rumored pirate treasure. The game is well known for its beautiful graphics, sophisticated level design, and dramatic narrative. While navigating gorgeous settings like verdant rainforests and historic ruins, players solve riddles and take part in thrilling battle scenes. The story, which explores themes of adventure, family, and legacy, is extremely personal. The focus of "*Uncharted: The Lost Legacy*" switches to Chloe Frazer and Nadine Ross, who set out on a mission to locate the Tusk of Ganesh in the Indian highlands. This stand-alone adventure adds new characters and locales while maintaining the series' distinctive fusion of action, puzzle-solving, and exploration. The relationship between Chloe and Nadine highlights themes of atonement and partnership while giving the narrative depth.

Higher resolution textures, quicker load times, and support for cutting edge features like haptic feedback and adaptive triggers on systems that are compatible are some of the ways that the "*Legacy of Thieves Collection*" improves these experiences. The collection confirms Naughty Dog's standing as the developer of some of the most memorable action-adventure games in the business by providing both new players and devoted fans with the chance to relive the grand adventures of the *Uncharted* series with contemporary improvements.

Table 22. All Critic and User Reviews of Uncharted Legacy of Thieves (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	Graphics	47	Experience	15	11	Level	8
2	Story/ Narrative	46	Fun/Enjoyable	12	12	Combat	7
3	Gameplay	31	Performance	9	13	Adventure	6
4	Fun/Enjoyable	31	Adventure	8	14	Design	6
5	Characters	17	Graphics	7	15	Performance	6
6	Bugs/Issues	18	Gameplay	6	16	Exploration	4
7	Optimization	13	Level	4	17	Community	3
8	Experience	11	Characters	3	18	Animation	3
9	World	10	Story	3	19		
10	Generation	10					

According to Table 22, most repeating words, which are considered keywords in this step, can be seen. The first ten of both user and critic reviews are chosen as metrics due to the fact that they are the most repeating keywords in the reviews.

3.9.1. Critic Reviews

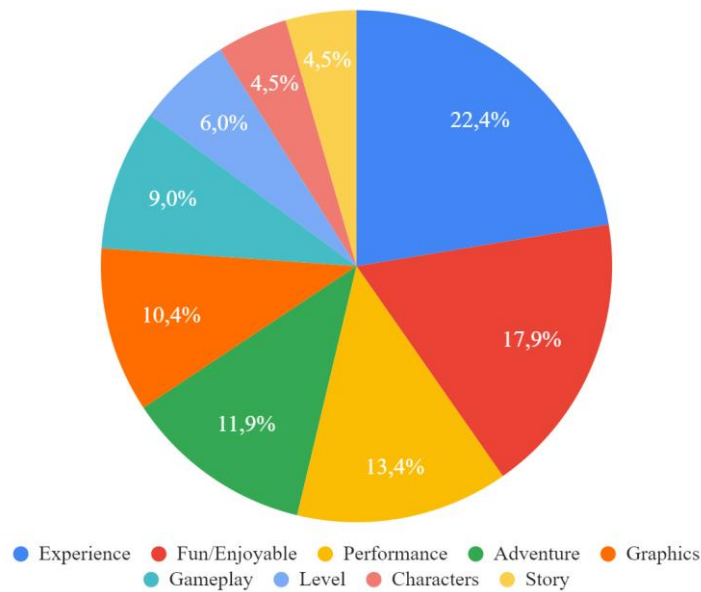


Figure 16. Critic Review Metrics of Uncharted Legacy of Thieves (2022)

As Table 22 shows the entire list of keywords for both critic and user reviews, Table 23 presents a list of critic review metrics of the research that were selected from the keywords in Table 23. In addition, Fig 16 highlights the distribution of those metrics visually.

Table 23. Critic Review Metrics of Uncharted Legacy of Thieves (2022)

Metrics	Frequency
Experience	15
Fun/Enjoyable	12
Performance	9
Adventure	8
Graphics	7
Gameplay	6
Level	4
Characters	3
Story	3

By eliminating the keywords, the remaining ones are selected as metrics for the study. Out of 20 critics opinions (Uncharted: Legacy of Thieves Collection critic reviews, n.d.), the metrics for Uncharted Legacy of Thieves (2022) are “Experience” 34,9%, “Fun/Enjoyable” 27,9%, “Graphics” 16,3%, “Gameplay” 14%, and “Story/Narrative” 7%. These metrics show the critics of *Uncharted Legacy of Thieves (2022)*, focus mainly on “Experience” aspect of the game.

3.9.2. User Reviews

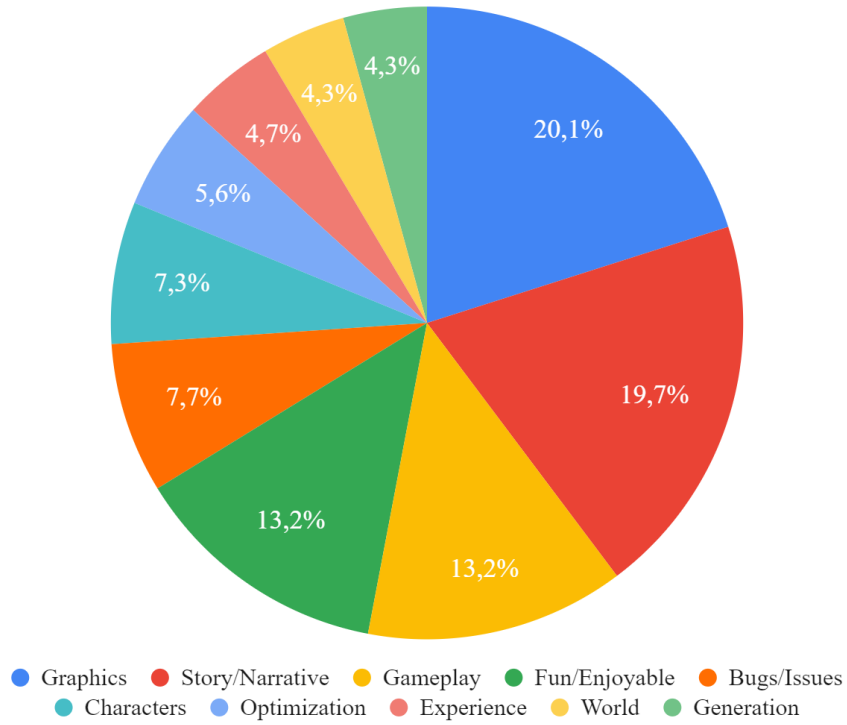


Figure 17. User Review Metrics of Uncharted Legacy of Thieves (2022)

Fig. 17 represents a visual form of Table 24, which is a list with high detail and precise figures of user review metrics on Uncharted Legacy of Thieves (2022). The focus of the users/players of the game can be seen in relation to game design.

Table 24. User Review Metrics of Uncharted Legacy of Thieves (2022)

Metrics	Frequency
Graphics	47
Story/Narrative	46
Gameplay	31
Fun/Enjoyable	31
Bugs/Issues	18
Characters	17
Optimization	13
Experience	11

Table 24 (Continued). User Review Metrics of *Uncharted Legacy of Thieves* (2022)

World	10
Generation	10

Additionally, between 257 eligible user reviews (*Uncharted: Legacy of Thieves Collection* user reviews, n.d.), the chosen user metrics are “Graphics” 20,1%, “Story/Narrative” 19,7%, “Gameplay” and “Fun/Enjoyable” 14,5%, “Bugs/Issues” 7,7%, “Characters” 7,3%, “Optimization” 5,6%, “Experience” 4,7%, and “World” and “Generation” share 4,3%. By looking at the distribution of metrics, it can be said that the players of *Uncharted Legacy of Thieves* (2022) mainly focus on the “Graphics” aspect of the game.

