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Research Article

Procedural design in digital games: Space and environment interaction in No Man's Sky

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Abstract
This study analyzes the effects of procedural design on the space and environment in No Man's Sky. The research includes 300,000 comments from Steam gaming platform users between 2016 and 2024. Player comments were analyzed using the following categories to understand players' experiences of space and environmental interaction: "creativity and possibilities," "environment and space design," "environmental interaction and dynamism," "exploration and diversity," "game mechanics," "procedural generation," and "repetition and predictability." Word frequency, thematic analysis, and sentiment analysis were used to assess players' perceptions of procedural design. The findings suggest that despite the procedural design's freedom of exploration and visual variety, players generally perceive the experience with neutral emotions. Repetitive designs and limitations were found to reduce player satisfaction. The impact of innovative content was limited. This study highlights the potential of procedural design to create aesthetics, functionality, and individualized experiences in game design. The procedural design should be optimized in future studies to create stronger emotional effects, and the design processes should be restructured based on insights from player comments.

Keywords: Procedural design, Game design, Environment design, Third-person game, No Man's Sky

Extended Abstract

Introduction: Procedural design expands the boundaries of digital game worlds by offering players unique and personal experiences in randomly generated, dynamic, and variable environments. This design method, which enables the creation of digital worlds through algorithmic processes, is widely used in various disciplines, such as game design, architecture, and environmental design. Advancements in digital technologies have enabled more effective procedural design increasing the aesthetic and functional diversity of game worlds. The No Man's Sky game stands out as a strong example of procedural design, featuring planets that provide unlimited freedom of exploration, different biomes, locations, environmental interactions, and survival mechanics. Procedural content generation techniques have been used to create millions of unique planets and star systems in the game's design. This situation has provided a platform for players to create their own stories, but it has also led to criticisms of repetitive structures and a lack of consistency. Current studies address the technical aspects of procedural design, but there is a notable lack of research aimed at understanding how players perceive and experience this design approach. Using direct user feedback, such as player comments, to gain insights into the perception and effects of procedural design could fill a significant gap in this field. Understanding how players experience the dynamic structure of game worlds and how procedural design shapes individual gaming experiences will offer new perspectives on the game design process. This study examines the effects of procedural design on digital spaces and player experience using No Man's Sky as an example.

Purpose and scope: This study aims to analyze the effects of procedural design on digital spaces and environmental interactions in the No Man's Sky game. Procedural design aims to offer players unique and personalized experiences in randomly generated worlds and understanding how players perceive this approach is crucial for improving game design processes. The comments will be used to understand aspects of player experiences such as aesthetics, environmental harmony, and creativity, in the context of digital spaces. The research excludes user feedback from other platforms because it is solely based on player comments on the Steam platform. This situation may limit the generalizability of the

results. Additionally, the subjective nature of player comments may make it difficult for the analysis results to represent the entire player base. The 2016–2024 time frame used in the study may exclude experiences from the game's first release period. Although the effects of major updates on player perception will be examined, the lack of sufficient data for some updates may limit this analysis. Finally, it may not be possible to fully measure the impact of the playtimes mentioned in the comments on the player experience. This study provides a comprehensive perspective on the impact of procedural design on player experience and contributes to the development of novel approaches to game design processes despite these limitations.

Method: In total, over 300,000 user comments from this dataset were analyzed to examine the effects of procedural design on spatial and environmental interactions in the No Man's Sky game. Data were obtained from a dataset published by Silas Rickards on the Kaggle platform under the CC0: Public Domain license. During the analysis process, the Python programming language was used; the Pandas and NumPy libraries were preferred for data cleaning and editing operations. For ease of analysis, the data were categorized into thematic categories using natural language processing (NLP) tools, such as NLTK and spaCy. The comments were classified as positive, negative, or neutral for sentiment analysis using the VADER and TextBlob tools. The Google Colab environment has enabled easy code sharing and reproducibility of the analysis process. These methods have enabled meaningful information extraction from large datasets and an in-depth understanding of players' experiences. The method's systematic and repeatable nature has enhanced the scientific value of the research and made it reproducible by other researchers.

Findings and conclusion: Players generally perceive the procedural design effects in No Man's Sky positively, but these effects are mostly limited to a neutral level. Players recognize the creativity of procedural design, spatial design, and exploration mechanics, but they express that they do not create a strong emotional connection with these elements. Especially the keywords "space" and "environment" indicate that players are aware of their perception of space and environment, but this perception generally remains at a neutral level. Despite satisfaction with the exploration mechanics, the elements of diversity and uniqueness, such as "diversity" and "uniqueness," have been insufficient. Repetitive content and limitations are among the most frequently voiced criticisms by players, indicating that the procedural design did not meet the expectations of the players. Research findings indicate that major game updates have a limited impact on players' perceptions of space and environment. Although players notice the innovations, they do not significantly contribute to the overall gaming experience. Analyses of playtime have shown that long-term players are more disturbed by repetitive content, whereas short-term players focus more on aesthetic and exploration elements. These findings suggest that developing procedural design can have a more significant impact on players. Enhancing elements of visual storytelling, uniqueness, and diversity is recommended to ensure that players establish a stronger connection with the spaces. In addition, major updates should include innovations that contribute to the story and spatial interactions, rather than being limited to technical improvements. Some suggestions are being offered for game designers. Reducing repetitive content in design processes, offering players more unique and dynamic spaces, and creating personalized experiences are critical. Adopting design approaches suitable for the player profile can optimize content for different play durations and experiences. Additionally, enriching game worlds in terms of both visual aesthetics and depth of meaning can help players have a more satisfying experience. Future studies should provide a broader perspective by comparing the effects of procedural design across different player profiles and game genres. These findings can guide game designers in enhancing their creative processes, contributing to the more effective and meaningful use of procedural design.

Keywords: Procedural design, Game design, Environment design, Third-person game, No Man's Sky

INTRODUCTION

The world of digital games is evolving to provide players with ever-wider, more diverse, and more personalized experiences. In this context, procedural design has become one of the cornerstones of innovation in this field by enabling dynamic and randomized construction of game worlds. With the potential to create an unlimited universe, procedural design expands players' freedom of exploration and offers a game world based on individual experiences. No Man's Sky places this technology at the center of game design, creating digital spaces and environmental interaction through personal experiences. As a game in which an unlimited number of planets are randomly generated and players experience the mechanics of exploration, construction, and survival, No Man's Sky demonstrates the contributions of procedural design to the game world. Each planet's unique structure, aesthetics, and resource dynamics constantly reshape players' perception of space. However, the freedom and diversity offered by this design approach have also been criticized for its repetitive structures and lack of predictability and consistency. This tension between the freedoms offered by procedural design

and the criticisms regarding repetition and unpredictability necessitates a more comprehensive consideration of its effects on digital spaces.

This study aims to analyze the effects of procedural design on the interaction between digital spaces and the environment, using No Man's Sky as a case study. This study aims to analyze the effects of procedural design on the interaction between digital spaces and the environment, using No Man's Sky as an example. In this context, the main goal of the study is to reveal the effects of procedural design on player experience and to offer new perspectives on the design of digital game spaces. Understanding the potential of procedural techniques in digital game design will not only improve the aesthetics and functionality of game worlds but also guide designers in creating individualized and authentic gaming experiences. In this context, the main goal of the study is to reveal the effects of procedural design on player experience and to offer new perspectives on the design of digital game spaces. Understanding the potential of procedural techniques in digital game design will not only improve the aesthetics and functionality of game worlds but also guide designers in creating individualized and authentic gaming experiences.