3.10. Control (2019)

Developed by Remedy Entertainment, the action-adventure game *Control* (2019) is renowned for its inventive gameplay features, atmospheric setting, and gripping story. Assuming the persona of Jesse Faden, players arrive at the enigmatic Federal Bureau of Control (FBC) in pursuit of her brother, who has gone missing. She finds the Bureau under attack by a mystical force called the Hiss upon her arrival, and to her surprise, she is named the new Director.

The game's gorgeous brutalism architecture contributes to the bizarre and immersive ambiance of the FBC's headquarters, also known as the Oldest House, where the action takes place in a constantly changing setting. The universe of *Control* (2019) is painstakingly constructed, fusing the supernatural with parts of the actual world to create an eerie and captivating environment for exploration. The gameplay centers on third-person shooting, with Jesse using telekinetic abilities and a shape-shifting weapon known as the Service Weapon. Combat gains a strategic depth thanks to these powers, which let players throw objects, influence the environment, and deflect assaults. Additionally, the game features characteristics of a *Metroidvania*, where players advance to unlock new skills and regions that were previously inaccessible.

Control (2019) is distinguished by its intricate, mysterious plot, which is full of lore and enhanced by a number of side quests and collectible documents that further the

story. Every interaction feels dynamic and significant because of the destructible landscapes and physics-based interactions in the game, which increase player immersion and engagement.

Table 25. All Critic and User Reviews of Control (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	Story/ Narrative	348	Story/ Narrative	16	15	Explore/ Exploration	23
2	Gameplay/ Mechanic	176	Experience	8	16	Variety	18
3	Fun/Enjoyabl e	132	Combat	8	17	Elements	14
4	Graphics	116	Gameplay	6	18	Performance	13
5	Combat	99	World	4	19	Content	13
6	Quests/ Missions	96	Enjoy	3	20	Immersive/ Immersion	11
7	World	71	Adventure	3	21	Progress	11
8	Design	64	Atmosphere	3	22	Optimization	9
9	Experience	54	Physics	3	23	Animation	7
10	Characters	50			24	Progression	7
11	Level	46			25	Adventure	6
12	Atmosphere	44			26	RPG	5
13	Physics	38			27	Generation	5
14	Bugs/Issues	26			28	Puzzle	4

The most repeating words, which are considered keywords, of Control (2019) can be found in Table 25 with the frequencies. These keywords analyzed and first ten rows are considered as the metrics, which can be seen in following sections.

3.10.1. Critic Reviews

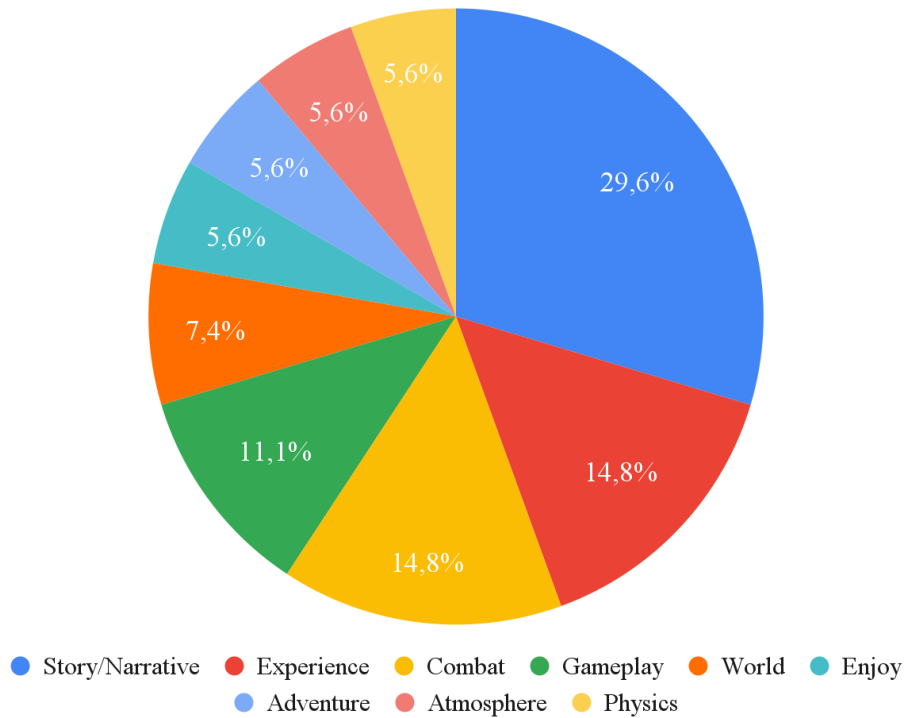


Figure 18. Critic Review Metrics of Control (2019)

There were many keywords in critic reviews of Control (2019), as can be seen in Table 25. However, after selecting the ones related to game design and combining the similar ones, only four metrics were used in the study. The list of these metrics can be seen in detail in Table 26, and the visual distribution can be seen in Fig.18.

Table 26. Critic Review Metrics of Control (2019)

Metrics	Frequency
Story/Narrative	16
Experience	8
Combat	8
Gameplay	6
World	4
Enjoy	3

Table 26 (Continued). Critic Review Metrics of Control (2019)

Adventure	3
Atmosphere	3
Physics	3

Following the elimination of keywords, the decided metrics for the study are selected. Out of 21 critic opinions (Control critic reviews, n.d.) the metrics for Control (2019) are “Story/Narrative” 29,6%%, “Experience” and “Combat” 14,8%, “Gameplay” 11,1%, “Fun” 7,4%, and “Enjoy”, “Adventure”, “Atmosphere”, and “Physics have 5,6%. These metrics show the critics of *Control* (2019), focus mainly on “Story/Narrative” portion of the game.

3.10.2 User Reviews

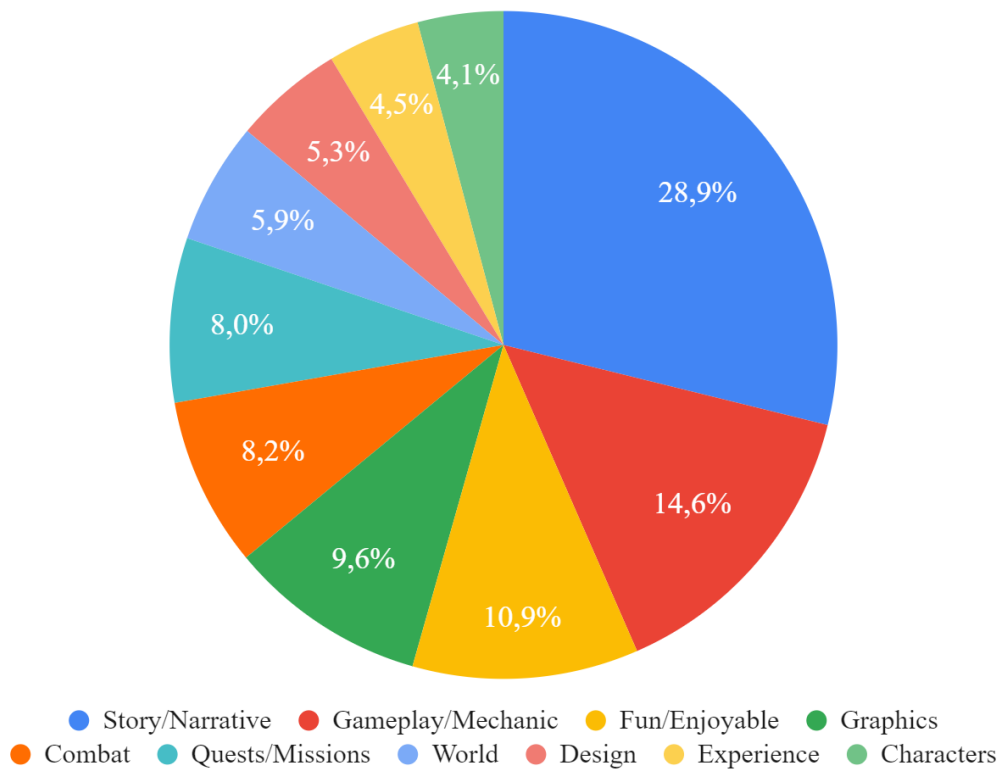


Figure 19. User Review Metrics of Control (2019)

The metrics that were chosen from the user review keywords of Control (2019) are presented in Table 27 as a list with the number of repetition frequencies. The visual

distribution of the list is shown in Fig. 19. It can be seen that the players of this game mainly mention “Story/Narrative” aspect.

Table 27. User Review Metrics of Control (2019)

Metrics	Frequency
Story/Narrative	348
Gameplay/Mechanic	176
Fun/Enjoyable	132
Graphics	116
Combat	99
Quests/Missions	96
World	71
Design	64
Experience	54
Characters	50

In the meantime, out of 414 eligible user reviews (“Control user reviews,” n.d.), the selected user metrics are “Story/Narrative” 28,9%, “Gameplay/Mechanics” 14,6%, “Fun/Enjoyable” 10,9%, “Graphics” 9,6%, “Combat” 8,2%, “Quests/Missions” 8%, “World” 5,9%, “Design” 5,3%, “Experience” 4,5%, and “Characters” 4,1% as shown in Fig. 1. This distribution shows that the players/users of the game mainly focus on “Story/Narrative” feature of the game.

3.11. *Horizon Zero Dawn Complete Edition (2020)*

The action role-playing game *Horizon Zero Dawn Complete Edition (2020)* by Guerrilla Games was first released in 2017 for other consoles. In 2020, it was released for PC, and since the study focuses on PC versions of the games, the 2020 version of the game is taken under the microscope. The game is well-known for its intricate plot, large open world, and cutting-edge gameplay. In a post-apocalyptic future where artificial creatures rule the earth and humans live in primitive tribes, players take on the role of Aloy, a talented hunter and archer. The game presents a remarkable contrast between the robots' sophisticated technology and the game's natural beauty, taking place in a rich, colorful landscape that has been reclaimed by nature.

The story traces Aloy's journey to discover her enigmatic history and comprehend the beginnings of the artificial animals that prowl the landscape. Through main objectives, side missions, and collection data points, the game's rich lore and captivating tale are progressively unveiled, making for an immersive and captivating experience. Aloy's path is one of self-realization, survival, and learning the truths that have molded the society she lives in. Also, Horizon Zero Dawn Complete Edition (2020) has amazing visuals thanks to its Decima engine, which creates realistic animations and intricate sceneries. The weather and dynamic day-night cycle enhance the game world's realism and immersion.

Table 28. All Critic and User Reviews of Horizon Zero Dawn Complete Edition (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	Story/ Narrative	256	World	18	15	Design	25
2	World	199	Experience	11	16	Missions	21
3	Gameplay/ Mechanic	107	Story	10	17	Level	19
4	Combat	106	Performance	9	18	Variety	15
5	Fun/Enjoyable	98	Graphics	8	19	RPG	14
6	Graphics	89	Adventure	8	20	Elements	12
7	Quests/ Mission	84	Combat	7	21	Immersion/ Immersive	12
8	Characters	74	Gameplay	7	22	Content	11
9	Optimization	57	Issues	6	23	Animation	8
10	Bugs	55	Enjoy	6	24	Atmosphere	6
11	Performance	48	Generation	4	25	Progress	5
12	Experience	40	Fun	3	26	Generation	5
13	Issues	40			27	Adventure	3
14	Explore/ Exploration	27			28	Sandbox	3

All the repeating words that are considered keywords can be seen in Table 28. From this table, first ten rows are considered the most repeating, therefore these keywords

are used as the metrics in the further analysis.

3.11.1. Critic Reviews

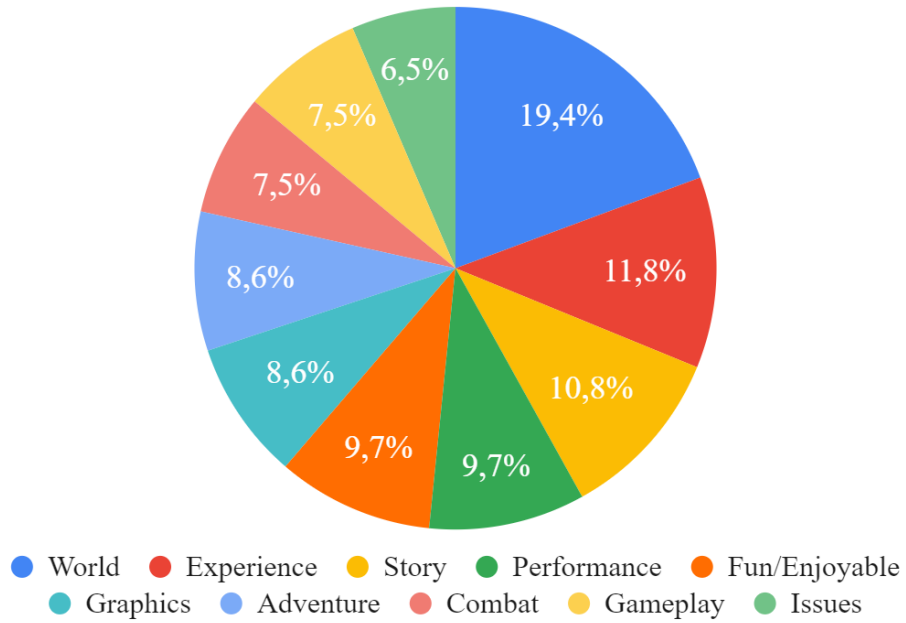


Figure 20. Critic Review Metrics of Horizon Zero Dawn Complete Edition (2020)

The metrics and their frequency of usage are shown in detail in Table 29, and a visual representation of these metrics can be seen in Fig. 20. The chart shows the distribution of the metrics and lays out the patterns among critics.

Table 29. Critic Review Metrics of Horizon Zero Dawn Complete Edition (2020)

Metrics	Frequency
World	18
Experience	11
Story	10
Performance	9
Fun/Enjoyable	9
Graphics	8
Adventure	8
Combat	7

Table 29. Critic Review Metrics of Horizon Zero Dawn Complete Edition (2020)
(Continued)

Gameplay	7
Issues	6

By eliminating and selecting metrics for the study, out of 54 critic reviews, (Horizon Zero Dawn: Complete Edition critic reviews, n.d.), the metrics for Horizon Zero Dawn Complete Edition (2020) are “World” 19,4%, “Experience” 11,8%, and “Story” 10,8%. The other metrics distribution can be seen in Fig. 20, and frequencies can be found in Table 29.