Background

This literature examines the role of procedural design in the context of digital space and environment design. The effectiveness of procedural design in the creation of dynamically changing and diverse digital spaces is specifically addressed in the context of game design. The literature has extensively explored the effects of this design approach on space and environment interactions and player experiences in digital worlds. It has also examined how procedural techniques are used to design elements such as planetary surfaces, biome diversity, resource distribution and environmental features, and how these processes contribute to players' experiences of exploring and making sense of the game world. Advances in digital technologies are reshaping the processes of design and content production, with procedural design techniques becoming increasingly important in fields such as game design and architecture. Procedural design enables the production of diverse and customizable content using algorithmic approaches. Schwarz and Wonka (2014: 1-16) showed that this technique can be used to generate automated design solutions considering complex constraints such as building facade lighting. Lienhard et al. (2017: 39-48) propose rule-based transformations to create new designs by combining elements of existing designs. While these studies demonstrate the versatile applications and potential of procedural design, they also point to user adoption challenges and articulating design problems (Craveirinha & Roque, 2015a). In the field of architecture and environmental design, procedural design enables the transformation of static spaces into dynamic, adaptive spaces. Anderson et al. (2018: 164-177) reported that using procedural algorithms in areas such as office planning can achieve close alignment with human engineering, efficiency, and standards compliance. Similarly, the autoencoder networks presented by Yümür et al. (2015: 111) allow for more intuitive exploration of complex modeling domains.

Procedural content generation (PCG) offers significant opportunities and challenges for both designers and players in the game design process. Notable for its capacity to accelerate development and prototyping processes, PCG is a particularly effective tool for creating large and dynamic game worlds (Galdieri et al., 2021: 47). However, users' general preference for hand-designed levels points to procedural content generation's shortcomings in user-centered design. However, procedural levels have also been found to have no apparent negative impact on users' ability to navigate the game world (Galdieri et al., 2021: 50). Designing user-friendly interfaces is crucial for effective use of PCG tools. Interfaces should have the capacity to guide users through complex options in a way that facilitates the design process (Barret et al., 2011). This makes procedural design processes more accessible for both professional and amateur users. Furthermore, an author-driven procedural content production approach places designer control at the center of the creative process, enabling designers to produce content that supports the player experience (Craveirinha & Roque, 2015b).

Experience Driven Procedural Content Generation aims to create content based on player behavior by combining user modeling with content adjustments (Yannakakis & Togelius, 2015). This approach offers a viable solution not only in game design, but also in other fields such as interface development and software design. The customization possibilities of procedural content generation techniques enable more effective guidance of creative processes in game design. PCG in game design offers both opportunities and challenges, as in the case of No Man's Sky. While PCG has the potential to reduce development costs and create expansive

game worlds (Cardona-Rivera, 2017), it also risks producing content that players find boring and repetitive (Tait & Nelson, 2021). This problem is particularly pronounced in games that increase the importance of exploration and novelty in the player experience. In this context, there are suggestions in the literature to improve PCG in a way that is compatible with players' perceptions of uniqueness (Cardona-Rivera, 2017). This requires not only a technical optimization process, but also an understanding of players' mental models and perception structures. The gap between academia and the gaming industry can be bridged by respecting designer control of procedural design processes, creative processes, and existing workflows (Gorm Lai et al., 2020). Designers' creative decisions can be implemented without being constrained by the procedural system itself. The success of procedural generation in games, such as No Man's Sky, largely depends on players perceiving a "designer's touch" in the algorithmically generated worlds. Approaches that enhance designers' control over procedural tools can make game worlds deeper and more meaningful, both technically and aesthetically.

Procedural design expands players' freedom of exploration with the potential to create an unlimited universe, offering a perception of the game world based on individual experiences. No Man's Sky's generative design shapes the aesthetics of human-machine interaction and constructs the game experience based on the relationship between designer, system and player (Carpenter, 2022: 180). This allows narratives discovered by the player to emerge rather than being predetermined. Thus, games become not only tools that deliver creative content, but also platforms that trigger players' creativity and imagination. Carpenter (2022: 178) argues that this approach reshapes notions of intentionality and creativity in digital contexts. In particular, such situations, where players can create their own stories, emphasize the dynamic nature of games. Future PCG developments should aim to ensure the alignment between the producer's conception of meaning and the player's cognitive experience (Cardona-Rivera, 2017). This requires not only the development of procedural algorithms, but also creating designs that support players' sense-making processes and make them active in the interaction. Diversifying game worlds, both aesthetically and functionally, can increase players' motivation for exploration. This approach is not limited to technical innovations but also emphasizes the adoption of a human-centered perspective in game design.

In game design, procedural design plays a critical role in diversifying the content creation process and individualizing the player experience. Smith and Mateas (2011) proposed answer set programming, which allows the specification of design spaces in procedural content generation. This approach allows game worlds to be both aesthetically and functionally customizable. No Man's Sky is a striking example of how procedural design can be effective in shaping game worlds. The game's design presents a galaxy of millions of star systems and planets, each with unique biomes and resources. Reinhard (2021) examined No Man's Sky as a model for digital archaeology in recording and preserving player-generated content. Flick et al. (2017) developed a code of ethics by treating the game as an archaeological site. Carpenter (2022: 187) considered the design of the game in terms of human-machine interaction, an approach that positions players not only as elements within the game but also as external actors. The ecological design of the game emphasizes biodiversity and natural resource dynamics, while diversifying players' interactions with the environment. Santos et al. (2023) observed that the scientific content of the game increased players' motivation and scientific understanding of chemistry. Biomes in the game provide a dynamic gameplay experience by forcing players to adopt different strategies and types of interactions. No Man's Sky presents a game world that invites players to create both individual and collective stories. Procedural production techniques shape the spaces within the game, testing the unpredictable nature of its design and the limits of creativity. These approaches offer new perspectives on digital game design, both theoretical and practical.

While the existing literature has extensively focused on the technical aspects of procedural design and its effects on shaping game worlds, there is a distinct lack of studies that directly understand the player experience. In particular, there is a need to learn about the perception and effects of procedural design by utilizing direct user feedback such as player comments. Understanding how the dynamic nature of game worlds is experienced by players and how procedural design shapes individual game experiences can make a significant contribution to this field. In this context, analyses based on game reviews provide an important resource for assessing the effects of procedural design on players and lay the groundwork for the development of more user-centered approaches to design processes.

Theoretical Framework

This study evaluates No Man's Sky players' perceptions of procedural design in line with three fundamental approaches highlighted in game theory literature: Jesper Juul's (2005) "semi- -real" game theory, Ian Bogost's (2007) conceptualization of "procedural rhetoric," and Salen & Zimmerman's (2004) "meaningful play" theory, along with Hunicke, LeBlanc, and Zubek's (2004) Mechanics–Dynamics–Aesthetics (MDA) model. These three approaches explain how players perceive in-game systems, under what conditions a game offers a meaningful experience, and in which situations procedural diversity results in emotional satisfaction.

According to Juul's (2005: 163) conceptualization of "semi-reality," digital games are systems that operate according to precise rules and fictional worlds that come to life in the player's imagination. In the fictional system-derived universe, the player interacts with an algorithm-guided mechanical system while also seeking meaning. Although No Man's Sky generates over 18 quintillion planets through procedural generation algorithms, the lack of environmental narrative and coherence in these planets caused players to quickly become emotionally detached from the exploration experience in the game. Players' frequent reports of "neutral" feelings (such as comments like "I was excited at first, but then all the planets started to feel the same") corroborate Juul's claim that a narrative context does not support nonfictional rules, which become ineffective.

Bogost's (2007) procedural rhetoric theory argues that game systems are not solely for entertainment; they can also convey specific ideologies, thoughts, or emotional states through rules and processes. In No Man's Sky, the developers attached the meaning to procedural universe creation to elevate the theme of infinite exploration and freedom. However, the frequently recurring complaints of a "feeling of emptiness" and 'aimlessness' in player reviews correspond to Bogost's "simulation void" phenomenon. As players spend time on algorithmically unique but perceptually similar planets, they begin to question the rhetoric of discovery expressed by this procedural universe. Despite the different appearances of the structures, creatures, or biomes they encounter early in the game, many players note that the game dynamics remain constant, diminishing the excitement. This reveals a disconnect between the narrative the procedures aim to convey and the players' experience of the meaning.