3.11.2. User Reviews

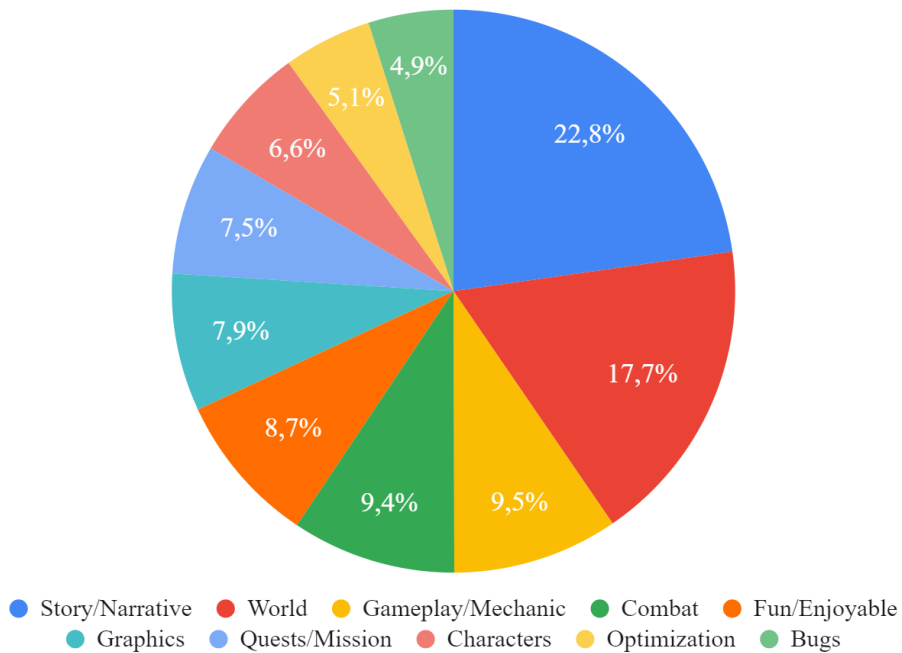


Figure 21. User Review Metrics of Horizon Zero Dawn Complete Edition (2020)

Table 28 shows the wide range of keywords found in critic and user reviews of Horizon Zero Dawn Complete Edition (2020). Only ten metrics were utilized in the study, though, after the ones linked to game design were chosen and the similar ones were combined. Table 30 provides a detailed breakdown of these metrics, and Fig. 21 displays the visual distribution of these data.

Table 30. User Review Metrics of Horizon Zero Dawn Complete Edition (2020)

Metrics	Frequency
Story/Narrative	256
World	199
Gameplay/Mechanic	107
Combat	106
Fun/Enjoyable	98
Graphics	89
Quests/Mission	84
Characters	74
Optimization	57
Bugs	55

Additionally, between 406 eligible user reviews (Horizon Zero Dawn: Complete Edition user reviews, n.d.), the chosen user metrics are “Story/Narrative” 22,8%, “World” 17,7%, and “Gameplay/Mechanic” 9,5%. By looking at the distribution of metrics, it can be said that the players of Horizon Zero Dawn Complete Edition (2020) mainly focus on the “Story/Narrative” aspect of the game.

3.12. Elden Ring (2022)

Elden Ring (2022) is an action role-playing game developed by FromSoftware and published by Bandai Namco Entertainment. The fantasy novelist George R.R. Martin and game designer Hidetaka Miyazaki worked together to create the broad and gloomy fantasy world that serves as the setting of the game. The enormous, networked Lands Between, which is home to complex lore, varied landscapes, and fearsome foes, is explored by players.

The game tells a sophisticated tale of ambition, power, and disaster. Players are encouraged to piece together the world's past through ambient narrative, dialogue, and item descriptions that explain the lore, which was developed with George R.R. Martin's participation. Elden Ring (2022) features gameplay that expands upon the trademark mechanics of FromSoftware by fusing difficult combat, extensive character customization, and strategic exploration. Gamers can customize their playstyle to suit

their tastes by selecting from a variety of classes and skill levels. In order to defeat challenging opponents, players must become proficient with their weapons and spells in the combat system, which places a strong emphasis on timing and tactical skill application. The open-world layout of the title, which permits non-linear exploration, is a key feature. In addition to exploring secret locations and riding horses, players can have lively interactions with NPCs and dangerous animals. A day-night cycle and fluctuating weather are further features that give the game's world more depth.

Since its release in 2022, "Elden Ring" has been noted for its expansive world, intricate design, and the challenging yet rewarding nature of its gameplay. The game continues FromSoftware's tradition of creating immersive and demanding experiences, appealing to players who appreciate the depth and difficulty of their gaming adventures.

Table 31. All Critics and User Reviews of Elden Ring (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	World	1357	World	36	17	RPG	89
2	Story/ Narrative	495	Combat	11	18	Atmosphere	62
3	Bugs/Issues	477	Experience	11	19	Characters	61
4	Fun/Enjoyable	453	Design	10	20	Adventure	53
5	Combat	397	Explore/ Exploration	11	21	Progress	41
6	Gameplay/ Mechanic	392	Level	7	22	Community	40
7	Performance	371	Gameplay	6	23	Progression	38
8	Graphics	338	RPG	5	24	Immersive/ Immersion	37
9	Explore/ Exploration	329	Issues	5	25	Elements	32

Table 31 (Continued). All Critics and User Reviews of Elden Ring (PC)

10	Design	301	Performance	4	26	Animation	29
11	Experience	301	Adventure	4	27	Generation	21
12	Level	210	Elements	3	28	Inventory	15
13	Quest(s)/ Mission(s)	177	Progression	3	29	Physics	12
14	Content	145			30	Puzzle	4
15	Optimization	123			31	Sandbox	3
16	Variety	93					

For Elden Ring (2022), all the critic and user reviews repeating words, which are considered keywords, can be seen in Table 31. Most repeating ten keywords are analyzed further and considered metrics in the next step of the research.

3.12.1. Critic Reviews

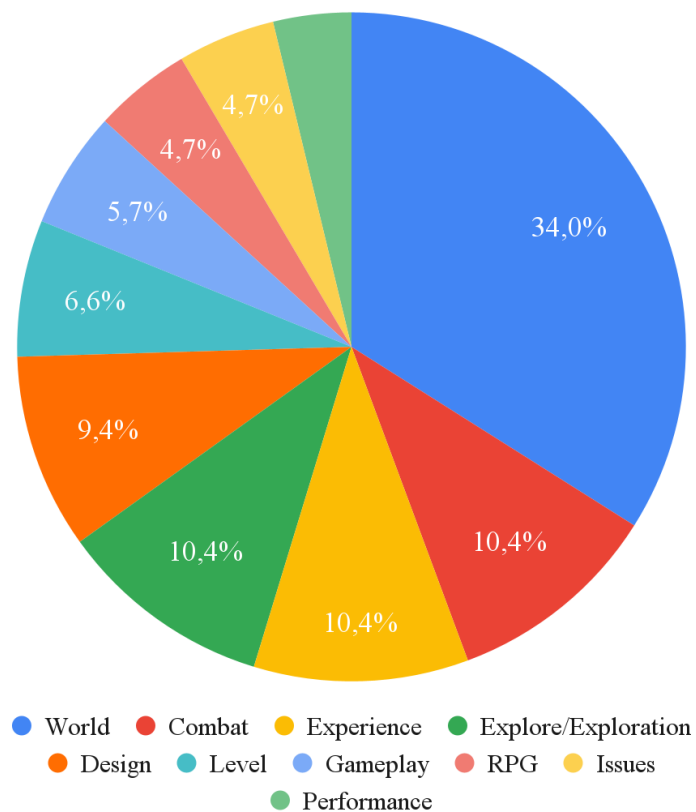


Figure 22. Critics Review Metrics of Elden Ring (2022)

The reviews of Elden Ring (2022) by critics contained a great deal of keywords, as Table 31 shows. In the end, though, the study only included four metrics—the ones associated with game design having been chosen and the similar ones combined. Table 32 provides a detailed list of these metrics, and Fig. 22 shows the visual distribution of these metrics.

Table 32. Critic Review Metrics of Elden Ring (2022)

Metrics	Frequency
World	36
Combat	11
Experience	11
Explore/Exploration	11
Design	10
Level	7
Gameplay	6
RPG	5
Issues	5
Performance	4

The most repeating keywords of critic reviews can be seen in Table 32 with the frequencies. Out of 63 reviews (Elden Ring critic reviews, n.d.), the metrics are “World” at 34%, and “Combat”, “Experience” and “Explore/Exploration” share the second position with each one at 10,4% in Fig. 22.

3.12.2. User Reviews

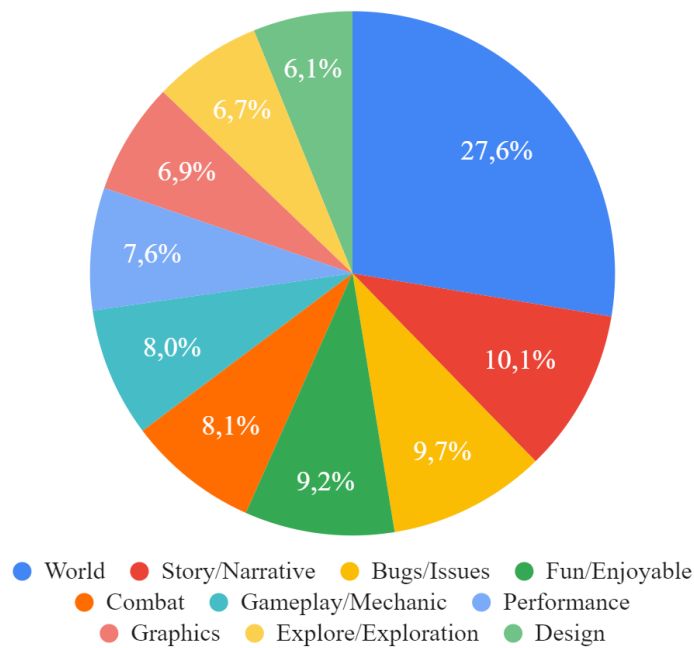


Figure 23. User Review Metrics of Elden Ring (2022)

As can be seen in Table 31, there are many keywords in the user reviews of Elden Ring (2022). A detailed list of these metrics with frequencies can be seen in Table 33 and the visual distribution is presented in Fig. 23.

Table 33. User Review Metrics of Elden Ring (2022)

Metrics	Frequency
World	1357
Story/Narrative	495
Bugs/Issues	477
Fun/Enjoyable	453
Combat	397
Gameplay/Mechanic	392
Performance	371
Graphics	338
Explore/Exploration	329
Design	301

While, between 2208 eligible user reviews (Elden Ring user reviews, n.d.), the chosen user metrics are “World” 27,6%, “Story/Narrative” 10,1%, “Bugs/Issues” 9,7%, “Fun/Enjoyable” 9,2%, and “Combat” 8,1%. The following metrics can be seen in Table 33.

3.13. *The Witcher 3: Wild Hunt (2015)*

Developed by CD Projekt Red *The Witcher 3: Wild Hunt* (2015) is an open-world action role-playing game. As a monster hunter traveling through the Continent's war-torn medieval fantasy landscape, players assume the role of Geralt of Rivia. The game has raised the bar for the role-playing game genre with its intricate world-building, nuanced characters, and rich storytelling. In the game, players take on the dangerous Wild Hunt while searching for the adopted daughter of Geralt, Ciri.

The game has a huge open world with a variety of locations, including bustling towns, charming villages, thick forests, and untamed mountains. With a ton of side missions and contracts that offer significant prizes and go further into the world's narrative, exploration is encouraged. The combat system in this game requires players to strategically engage with a variety of foes through the use of swordplay, magic (known as Signs), and alchemy. To increase his battle efficiency, Geralt can make explosives, potions, and other items in addition to using a variety of weapons. Because Geralt's character advancement is variable, players can customize his skills and abilities to fit their preferred style of play. The game's rich narrative is one of its best qualities. The decisions of players have a big influence on the plot and the environment they are in, which can result in a variety of outcomes and gameplay experiences. The primary quests and secondary missions in the game are well written, frequently putting players in ethically difficult circumstances that test their judgment.

Table 34. All Critic and User Reviews of The Witcher 3: Wild Hunt (PC)

	User Reviews		Critic Reviews			User Reviews	
	Keywords	Frequency	Keywords	Frequency		Keywords	Frequency
1	Story/ Narrative	1860	World	14	17	Design	150
2	World	1490	RPG	14	18	Issues	103
3	Quest(s) /Mission(s)	1407	Combat	7	19	Adventure	82
4	Combat	864	Content	5	20	Variety	78
5	RPG	813	Issues	4	21	Inventory	70
6	Characters	775	Quests	4	22	Performance	48
7	Graphics	738	Explore	4	23	Elements	44
8	Gameplay/ Mechanic	615	Story	3	24	Generation	43
9	Fun/Enjoyable	542	Characters	3	25	Optimization	38
10	Level	291	Adventure	3	26	Animation	31
11	Experience	288			27	Progression	26
12	Content	221			28	Physics	20
13	Immersive/ Immersion	187			29	Community	15
14	Explore/ Exploration	178			30	Progress	12
15	Atmosphere	174			31	Sandbox	9
16	Bugs	173			32	Puzzle	4

Table 34 provides the insight on most repeating words for The Witcher 3: Wild Hunt (2015). Out of these words that repeat frequently, first ten for both critic and user reviews are chosen as these are considered the most repeating ones. After choosing these keywords, they are used as metrics in the following steps of the study.

3.13.1. Critic Reviews

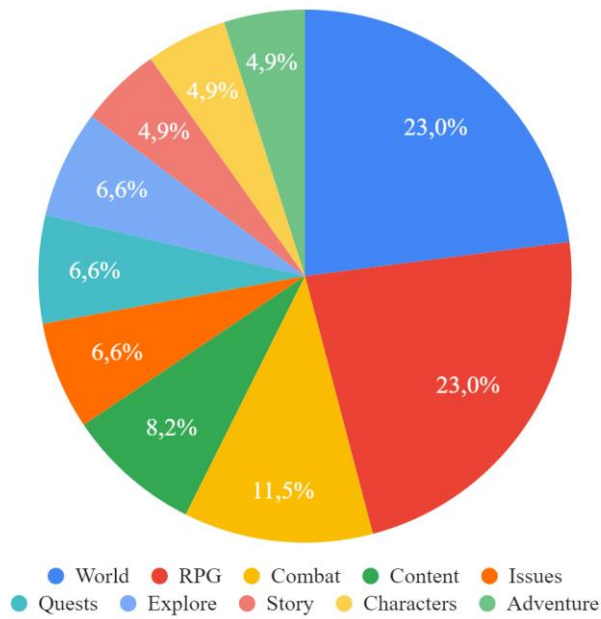


Figure 24. Critics Review Metrics of The Witcher 3: Wild Hunt (2015)

As can be seen in Table 33, there are several keywords in the critic reviews of The Witcher 3: Wild Hunt (2015). Within these keywords, the most repeating ones are chosen and used as metrics. A detailed list of these metrics can be found in Table 35 and the visual distribution is in Fig. 24.