The "meaningful play" and MDA model developed by Salen and Zimmerman (2004) and Hunicke et al. (2004) emphasize that the mechanical structures of the game must produce perceptible and contextual outcomes to create an emotional (aesthetic) impact on the player. Although numerous content types (e.g., resource gathering, building structures, trading, and exploration) are technically integrated into the No Man's Sky example, the aesthetic (emotional) satisfaction of players remains limited because a consistent narrative or feedback system does not support many of these mechanics. A large portion of players stated that, for example, discovering a planet's atmosphere or finding a rare creature has no lasting impact on the game world. This situation reveals the lack of mechanical-dynamic-aesthetic integrity, as emphasized by the MDA model.

These three theoretical approaches provide a multidimensional explanation for why procedural generation fails to translate into a meaningful gaming experience in No Man's Sky. When the content generated by the rules lacks a clear structure that the player can perceive and integrate into the context, even if they are technically powerful, procedural systems remain weak in terms of meaning production. In this context, it is crucial not only to increase content diversity in game design but also to theoretically ground how this diversity will interact with the player experience.

Space-Environment Relationship in No Man's Sky

No Man's Sky is a sci-fi-themed survival and exploration game developed and published by Hello Games. Originally released in 2016, the game allows players to explore, survive, and create their own stories in a vast galaxy containing millions of planets. The core mechanics of the game include gathering resources, building bases, trading, and interacting with various aliens (Hello Games, n.d.). The procedural design used to create spaces in No Man's Sky forms the basic structure of the game and offers diversity and exploration in a limitless universe. Procedural design algorithms randomly generate structures such as abandoned locations, historical ruins, space stations, and bases. These spaces allow players to engage in meaningful interactions in the game world (Figure 1).

Figure 1. In-game space screenshots

Abandoned locations often contain clues to the game's story and rare resources, while historical ruins offer players insight into the galaxy's past. Space stations perform many functions, such as trading, upgrading ships, and undertaking new missions (Figure 2). Players also have the opportunity to build their bases and establish a permanent place in the game world. These bases can be used for various purposes, such as resource production, defense and aesthetic design. The customizable nature of the bases contributes to the process of players expressing their personal creativity and integrating with the game world (Hello Games, n.d.).

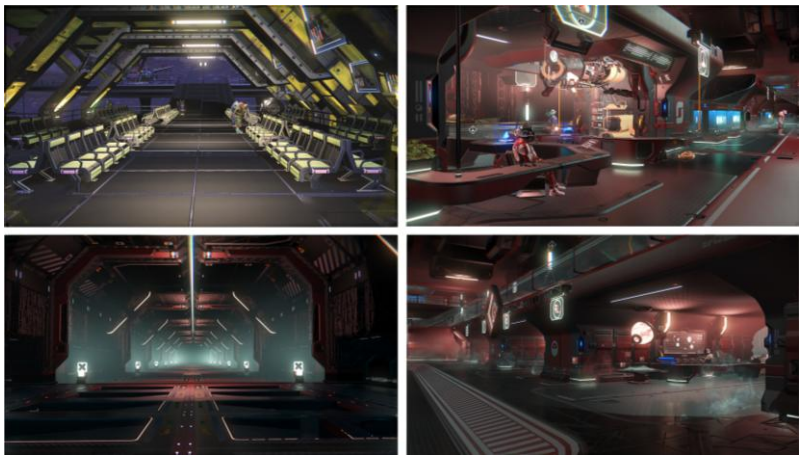

Figure 2. In-game space station interior images

Frothing-type planets are rare and visually striking in the *universe of No Man's Sky.* Owing to the intense acidic components of its atmosphere, this planet has a unique chemical structure. The round, transparent, and dynamic bubbles often seen on the surface reflect the acidic nature of the atmosphere, and their constant formation and disappearance give the planet both a lively atmosphere and visual appeal. Frothing's surface is generally eroded and mineral-rich, but vegetation is very limited. The planet's flora and fauna are limited to a few species that have adapted to harsh environmental conditions, challenging players' survival strategies. The climate is fraught with challenges, such as intense acid rain and low visibility, which necessitate careful planning for explorations (Figure 3).

Figure 3. Visual example of environmental design of the Frothing type of planets

A striking similarity exists between the round bubbles observed on the planet Frothing and the structures that players can explore in terms of space and environmental harmony. Large rings or other geometric structures

on the planet's surface create a harmonious aesthetic with the rounded contours of the bubbles. This similarity not only creates visual harmony but also demonstrates how design in the game world is integrated with procedural algorithms. The rounded forms used in the design of the spaces seem to reflect the natural elements of the planet, allowing players to experience the relationship between the environment and the spatial design more deeply (Figure 4). The constant movement of the round bubbles emphasizes the dynamic nature of the planet, while the fixed and rounded structures create an element of balance in the planet's design. These design elements enhance players' sense of exploration while preserving the naturalness of the environment. This harmony on the Frothing Planet provides an important example of how the procedural design of No Man's Sky can combine both aesthetic and functional balance. Players can experience an exploration that connects the planet's natural and artificial elements through these unique environmental and spatial elements.

Figure 4. Bubbles and circular space design on the planet Frothing

The procedural design in No Man's Sky shapes not only the geographical structure of planets but also the spatial organization and typology of buildings (Figure 5). The different architectural forms in the game, as seen in the image, demonstrate the modular design elements that can adapt based on technological level, planetary atmosphere, and the player's progress. This design philosophy enables players to distinguish between spaces during exploration while also emphasizing the variety provided by procedural generation. Each structure serves a distinct purpose; some are designed for trade and social interaction, while others are linked to survival and defense mechanics. This differentiation highlights that procedural design is not merely about random generation but rather a fundamental element that shapes players' spatial and environmental experiences.

Figure 5. Transforming Spaces through Procedural Design. Procedurally generated modular buildings in No Man's Sky showing variations in form, color, and material that create architectural diversity across planets.

Environmental design is one of the most striking features of No Man's Sky. Animal diversity, vegetation, climate, and material wealth play a significant role in the game's procedurally generated planets. Each planet contains different animal and plant species. Animals are rich in biodiversity and exhibit different behavioral patterns. Some animals are friendly, whereas others are aggressive. This diversity shapes players' interactions and strategies in the game world. On the other hand, vegetation not only defines the visual identity of planets but also has functional aspects, such as agriculture and resource gathering. Some planets may be adorned with giant mushrooms or exotic flowers, while others may be barren and devoid of vegetation.

The environment of the planet Jioka 14/G4 stands out as an area where organic and structural elements combine to form a diverse ecosystem. The perforated and organic forms on the surface appear to have emerged as a result of a biological process and are integrated with the natural environment (Figure 6). The floating purple and pink formations offer a unique visual and environmental experience. This environmental design allows players to explore the dynamics of the planet, while the organic details of the surface forms and the mobility of the floating structures provide both visual harmony and the opportunity to reflect on the ecosystem. The question of whether these structures were created by a natural process or a deliberate ecological order increases players' sense of wonder as they explore the planet. This diversity in the ecosystem deepens the discovery process and reveals the visual and functional integrity between environment and space.

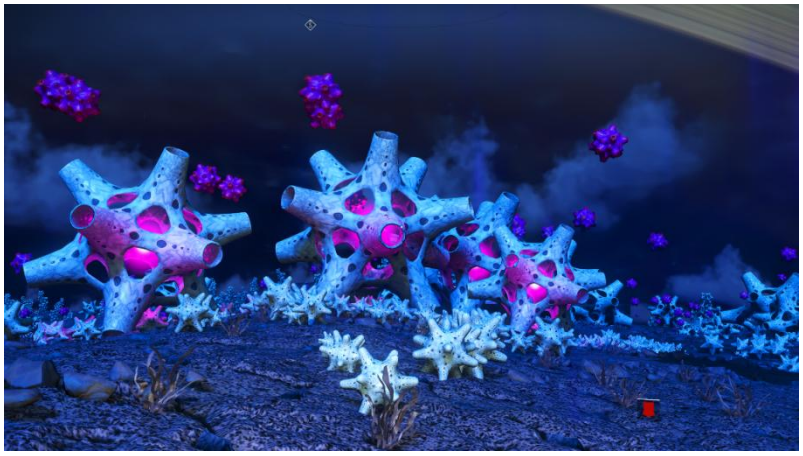

Figure 6. Surface structure and environmental forms of planet Jioka 14/G4

Climate is another important factor that directly affects the gaming experience of players. Some planets have harsh environmental conditions, such as high radiation, extreme temperatures, or toxic atmospheres, while others may be habitable and more favorable for exploration. This dynamic enables players to devise diverse strategies for survival across various planets. Material wealth provides players with a critical resource to upgrade their technology, build bases, and trade. The availability of rare materials on specific planets increases players' motivation to explore and encourages the diversity of the game world. No Man's Sky allows players not only to explore, but also to create their own unique stories within the game universe. Procedurally generated locations and environmental features provide players with a unique and personalized experience. The construction and customization of bases contribute to the process of expressing players' creativity. Dynamic interactions, especially with the environment, combined with survival and resource management mechanics, provide a deep gameplay experience. This dynamic nature of the game world allows players to constantly discover new experiences, making No Man's Sky a unique example of game design, both technically and aesthetically.

METHOD

Research Assumptions and Hypotheses

Main Hypothesis (H1): Procedural design enriches the player experience by positively affecting space and environment interactions in *No Man's Sky*.

Sub Hypotheses:

H1a: Procedurally generated spaces allow players to individualize the exploration experience.

H1b: Player-built structures provide environmental harmony and aesthetic variety through procedural design.

H1c: Major updates may influence players' awareness of spatial and environmental elements rather than directly transforming their perception.

Null Hypothesis (H0): Procedural design does not have a significant impact on space and environment interactions and does not enrich the player experience.

Research Questions

1. How is procedural design perceived in Steam user comments in the context of space and environment interaction?
2. What are the themes of players' satisfaction with or criticism of procedurally generated spaces?
3. What changes, if any, can be observed in players' awareness and interpretation of space and environment following major game updates?
4. How is playing time associated with positive or negative perceptions of procedural design?
5. What general trends emerge in Steam reviews on procedural design and perception of space over the years?

Boundaries and Scope of the Study

This research aims to analyze the effects of procedural design on space and environmental interactions in No Man's Sky based on user reviews written on the Steam platform between 2016 and 2024. The scope of the research includes understanding players' perceptions of procedural design, their interactions with spaces, and the effects of major game updates on these perceptions. The comments will be used to examine aspects of player experiences such as aesthetics, environmental harmony, and creativity in the context of digital spaces.

The limitations of the research include the fact that data were collected only from the Steam platform, and player feedback from other platforms was excluded. The subjective nature of the comments may make it difficult for the analysis results to be representative of the entire player population. The selected time frame may result in the exclusion of experiences from the initial release of the game and does not provide sufficient data for every major update. In addition, although the playing times mentioned in the comments are analyzed, it is not possible to directly measure the impact of these times on player experience. Despite these limitations, this study aims to provide a comprehensive perspective for understanding the effects of procedural design on player experience.

Data Collection

This research aims to analyze the impact of procedural design on space and environment interactions in No Man's Sky and is based on Steam user reviews. The research includes comments written on the Steam platform between 2016 and 2024. The data is taken from the dataset titled "No Man's Sky Steam Reviews (as of August 20, 2024)" shared by Silas Rickards on the Kaggle platform (Rickards, 2024). This dataset contains more than 300,000 user reviews and is released under the CC0: Public Domain license. The license terms allow the data to be freely used and analyzed (Figure 7).

Data Processing and Preparation

The dataset includes variables such as the number Steam assigns to each review (Review ID), the anonymized identities of the users (SteamID), the rating of the game as "Recommended" or "Not Recommended" (Rating), the users' written reviews of the game (Review), the date the reviews were written (Date Posted), the total time players spent in the game (Hours Played), and the number of "Voted Helpful" votes given to the reviews. This large dataset was divided into 10 equal parts for ease of analysis, and each part was processed as a separate .csv file. This was done with the help of the Pandas library using the Python programming language. Each file was structured in such a way as to preserve the date and content information of the comments and to ensure

accurate classification and analysis. The comments within each file were then categorized according to their themes and divided into separate analysis groups using specific keywords.

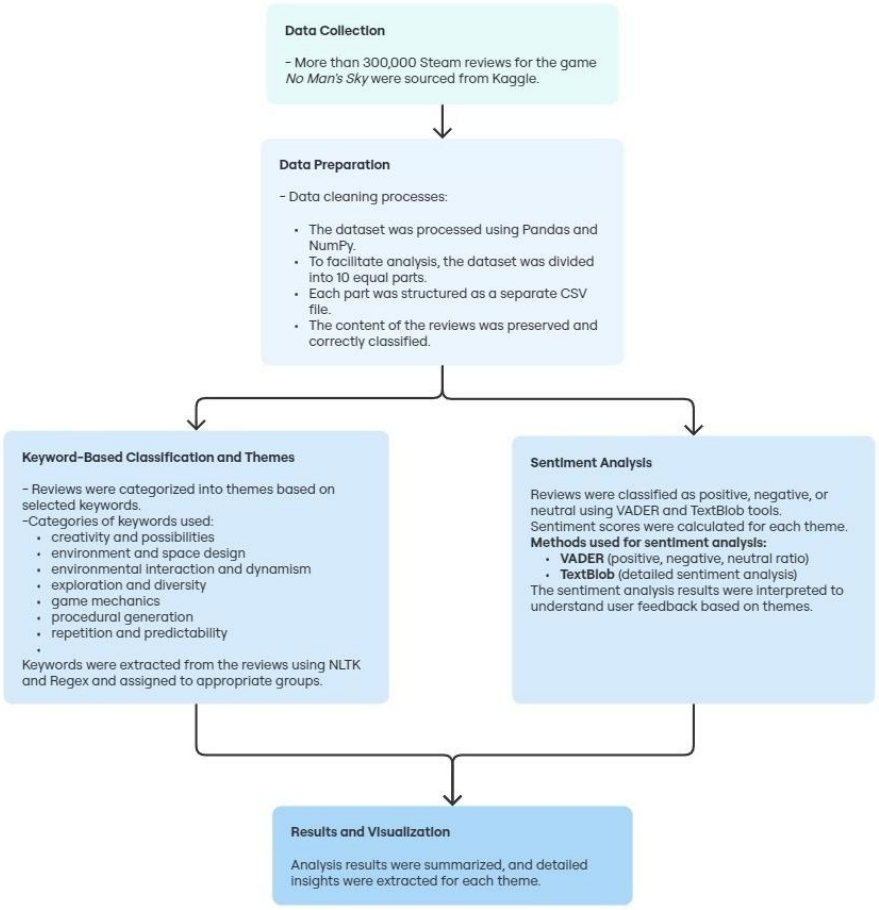

Figure 7. Data collection procedure

Categories and Keywords Used for Content Analysis

The identified categories and keywords were structured to systematically represent the semantic patterns in player comments. The categories were created based on both the core experience areas of the *No Man's Sky* game and the themes of aesthetics, interaction, and meaning production found in the game studies literature. To this end, thousands of player comments were first analyzed using natural language processing (NLP) methods to identify high-frequency words and emotional expressions. These words were then clustered according to their semantic similarities. The resulting clusters were thematically matched with the fundamental dimensions of the literature describing the gaming experience.