Table 35. Critic Review Metrics of The Witcher 3: Wild Hunt (2015)

Metrics	Frequency
World	14
RPG	14
Combat	7
Content	5
Issues	4
Quests	4
Explore	4
Story	3
Characters	3
Adventure	3

Following the elimination of keywords, the decided metrics for the study are selected. Out of 53 critics opinions (The Witcher 3: Wild Hunt critic reviews, n.d.) the metrics for The Witcher 3: Wild Hunt (2015) are “World” and “RPG” share the same position with 23%, and “Combat” follows them with 11,5%. The rest of the distribution can be seen in Fig. 24, as well as a more detailed list with repeating frequencies in Table 35.

3.13.2. User Reviews

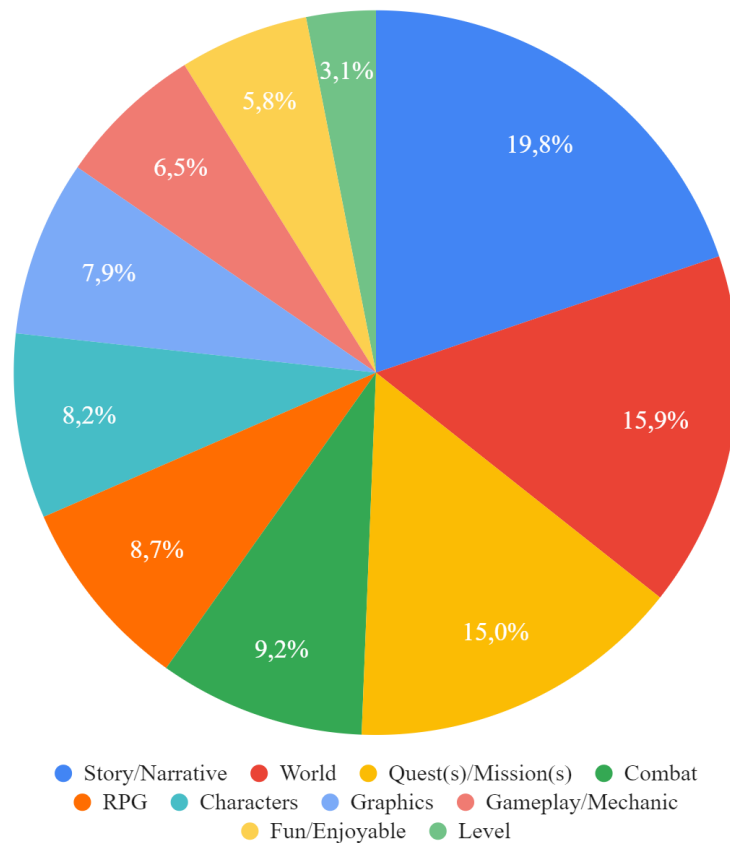


Figure 25. User Review Metrics of The Witcher 3: Wild Hunt (2015)

All the keywords that repeat frequently in the user reviews of The Witcher 3: Wild Hunt (2015) can be seen in Table 33. However, the most repeating ones, which are considered metrics, can be found in Table 36.

As shown in Table 33, all the keywords that repeated in the user reviews of The Witcher 3: Wild Hunt (2015), after choosing the ones related to game design and combining the similar ones (Table 4), the final metrics can be found in Table 35. Also,

the visual distribution of these metrics is presented in Fig. 25 in order to clearly show the trends in the user reviews.

Table 36. User Review Metrics of The Witcher 3: Wild Hunt (2015)

Metrics	Frequency
Story/Narrative	1860
World	1490
Quest(s)/Mission(s)	1407
Combat	864
RPG	813
Characters	775
Graphics	738
Gameplay/Mechanic	615
Fun/Enjoyable	542
Level	291

Additionally, among the 2903 eligible user reviews (The Witcher 3: Wild Hunt user reviews, n.d.), the chosen user metrics are “Story/Narrative” (19.8%), “World” (15,9%), and “Quest(s)/Mission(s)” (15%). The other metrics and frequencies can be seen in Table 36. By looking at the distribution of metrics, it can be said that the players of The Witcher 3: Wild Hunt (2015) mainly focus on the “Story/Narrative” aspect of the game.

3.14. Results

The analysis of reviews by critics and users reveals the differences and similarities between video games that use and do not use procedural content generation. By creating an analytical framework on the subject, it was aimed to see how it impacts the end product, user experience, and efficiency in the design process. After analyzing all the reviews of the chosen games, out of the most repeating keywords, the metrics of the study were selected.

Table 37. Metrics and Frequency in PCG and Non-PCG Games

	PCG Games		Non-PCG Games			PCG Games	
	Keywords	Frequency	Metrics	Frequency		Keywords	Frequency
1	Game	1976	World	3127	18	Experience	166
2	World	1875	Story/ Narrative	3005	19	Space	157
3	Fun/ Enjoyable	1698	Quests/ Missions	1587	20	Update(s)	135
4	Quest(s)/ Mission(s)	1498	Combat	1466	21	Ship	93
5	Graphics	1392	Graphics	1328	22	Multiplayer	88
6	Gameplay/ Mechanics	864	Gameplay	1321	23	Rock	57
7	Bugs/Issues	855	Fun/ Enjoyable	1256	24	Play	66
8	Story/ Narrative	840	Characters	916	25	Developer(s)/Dev(s)	58
9	Combat	658	RPG	813	26	Deep Rock	14
10	RPG	626	Bugs/Issues	550	27	Replayability	14
11	Level	370	Performance	371	28	Atmosphere	12
12	Survival	350	Design	365	29	Base Building	7
13	Exploration	331	Explore/ Exploration	329	30	Repetitive	5
14	Community	313	Level	291			
15	Planet(s)	298	Optimization	70			
16	Sandbox	253	Experience	65			
17	Content	240	Generation	10			

Table 37 provides an overview on the combination of all metrics. However, in order to make a more accurate conclusion, only metrics that are part of the both categories needs to be chosen. Unfortunately, within these metrics, there are still not applicable to both categories, therefore, the ones that are missing in PCG games is not included in the further steps. These metrics are provided in the Table 38.

Table 38. List of metrics that are included in both categories

	Metrics	Frequency	
		PCG Games	Non-PCG Games
1	World	1875	3127
2	Fun/Enjoyable	1698	1256
3	Quests/Missions	1498	1587
4	Graphics	1392	1328
5	Gameplay	864	1321
6	Bugs/Issues	855	550
7	Story/Narrative	840	3005
8	Combat	658	1466
9	RPG	626	813
10	Level	370	291
11	Explore/Exploration	331	329
12	Experience	166	65
13	Characters	0	916
14	Performance	0	371
15	Design	0	365
16	Optimization	0	70
17	Generation	0	10

The visual distributions of Table 38 can be seen in Fig. 26 and Fig. 27. These charts provide a better understanding and easy comparison of two categories which are PCG Games and Non-PCG Games.

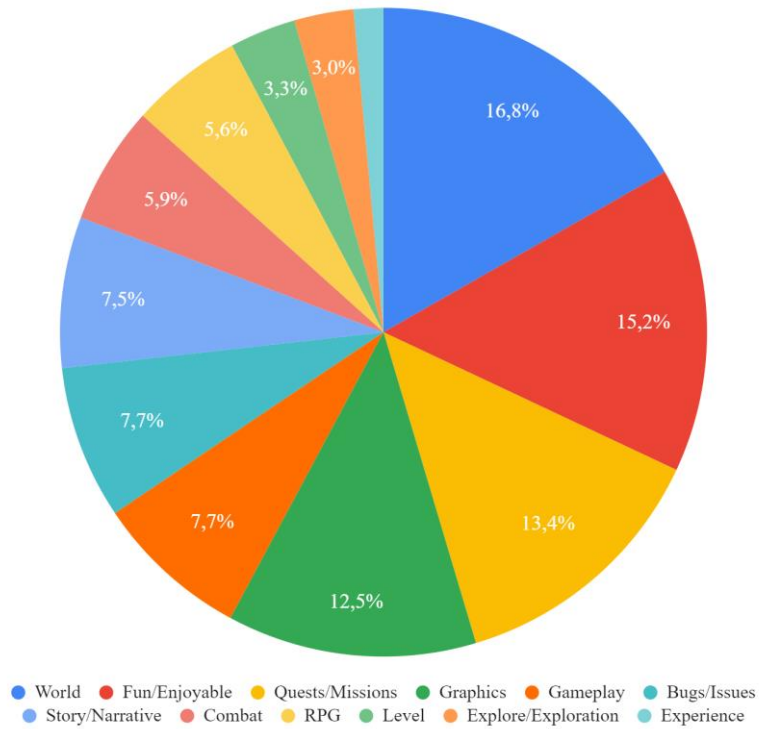


Figure 26. All User Review Metrics of Games that Use PCG

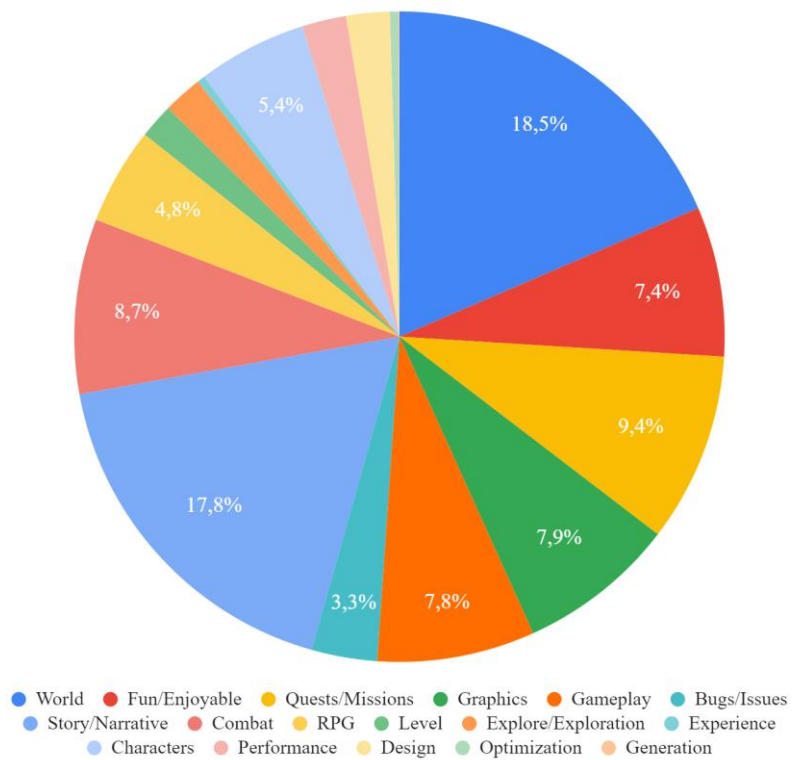


Figure 27. All User Review Metrics of Games that Do Not Use PCG

In the reviews of video games that use procedural content generation, when combined, there were a total of twelve metrics (Table 33, Fig. 26) that were used in the study. On the other hand, out of the reviews of video games that do not use PCG, there were eight metrics (Table 33, Fig. 27) in total.

When all the user reviews of games that use PCG are combined, the total number of repetition of the metrics is seen in Table 33. According to Table 33, Fig. 26 shows the distribution of the said metrics, which are “Fun/Enjoyable” (20.3%), “Graphics” (17,2%), “Bugs/Issues” (12,2%), “Story/Narrative” (12,2%), “Gameplay/Mechanics” (11.8%), “Exploration” (8%), “Experience” (6,1%), “Immersion” (5,8%), “Survival” (4,5%), and “Co-op/Multiplayer” (1,6%) with 5648 being the total number of eligible reviews.

Combining all the user reviews of games that do not use PCG combined, the total number of repetitions of the metrics is seen in Table 33. According to Table 33, Fig. 27 shows the distribution of the metrics mentioned, which are “Story/Narrative” (32,5%), “Graphics” (14,4%), “Gameplay/Mechanics” (14,2%), “Fun/Enjoyable” (13,6%), “Bugs/Issues”(9,2%), “Experience” (7,5%), “Explore/Exploration” (6,1%), and “Immersion” (2,6%) with 6188 being the total number of eligible reviews.

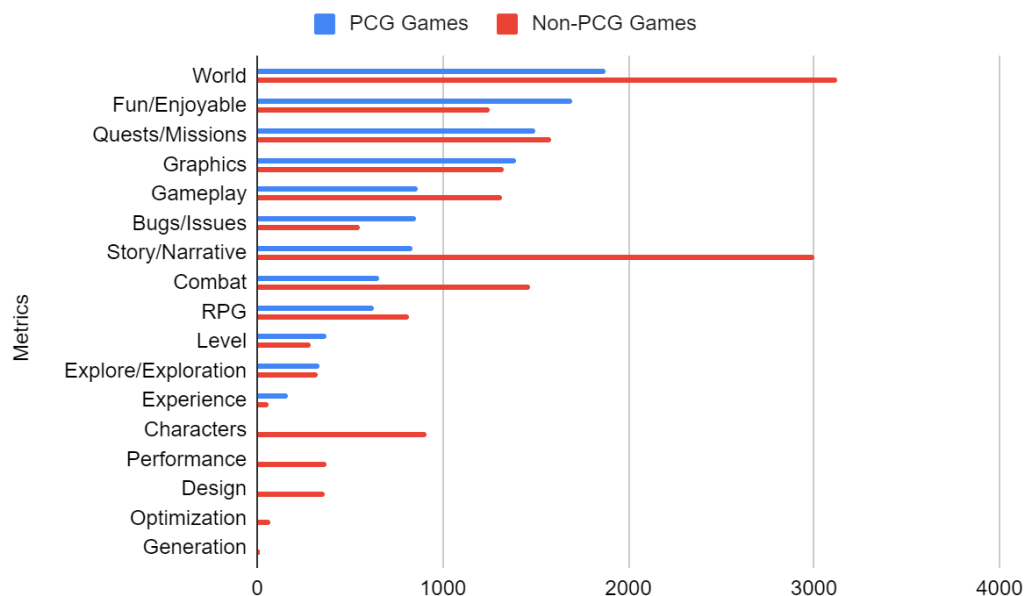


Figure 28. Comparison Chart of Metrics in Between PCG and Non-PCG Games

It can be clearly seen in Fig. 28 that PCG game players/users focus mainly on “World” aspects of these games, as well as Non-PCG game players/users do. However, the second place is not as close to the first one. While PCG game players focus on “Fun/Enjoyability”, Non-PCG players focus on “Story/Narrative” aspects of these games. This deduction does not imply that Non-PCG games are not “Fun/Enjoyable” or PCG games lack “Story/Narrative”, but they have their own strengths in these respective aspects. However, in the games inspected during the study, it is seen that users of PCG games did not mention “Characters”, “Performance”, “Design”, “Optimization”, and “Generation” metrics. Due to the fact that these metrics are not mentioned, it is possible to say the inspected games lack these aspects.