The Creativity and Possibilities category contains players' assessments of the game's level of creativity, innovation, and originality. In this context, the selected words "originality," "creative freedom," "innovative," "inspiration," and "unlimited" represent the freedom of design and scope for the discovery of procedural systems. The Environment and Space Design category was created to measure the emotional impact of the spatial organization and visual atmosphere of the game on players. In this category, words such as "space," "environment," "design," "atmospheric," "light," "beautiful," "atmosphere," "texture," and "scale" reflect players' perceptions of environmental aesthetics and spatial experience. The Environmental Interaction and Dynamism category was selected to evaluate the interaction between players and the environment and the responsiveness of the game world. In this context, words such as flexibility, variable, interaction, dynamic, limited, and environment help explain how the game's dynamic or limited structures are perceived. The Exploration and Diversity category is structured to understand the impact of the game's exploration-based nature on players; the words adventure, diversity, richness, uniqueness, and exploration in this category reveal players' emotional responses to the concepts of exploration and diversity. The game mechanics category

examines the relationship between players and mechanical systems and the level of meaning conveyed by these systems. The terms superficial, logical, depth, skill, action, and physical represent the cognitive, physical, and interactive aspects of game mechanics, respectively. The Procedural Generation category evaluates perceptions of algorithmically generated content in the game; the words "randomness" and "infinite exploration" enable understanding of the role of randomness and infinity themes in the player experience. The Repetition and Predictability category examines the emotional impact of repetitive structures and the predictability of the game. The words similar, change, innovation, repetition, and monotony represent the sense of uniformity associated with procedural generation, change expectation, and innovation perception, respectively.

All these categories are determined not only based on word frequency but also by considering the emotional and semantic context of the players' comments. Thus, the keywords used in this study ensure conceptual consistency and data-driven representativeness. This approach enables a multidimensional analysis of the relationship between the procedural systems of the game and player experience, strengthening the generalizability of the findings. This classification was constructed inductively in line with both the game studies' conceptual themes and the statistical trends of the dataset.

Analysis Process

The Python programming language was used for data processing and analysis. The following tools and libraries were used effectively in the analysis processes.

Data cleaning: Pandas and NumPy Libraries

Time series analysis and visualization: Matplotlib and Seaborn Libraries

Natural language processing: NLTK and spaCy Libraries

Sentiment analysis: VADER and TextBlob Libraries

Methodological Details

Comments were categorized according to themes such as procedural design, space layout, environmental aesthetics and game updates. Through language processing steps, unnecessary words were removed and the texts were made suitable for analysis. In particular, word frequency analysis was used to assess how often certain themes were discussed among players. In addition, the content of the comments contained positive, negative and neutral information, revealing the mood analysis. This comprehensive methodological framework provides a solid foundation for understanding the effects of procedural design on player experience in No Man's Sky and enhances the reliability of the data. This methodology used in the analysis process also offers a general model that can be applied in similar studies.

FINDINGS

This section presents the main findings of the study in three steps. First, it summarizes the word frequency and sentiment distributions across the seven thematic categories (Table 1, Figures 8 and 9). Second, these patterns are evaluated in relation to the main and sub-hypotheses (H1, H1a–H1c, H0). Finally, the results are interpreted through the research questions and discussed within the theoretical framework.

Table 1. Word frequency and emotional state analysis through categories

Category	Keywords	Sentence Count	Average Positive	Average Negative	Average Neutral
Creativity and Possibilities	originality	1	0.36	0.0	0.64
	creative freedom	1	0.57	0.0	0.43
	innovative	4	0.27	0.1	0.63
	inspiration	4	0.45	0.02	0.53
	unlimited	10	0.18	0.06	0.76
Environment and Space Design	space	9631	0.24	0.09	0.67
	environment	521	0.22	0.1	0.68
	design	912	0.21	0.11	0.68
	atmospheric	12	0.22	0.11	0.67
	enchanting	1	0.34	0.0	0.66

	light	256	0.21	0.1	0.69
	beautiful	125	0.5	0.05	0.45
	atmosphere	45	0.22	0.06	0.72
	texture	15	0.16	0.14	0.71
	scale	60	0.23	0.07	0.7
Environmental Interaction and Dynamism	flexibility	2	0.48	0.0	0.52
	variable	2	0.11	0.08	0.8
	interaction	43	0.18	0.07	0.76
	dynamic	14	0.42	0.04	0.54
	limited	88	0.13	0.23	0.64
	environment	521	0.22	0.1	0.68
Exploration and Diversity	adventure	154	0.49	0.04	0.47
	diversity	16	0.22	0.03	0.75
	richness	1	0.18	0.19	0.64
	uniqueness	2	0.22	0.12	0.67
	exploration	1265	0.47	0.04	0.5
Game Mechanics	superficial	1	0.23	0.05	0.72
	logical	5	0.28	0.06	0.66
	depth	50	0.23	0.07	0.7
	skill	7	0.21	0.18	0.61
	action	121	0.2	0.11	0.69
	physical	3	0.21	0.16	0.63
Procedural Generation	randomness	3	0.14	0.25	0.61
	infinite exploration	1	0.25	0.11	0.65
Repetition and Predictability	similar	60	0.22	0.06	0.71
	change	107	0.16	0.07	0.76
	innovation	1	0.44	0.0	0.56
	repetition	2	0.0	0.24	0.76
	monotony	1	0.09	0.0	0.91

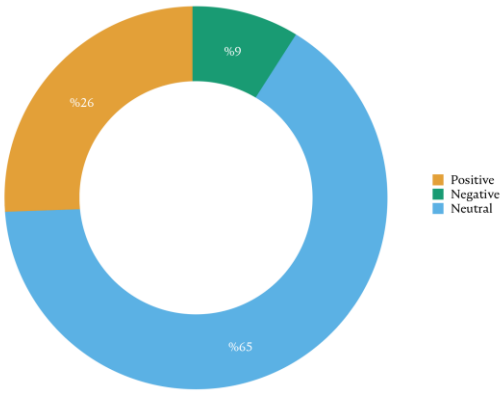

Figure 8. Weighted overall sentiment distribution of player reviews

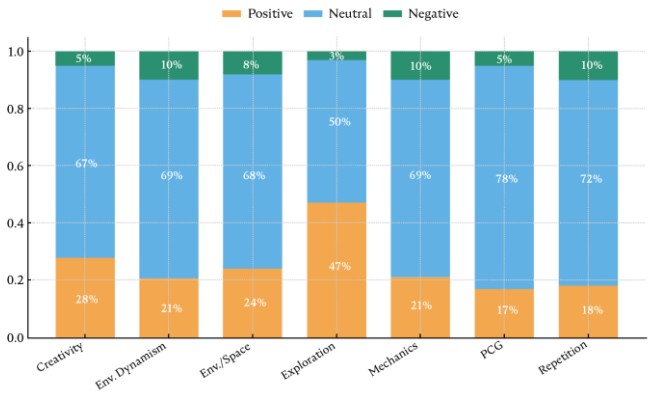

Figure 9. Weighted sentiment distribution by category

The analysis across seven thematic categories shows that No Man's Sky players' perceptions are largely neutral, with positive reactions concentrated in Creativity and Possibilities, Environment and Space Design, and Exploration and Diversity (Figure 8). The fact that neutral sentiment rates range from 60% to 75% across

all categories indicates that players notice the design elements, but that these do not create a strong emotional impact. Keywords such as originality, creative freedom, innovation, and inspiration show moderately positive sentiment in the Creativity and Possibilities context, ranging from 18% to 57% (Figure 9). However, the limited frequency of these concepts suggests that while players recognize the game's creative potential, they do not place it at the center of their overall experience. Similarly, the term "unlimited" is perceived with neutral sentiment 76% of the time, indicating that the sense of scale is noticed but does not create a deep emotional connection. The environment and space design are among the most frequently mentioned aspects of the game. The words "space" and "environment" generated positive and neutral sentiments in 22%–24% and approximately 70% of the time. This shows that the game's large-scale structure is noticed, but its emotional impact remains limited. Aesthetic terms such as "beautiful" (50% positive) and "atmosphere" (22% positive) reveal that the visual design is appreciated, but these aesthetic elements fail to create a lasting impact when they are not supported by narrative or interaction.