As it can be seen clearly in Fig. 28, out of twelve common metrics, PCG games surpass Non-PCG games. If the other four metrics are included, it can be said that PCG games satisfy most player expectations. However, Non-PCG games exceed in one metric more than any other, “Story/Narrative”. According to the numbers in Table 33, PCG games have a long way to go before they succeed in this aspect.

As a result of the analysis, a sample chart to evaluate these games was created. With the help of this sample chart, any game can be analyzed for its strengths and weaknesses. In the context of this study, this chart was used to see the strengths of video games that use and do not use PCG in order to determine whether PCG is the future of video game development or not. But still, the games chosen from these categories for the study show similar strengths, but the number of reviews for each game shows the differences.

3.15. Sample Evaluation Chart

The sample evaluation chart includes all the video games used in the study and the metrics that were analyzed. This chart is simply a scoring table, which has points of 1, 0, and -1 for each metric. Among these metrics, one of them is negative, which means if it is used, the total score would gain a negative point. In the meantime, if the metric is not used, the total score would not be affected. The metrics are chosen after the elimination and analysis of repeating keywords and finding the common metrics between both PCG and Non-PCG games.

Table 38. A sample chart to evaluate video games

Game Name / Metrics	Uncharted Legacy of Control	Horizon Zero Dawn	Elden Ring	The Witcher 3:	Astroneer	Deep Rock Galactic	No Man's Sky	The Elder Scrolls V: Skyrim	Minecraft
Bugs/Issues	-1	0	-1	-1	0	-1	0	-1	0
Combat	0	1	1	1	1	0	0	1	0
Experience	1	1	0	0	0	0	0	0	1
Explore/ Exploration	0	0	0	1	0	1	1	0	1
Fun/ Enjoyable	1	1	1	1	1	1	0	1	1
Gameplay/ Mechanic	1	1	1	1	1	1	1	1	1
Graphics	1	1	1	1	1	1	0	1	1
Level	0	0	0	0	1	0	0	1	0
Quests/ Missions	0	1	1	0	1	0	0	1	0
RPG	0	0	0	0	1	0	0	1	0
Story/ Narrative	1	1	1	1	1	0	0	1	0
World	1	1	1	1	1	0	0	1	1
Total Points (Out of 11)	5	8	6	6	9	3	3	8	6

As a result, the lowest score is 3/11 and the highest one is 9/11. The lowest score is within games with PCG and the highest score is from the Non-PCG games, while video games that do use PCG have lower scores of 2/11 and 3/11. These scores display that current PCG games have the potential to be both better and worse than Non-PCG games.

The primary objective of this chart is to assess whether players of PCG games experience comparable levels of satisfaction to those who play non-PCG games. By visualizing the scores across these selected metrics, identifying patterns and trends in player feedback is possible. This comparative approach provides an understanding of how PCG elements impact the overall gaming experience, highlighting areas where PCG games excel and where they may fall short compared to their non-PCG counterparts.

These qualitative metrics offer valuable insights into player preferences, ensuring the chart reflects elements players deem important, and serve as a foundation for future research to gain a deeper understanding of player satisfaction in PCG versus non-PCG games by allowing for modifications and expansions. This approach not only highlights the strengths and weaknesses of procedural content but also contributes to the broader discussion on its role in enhancing player satisfaction.

3.16. Future Work

This study only focused on ten video games and twelve metrics in total. In future studies, more video games could be analyzed, and different metrics could be achieved and used in a similar chart as Table 37. Also, the subject may be different than procedural content generation; however, the chart in Table 34 is designed to be edited and reconstructed for the needs of the study. In addition, a study that focuses purely on what critics say and what users say about a video game could be helpful for the literature. Also, according to the study, the sample chart (Table 37) could have more complicated point systems. For instance, one of the negative metrics could have a higher penalty or one of the positive ones could be more rewarding.

CHAPTER 4: CONCLUSION

This study aimed to measure overall player satisfaction and identify key player preferences with games that feature procedural content generation (PCG) compared to those without. It also examined how these preferences and experiences change with the inclusion of PCG elements under core game conditions, such as world generation and quest generation.

The findings of this research align with existing literature that emphasizes the evolving role of PCG in enhancing game design and player engagement. Previous studies have highlighted the potential of PCG to create diverse and unpredictable game environments, thus increasing replayability and player satisfaction (Shaker et al., 2016; Smith et al., 2010). However, this study expands on the literature by providing a detailed comparison of player preferences for PCG versus non-PCG games, and by identifying specific metrics that contribute to these preferences. This nuanced understanding is crucial for developers aiming to balance automated content generation with handcrafted game elements.

The analysis revealed that players focused on twelve shared metrics and five specific to Non-PCG games. Conceptually, of these twelve metrics, eleven are positive and one is negative. However, these positive and negative values are determined depending on the meanings of the metric itself. These metrics are represented in a sample chart (Table 37), where positive metrics add to the total score and negative metrics subtract from it. Metrics that score zero have no impact on the total game score. Also, the sample chart that shows point values for the games, aims to be a starting point for further research. If more enhancements and tweaking are done in both the Keyword Analyzer Tool and Sample Evaluation Chart, it is possible to generate accurate quantitative outputs. The main goal of the Sample Evaluation Chart was to present qualitative data with the comparison of PCG and Non-PCG games. It aimed to show the similarities and differences of both categories with the selected games.

These qualitative metrics are included because they provide insightful information on player preferences and perceptions. The chart ensures that the data represents the elements of the games that players think are most important by concentrating on the

most common words from user reviews. This analytic approach highlights the advantages and disadvantages of procedural material in games as well as adds to the larger conversation about the usefulness and allure of procedural content in raising player pleasure.

Moreover, this chart is meant to function as a starting point for additional investigation. A more comprehensive understanding of player happiness in PCG versus non-PCG games could be obtained by future research by adjusting the measurements or broadening the dataset to include additional games or different genres. The design flexibility of the chart facilitates adjustments and improvements, promoting continued investigation and a more profound understanding of the dynamic interplay between procedural content creation and player experience.

The study sought to highlight player priorities in video games by analyzing user reviews of video games with and without PCG. When compared, these categories by analyzing frequent words in the reviews are defined as "keywords" and the most repeating ones are further refined to "metrics". The unique strengths of each game were cataloged through these metrics, encompassing both user and critic reviews. Critic reviews, regarded as expert opinions, were analyzed with the same methodology as user reviews to ensure comprehensive results.

While the methodology provided valuable insights, it also had limitations, including potential biases in reviews and the subjective nature of player feedback. Future research could benefit from a more diverse data set, incorporating quantitative data from in-game metrics to enhance qualitative review analysis. Further studies should explore the impact of different PCG algorithms on player satisfaction to determine the most effective approaches. Additionally, examining long-term effects on player retention and engagement over extended periods would provide deeper insights.

In conclusion, this work underscores the significance of procedural content generation in modern game design and its potential to enhance player experiences. The findings contribute to a deeper understanding of player preferences and offer practical guidance to game developers on utilizing PCG effectively. By leveraging these insights,

developers can design games that maximize the advantages of procedurally generated content while addressing current PCG challenges.

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