Players show a positive tendency toward environmental responsiveness. Words such as dynamic (42% positive) and flexibility (48% positive) in the Environmental Interaction and Dynamism category reflect this satisfaction, while the perception of limited (23% negative) and variable (80% neutral) indicates that environmental constraints negatively affect the experience. The term "interaction" (76% neutral) suggests that players are aware of their interaction with the environment, but it does not achieve a sufficient level of depth. Exploration and diversity are the strongest motivating factors in player experience. The words adventure and exploration generated positive feelings at a rate of approximately 47%–49%, indicating that discovery is one of the game's fundamental sources of satisfaction. However, the fact that words such as diversity and uniqueness contain a high percentage of neutral feelings (over 70%) suggests that repetitive spatial structures weaken the sense of discovery. Terms related to game mechanics, such as logical, depth, skill, and action, were rated with neutral rates ranging from 60% to 70%. This result shows that while game systems are functional, their emotional impact is limited. Players appreciate mechanical consistency but demand more meaningful feedback and variety. The concepts of randomness (25% negative) and infinite exploration (25% positive) indicate that algorithmic diversity is both exciting and detrimental to consistency in the context of procedural generation. Even when content diversity is provided, it does not translate into emotional depth when narrative continuity is not supported.

The Repetition and Predictability category revealed the most negative emotional tendencies. Words such as *repetition*, *monotony*, and *similar* reflect a feeling of fatigue toward repetitive patterns, while terms such as *change* and *innovation* were mostly perceived as neutral (56%–76%). This shows that although players notice the updates, their experience does not change meaningfully. Overall, the findings reveal that *No Man's Sky*'s procedural systems successfully provide spatial and visual diversity but struggle to maintain emotional depth. Positive emotions are concentrated around exploration, beauty, and dynamism, whereas neutrality dominates creativity, interactivity, and mechanics. This imbalance could be addressed through procedurally generated designs supported by narrative coherence and stronger environmental feedback, thereby increasing player engagement and meaning production.

Perception of Procedural Space in Player Discourse

This section examines how procedurally generated space is experienced through six sample player reviews (R1–R6) of *No Man's Sky*. The reviews were selected and coded to provide a balanced distribution of Recommended and Not Recommended ratings. Following the analysis of word frequency and emotional tone presented in the previous section (Table 1), this qualitative reading aims to show how the categories *Exploration and Diversity* and *Repetition and Predictability*, in particular, are embodied in player discourse.

First, it can be seen that the static and repetitive structure produced by procedural design is not a negative but, for some players, a preferred feature. The player coded R1 expresses the repetition of the game in a positive way as follows:

R1 (Recommended): "I have played it on PC for a long time, and it's the game of my dreams. It might be yours too. Just remember it's not for everyone, because it's very static and repetitive, something I really like in a game." This statement illustrates the study's argument that procedural space can generate pleasure not only through variety and surprise but also through ritual, routine, and meditative repetition, with the "static and

repetitive" structure framed as a constitutive part of the "dream game" experience. Similarly, comments coded R5 and R6 emphasize the wide range of exploration offered by procedural space and a sense of "digital tourism." R5 describes the fundamental core of the game as follows:

R5 (Recommended): "Yes, if you like self directed gameplay, enjoy exploration for exploration's sake, and don't mind that while there's a lot of stuff to do, none of it is terribly deep. No Man's Sky takes the basic premise of a walking simulator … and adds gameplay building blocks on top of it that constantly reference the basic experience … instead of one wooded meadow, you have a mind bogglingly huge array of possible combinations of terrain, flora, fauna, and atmosphere."

R6 supports this feeling in more casual language:

R6 (Recommended): "There is always something to do, somewhere to explore, and places to visit. At times, it does feel stagnant, but finding new technology, places, and solar systems really keeps things fresh." Reading these two quotes together, it becomes clear that the procedural system offers players a sense of "infinite" or near-infinite variety, but that this variety operates through constant slight variations rather than "deep" gameplay cycles. Consistent with the study's central argument, the experience is based more on a richness of spatial combinations than on mechanical density. At the same time, the repetition/novelty tension, marked by terms such as "repetition," "similar," and "change" under *Repetition and Predictability*, is embodied here in player discourse through experiential language. By contrast, the negative comments coded R3 and R4 show that the same procedural logic can also trigger feelings of emptiness, meaninglessness, and boring repetition. R3 makes the following statement about the representation of the cosmos:

R3 (Not Recommended): "this game just makes space feel so real full of emptyness, and full of nothingless … do i recomand this game no SAVE YOUR MONEY BUY KERBAL SPACE PROGRAM" The phrase "space feels so real, full of emptiness" suggests that the game's spatial aesthetics convey a sense of "cosmic emptiness," while also underscoring that this aesthetic ultimately translates into an experience of "nothingness" for the player. The space, although visually convincing, is perceived as "empty" because it lacks sufficient meaningful activities.

R4 directly targets the quantitative exaggeration of procedural repetition:

R4 (Not Recommended): "This game appears to be fun for around, 10 hours or so. Unless you like doing the same exact things on 1X10^59 planets. This'll get boring. Quick." This comment embodies the "scale/density paradox" discussed in the study: Increasing the number of planets to an astronomical scale is, in the player's eyes, reduced to a repetition of the same action on a cosmic scale when the action repertoire is not sufficiently diversified. R4's praise of another game, *Endless Sky*, as "almost the same thing … except more interesting" shows that procedural plurality alone is not enough to be engaging; spatial diversity produces an "empty crowd" when meaningful ludic differences do not support it. Among the selected comments, the short expression coded R2 points to the cultural discourse and meta-narrative surrounding the game:

R2 (Recommended): "I've had the game since launch. Internet Historian literally hit the nail on the head with this one." This sentence does not detail the player's own experience but instead refers to a popular YouTube video discussing the game. This suggests that the reception of procedural design is shaped not only by individual player–space relations but also by a wider network of collective commentary.

Overall, the comparative analysis between R1–R6 shows that procedural design can be experienced simultaneously as "endless exploration" and "endless repetition." For some players, the static and repetitive structure produces a calming, meditative, "dream game" effect (R1, R5, R6), whereas for others it generates feelings of emptiness and frustration (R3, R4). This bidirectional perception supports the study's central argument that procedurally generated space gains value in the player experience only when combined with design framing, expectation management, and meaningful variation in activities.

Main Hypothesis (H1)

The main hypothesis that procedural design enriches the player experience by positively influencing space and environment interactions in No Man's Sky is partially supported based on the data analysis. The keywords "space" (n = 9631) and "environment" (n = 521) related to environment and space design indicate that players

notice these elements on a large scale but remain neutral in terms of emotion. The 24% positive emotion rate for space indicates that the effects of procedural design are positive, but the 67% neutral rate suggests that these effects are limited. This suggests that H1 is only supported under certain conditions.

Sub Hypothesis 1 (H1a)

H1a: Procedurally generated spaces allow players to individualize the exploration experience.

The keyword Exploration (n = 1265) indicates that players are generally satisfied with the exploration mechanics, with 47% expressing positive sentiments. However, the 50% neutral rate suggests that this individualization experience is limited for some players. Similarly, adventure (n = 154) emerged as a significant factor in increasing player motivation, with a 49% positive rate. Although these results confirm the potential of procedural design to individualize the exploration experience, they suggest that H1a is only partially supported due to the high neutral rates.

Sub-Hypothesis 2 (H1b)

H1b: Player-built structures provide environmental harmony and aesthetic diversity through procedural design.

The 21% positive rate of the keyword design (n = 912) reveals a limited potential for procedural design to create aesthetic diversity. Beautiful (n = 125), with a positive rate of 50% indicates that environmental elements are aesthetically pleasing, while diversity (n = 16), with a positive rate of 22% indicates that this diversity should be emphasized more. These data provide limited support that procedural design provides environmental adaptation and aesthetic variety; therefore H1b is partially confirmed.

Sub-Hypothesis 3 (H1c)

H1c: Major updates may influence players' awareness of spatial and environmental elements rather than directly transforming their perception.

Major game updates have a limited effect on players' awareness of spatial and environmental elements. The keyword innovation (n = 1) was associated with a 44% positive and 56% neutral sentiment, suggesting that while updates were acknowledged, their emotional impact remained minimal. Similarly, the keyword change (n = 107) showed a limited positive perception (16%) and a predominant neutral response (76%), indicating that these updates did not substantially alter players' perception or emotional engagement with space and environment. Therefore, the findings suggest that major updates may raise awareness of new environmental features without significantly transforming how players perceive or experience these spaces.

Null Hypothesis (H0)

H0: Procedural design has no significant effect on space and environment interactions and does not enrich the player experience.

The analysis results show that procedural design has certain positive effects on the perception of space and environment. For example, high positive rates for keywords such as "beautiful" and "exploration" suggest that players are satisfied with the visual and exploration elements. However, the overall high proportion of neutrals (50-76%) suggests that the impact of procedural design is limited. Therefore, although hypothesis H0 is rejected, it is concluded that the effects of procedural design should be optimized.

The impact of procedural design in No Man's Sky is generally perceived positively by players; however, these effects are limited and usually confined to neutral emotions. Elements of procedural design, such as individualization, aesthetic variety, and novelty, need to be made more prominent and effective to enrich the player experience. These findings suggest that game designers need to restructure procedural production processes to create a deeper emotional connection. Procedural design is notable for promising variety and uniqueness, offering players a wide range of exploration possibilities. However, questions such as how this design approach is perceived by players, which themes generate satisfaction or criticism, and how major updates affect these perceptions remain to be answered for a deeper understanding of the game experience. This article examines player perceptions by focusing on five key research questions about procedural design and aims to provide implications for game design processes.

1. How is procedural design perceived in Steam user comments in the context of space and environment interaction?

According to Steam user comments, procedural design is considered a technical achievement. However, the keywords space (24% positive, 67% neutral) and environment (22% positive, 68% neutral) indicate that this design approach has a more neutral effect on players. This suggests that while players appreciate procedural design, they expect these spaces to be designed to create deeper emotional connections. In particular, an approach that emphasizes visual storytelling and spatial aesthetics may shift this perception in a more positive direction.

2. On which themes do players' satisfaction or criticism of procedurally generated spaces concentrate?

While players are satisfied with exploration mechanics (exploration, 47% positive) in procedurally generated spaces, they feel deficiencies in themes such as diversity (diversity, 22% positive, 75% neutral) and uniqueness (uniqueness, 22% positive, 67% neutral). In addition, repetition (repetition, 24% negative) and limitations (limited, 23% negative) are among the most frequently cited criticisms. These findings suggest that players need more unique and dynamic spaces. Game designers should consider mechanics that minimize repetitive designs and increase variety, which may increase player satisfaction.

3. What changes, if any, can be observed in players' awareness and interpretation of space and environment following major game updates?

Although the study initially assessed the impact of major updates on players' perceptions of space and environment, the analysis revealed that these effects are limited. Instead of claiming a direct causal relationship, this section now interprets change and innovation as indicators of players' awareness of updates rather than their emotional evaluation of them. Players' comments show that while updates are noticed, they rarely alter the overall perception of the environment or spatial experience. Therefore, this analysis's scope was moderated to reflect correlation rather than causation.

4. How is play time related to positive or negative perceptions of procedural design?

Playing time has a significant impact on perceptions of procedural design. Long-term players tend to complain about repetitive designs and a sense of monotony, whereas short-term players focus more on visual aesthetics and exploration. This difference highlights the need for customized design approaches based on playing time. For example, deeper storylines and dynamic content could be developed for long-time players, while mechanics that reward exploration could be designed for short-time players.

5. What general trends on procedural design and perception of space emerge in steam reviews by year?

Over the years, there have been clear trends in players' perception of procedural design and space. While interest in exploration mechanics has remained consistent, criticism of repetitive content has increased. This trend can be considered as a reflection of increasing player expectations with technological developments. Presenting procedurally designed spaces in an innovative and engaging way is critical to respond to these rising expectations.

The results of the analysis reveal that although procedural design is often recognized by players, it is mostly perceived in a neutral emotional context. For example, the keywords "space" (67% neutral) and "environment" (68% neutral) indicate that players notice space and environment elements on a large scale, but that these elements are limited in creating an emotional impact. Similarly, the keywords "exploration" (50% neutral) and "dynamic" (54% neutral) indicate that exploration and environmental dynamism are salient to players but fail to create a strong connection. These high neutral rates suggest that procedural designs fail to have a truly profound impact on players.

There may be several reasons for such high neutral perceptions. First, procedural design's tendency to create a repetitive perception of space and content may lead players to find their experience limited. Comments expressed through terms such as "repetition" (76% neutral, 24% negative) and "limited" (64% neutral, 23% negative) indicate that players perceive a lack of variety and uniqueness. Moreover, the insufficient delivery of innovations appears to be another contributing factor. The keywords "innovation" (56% neutral) and

"change" (76% neutral), which were analyzed in relation to major updates, reveal that players recognize these innovations but do not consider them as a meaningful experience transformation. The algorithmic and randomized nature of procedural designs is another important reason why players struggle to connect emotionally with the game world. While spatial designs and environmental details are aesthetically noticeable, the lack of strong storytelling or the creation of meaningful spaces can limit this connection. Finally, differences in player profiles and playing time can also affect this perception. Long-term players may take a more critical approach due to repetitive elements, while short-term players may have a more superficial experience.

This suggests that procedural design should be improved to increase players' emotional engagement. An approach that reduces repetition and predictability and emphasizes dynamic and unique content should be adopted. Furthermore, major updates should not be limited to technical improvements, but should include innovations such as story and space design that transform the player experience. A design approach that prioritizes visual storytelling and spatial aesthetics can help players develop a stronger connection with the game world. In this regard, it is suggested that future research should focus on player profiles, playing time and individual interpretation details, examining the causes of neutral perceptions in more depth. Such analyses can contribute to identifying shortcomings of procedural design and developing concrete strategies to improve the game experience.

Theoretical Interpretation of Findings

The findings of this study align with established approaches in the game theory literature. The limited emotional engagement observed in player comments is consistent with Juul's (2005) concept of semi-reality; it demonstrates that purely procedural systems cannot sustain interaction without narrative coherence. Similarly, Bogost's (2007) procedural rhetoric approach explains why, unsupported by contextual cues, algorithmic diversity fails to create meaning. Finally, Salen and Zimmerman's (2004) meaningful play framework and Hunicke et al.'s (2004) MDA model reveal how the disconnect between mechanics and aesthetic experience explains why procedural diversity does not always create satisfaction. These theoretical perspectives demonstrate that meaningful and emotionally engaging game worlds can only be produced when the designer's intent is balanced with procedural generation.

CONCLUSION

Although the effects of procedural design in No Man's Sky are generally perceived positively in terms of players' perceptions of space and environment, these perceptions are mostly limited to neutral emotions. The results suggest that players recognize procedurally generated spaces but do not generate sufficient emotional connection. The players frequently mentioned the keywords "space" and "environment," but the high neutral rates (67% and 68%) indicated that these elements are not sufficiently expressive. Similarly, while the exploration mechanics (exploration, 47% positive) were appreciated, the lack of individualization and the limited variety of this experience prevented players from forming a stronger bond. Regarding comments related to innovations (innovation, 44% positive), although players recognized updates, their impact was not widespread and did not significantly change the overall experience of the game.

Players generally perceive procedural design as a positive element; however, repetitive space designs and limitations cause negative reactions, which is consistent with the research questions. Major game updates had a limited impact on players' perception of space and environment and did not significantly affect their experience. There also appears to be a clear correlation between playing time and perceptions of procedural design, with long-term players often complaining of repetition and monotony. In contrast, short-term players focus more on visual aesthetics. Over the years, player comments have indicated a continued interest in exploration mechanics, alongside increased criticism of repetition and limitations.

Considering these findings, game designers should take steps to improve procedural design. Visual storytelling and spatial design should be integrated with the story to create a stronger emotional connection between spaces and players. Increasing the elements of exploration and variety by offering dynamic and unique locations, rather than repetitive content, is also important. Updates should not only include technical improvements but

also incorporate innovative features that enhance the game's story and spatial interactions. By developing dynamic and adaptive spaces, individualized experiences can be offered that change according to the way players play. This can make players' experiences more meaningful and satisfying.

For future academic work, more in-depth analyses should be conducted on why neutral rates are so high, the effects of dynamic spaces on player strategies, and comparative analyses of procedural design in different game genres. Detailed sentiment analysis of players' preferences and behaviors can increase the effectiveness of design processes. In conclusion, procedural design is recognized and perceived positively by players. However, its effects must be strengthened and structured to increase player satisfaction. These findings can shed light on game designers and academic studies, enabling more effective and meaningful use of procedural design.

Authors' Contributions
The authors contributed equally to the study.

Competing Interests
There is no potential conflict of interest.

Ethics Committee Declaration
The study does not require ethics committee approval.

REFERENCES

Anderson, C., Bailey, C., Heumann, A., & Davis, D. (2018). Augmented space planning: Using procedural generation to automate desk layouts. *International Journal of Architectural Computing, 16*(2), 164-177. https://doi.org/10.1177/1478077118778586

Barret, L., Vance, C., & Youngblood, M. (2011, June 28). *Lessons in user interface design in the procedural city generation for games tool Urban PAD.* [Conference presentation]. PCGames 2011: 2nd International Workshop on Procedural Content Generation in Games, Bordeaux, France. https://dl.acm.org/doi/proceedings/10.1145/2000919

Bogost, I. (2007). *Persuasive games: The expressive power of videogames*. MIT Press.

Cardona-Rivera, R. E. (2017, February 4). Cognitively-grounded procedural content generation. [Conference presentation]. Whats's Next for AI in Games? Workshop at the Thirty-First AAAI Conference on Artificial Intelligence (AAAI-17), San Francisco, CA, United States. https://aaai.org/papers/aaaiw-ws0286-17-15083/

Carpenter, J. (2022). The aesthetics of human–machine interaction: Generative textuality in Hello Games's *No Man's Sky*. *Journal of Aesthetics and Phenomenology, 9*(2), 173-190. https://doi.org/10.1080/20539320.2022.2150464

Compton, K. (2016). 10,000 bowls of oatmeal. *Vice*. https://vice.com/en/article/10k-oatmeal (08.10.2024).

Craveirinha, R., & Roque, L. G. (2015). Designing games with procedural content generation: An authorial approach. In *CHI '15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 1199-1204). ACM.

Craveirinha, R., & Roque, L. G. (2015). Studying an author-oriented approach to procedural content generation through participatory design. In *International Conference on Evolutionary Computation* (pp. 1-12). https://doi.org/10.1007/978-3-319-24589-8_30

Flick, C., Doughty, M., & Reinhard, A. (2017). Exploring simulated game worlds: Ethics in the *No Man's Sky* archaeological survey. *Orbit, 1*(2), 1-13. https://doi.org/10.29297/orbit.v1i2.46

Galdieri, R., Longobardi, A., De Bonis, M., & Carrozzino, M. A. (2021, September 7-10*). Users' evaluation of procedurally generated game levels.* [Conference presentation]. 8th International Conference on Augmented Reality, Virtual Reality, and Computer Graphics (AVR 202, virtual event), Otranto, Italy. https://doi.org/10.1007/978-3-030-87595-4_4

Hello Games (n.d.). *Hello Games official website*. Hello Games. https://hellogames.org (08.10.2024).

Hunicke, R., LeBlanc, M., & Zubek, R. (2004, July 25-26). *MDA: A formal approach to game design and game research* [Conference presentation]. Challenges in Game AI Workshop at the Nineteenth National Conference on Artificial Intelligence (AAAI-04), San Jose, CA, United States. https://users.cs.northwestern.edu/~hunicke/MDA.pdf

Juul, J. (2005). *Half-real: Video games between real rules and fictional worlds*. MIT Press.

Lienhard, S., Lau, C., Müller, P., Wonka, P., & Pauly, M. (2017). Design transformations for rule-based procedural modeling. *Computer Graphics Forum, 36*(2), 21-30. https://doi.org/10.1111/cgf.13105

Reinhard, A. (2021). Archaeology of abandoned human settlements in *No Man's Sky*: A new approach to recording and preserving user-generated content in digital games. *Games and Culture, 16*(6), 855-884. https://doi.org/10.1177/15554120211005236

Rickards, S. (2024). *No Man's Sky* Steam reviews [Data set]. Kaggle. https://www.kaggle.com/datasets/filas1212/no-mans-sky-steam-reviews-as-of-july-18-2024 (16.09.2024).

Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. MIT Press.

Santos, D., Zagalo, N., & Morais, C. (2023). Players' perception of the chemistry in the video game *No Man's Sky*. *Simulation & Gaming, 54*(3), 375-394. https://doi.org/10.1177/10468781231169301

Schwarz, M., & Wonka, P. (2014). Procedural design of exterior lighting for buildings with complex constraints. *ACM Transactions on Graphics, 33*(2), 1-16. https://doi.org/10.1145/2629573

Smith, A. M., & Mateas, M. (2011). Answer set programming for procedural content generation: A design space approach. *IEEE Transactions on Computational Intelligence and AI in Games, 3*(3), 187-200. https://doi.org/10.1109/TCIAIG.2011.2158545

Tait, E. R., & Nelson, I. L. (2021). Nonscalability and generating digital outer space natures in *No Man's Sky*. *Environment and Planning E: Nature and Space, 5*(3), 694-718. https://doi.org/10.1177/25148486211000746

Yannakakis, G. N., & Togelius, J. (2015). Experience-driven procedural content generation (Extended abstract). In *2015 International Conference on Affective Computing and Intelligent Interaction (ACII)* (pp. 519-525). IEEE.

Yumer, M. E., Asente, P., Mech, R., & Kara, L. B. (2015, November). Procedural modeling using autoencoder networks. In *Proceedings of the 28th Annual ACM Symposium on User Interface Software and Technology* (pp. 109-118). ACM. https://doi.org/10.1145/2807442.2807448

Figure References

Figure 1-4, 6: *No Man's Sky* (PC version) [Video Game]. (2016, August 12). Hello Games.

Figure 5: Beau Lamb. (n.d.). *No Man's Sky.* Art Station. https://www.artstation.com/artwork/0O554 (12.10.2024).

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