

Research On Game Development and Revenue Based on Generative Artificial Intelligence: A Case Study of Netease

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Abstract. This study investigates the application of Generative AI in game development and its impact on the final profit of a company. Firstly, the article introduces the development history of generative AI and its application in different fields, focusing on the application in the game industry. Subsequently, the specific application of generative AI technology in game development and its impact on the company's performance is analysed through a case study of NetEase. It is found that through the introduction of generative AI technology, NetEase has successfully developed a series of innovative and unique games, such as "Ni Shuihan" and "Eggy Party", and achieved significant commercial success. Finally, the study suggests directions for further research in the future, including more in-depth quantitative analyses of the application of generative AI in different game genres and markets, as well as exploring how individual or small team developers can benefit from the rise of generative AI.

Keywords: Generative Artificial Intelligence, Game Development, Revenue Enhancement, NetEase.

1. Introduction

Tom Freston said, "Innovation is taking two things that exist and putting them together in a new way". For a long time, people kept one thought that many actions or works full of humanism, such as painting, writing, arranging, directing, and, of course, chatting, can only be done by humans. However, this thought is being challenged with the development of artificial intelligence. Especially when the symbol of generative AI-Chat GPT suddenly appears in our vision.

Generative artificial intelligence mainly refers to those that can be excavated, organized, and judged based on known data sets, and based on this, can further create a type of AI that meets certain specific requirements. The concept of generative AI can be traced back to 1943 when it was proposed by Warren S. McCulloch & Walter Pitts. In this paper, they simulated the behavior of biological brains using simple circuits to simulate brain neurons. They proposed the M-P neural network model, which became the basis for further artificial intelligence research [1].

In modern times, thanks to the development and breakthroughs of deep learning algorithms and the further development of computer hardware and data science, the field of generative AI has made tremendous progress. From the earliest Eliza and Shrdlu, which can only perform simple and rough language conversations or operate blocks, to Deep Blue and Alpha Go in previous years, which can perform more powerfully than humans in specific fields, to GPT-3 in 2020 was proposed, we can see that today's generative AI can already achieve an extremely wide range of functions through an extremely simple operation, and in this way, it has won more and more widespread attention and applications [2].

Current generative AI has realized the functions of generating text, images, music, translation, answering specific questions, and can even generate extremely realistic videos based on people's descriptions. These functions have gradually been applied to many industry fields. In media and entertainment, generative AI can assist people in creating manuscripts or works; in the financial field, generative AI can predict market trends, analyze risks, and provide information based on data. Investment decision support: in the medical field, generative AI can assist in diagnosis, generate prescriptions, provide reference directions for developing new drugs, etc. Generative AI is in a stage of rapid development and rising.

According to Newzoo's survey report, it can be found that the global game market has shown an upward trend since 2018, and Newzoo predicts in the report that the global game market will reach \$205.4 billion in 2026 and the number of players will reach 3.79 billion. The game market is still relatively large. Great development potential.

With the continuous development of generative AI technology, this technology has gradually begun to show its unique role in the game industry, becoming a thrust that cannot be ignored.

Benefiting from the development of generative AI, game content has gradually shifted from traditional PCG to AIGC. PCG generates game content by using predefined algorithms and rules [3]. Minecraft, developed by Mojang, is a classic PCG generative game. Randomly generated seed numbers are used to generate completely different random worlds, terrains and populations according to preset algorithm rules to achieve infinite expansion of game content [4].

PCGs have high production efficiency and strong content controllability, which makes them convenient for personnel to operate and test. However, while PCGs benefit from generating content based on preset algorithmic rules, their creativity and versatility are greatly limited. To a certain extent, the worlds with "infinite possibilities" generated by PCGs are many combinations of their preset algorithms. Their content is limited by the preset rules, and the so-called "infinite" is just different combinations of finite content.

AIGC, based on generative AI models, can generate new content by learning from massive datasets and extracting and mining new information. This is the main function of generative AI. In the context of games, AIGC can generate game content with greater creativity and diversity than PCG. Moreover, with the current generative AI technology, AIGC can cover almost all aspects of game content, including graphics, music, text, NPCs, and more. It can also generate personalized experiences based on player behavior and preferences [5].

Compared to PCG, AIGC has a lower barrier to entry. Although the quality of its output can be unstable due to the technology's immaturity, large companies can apply AIGC directly to game production through experimentation and debugging. Individual developers may use AIGC more for auxiliary production. Nevertheless, generative AI can significantly improve the development efficiency of individual developers. For large companies, perfecting the application of generative AI in games can also greatly improve development efficiency and personalized design and attract more players and profits.

This study aims to investigate the impact of generative AI on developing company games and acquiring final profits under the current technical conditions. As a large game developer in China, NetEase has made many attempts and applications in this field. Therefore, this paper studies the changes in revenue and player numbers of NetEase after researching and applying generative AI to its games to prove the current and potential impact of generative AI on the final profits of the company.

2. Literature Review

The application research of generative AI in the game industry is mainly divided into three categories.

The first category of research questions focuses on the game design stage, which encompasses the initial game proposal, the establishment of the overall visual style, the design of key characters, and the design of the user interface (UI). These aspects involve the core elements of the game, such as game mechanics, game world-building, and game narrative [6].

The second category of research focuses on the application of generative AI in-game content production, encompassing aspects such as game world construction, level design, player engagement and interactivity enhancement, and NPC humanization. Existing research suggests that generative AI is more suitable for assisting game developers in their creative endeavors than completely dominating the production process. Moreover, some studies have proposed that generative AI plays three roles in game design and development: the role of an actor mediating between the game and the player, the role of the designer mediating between the design and the system comprising the game and the player,

and the role of the producer mediating between producers and the overarching systems connecting users, designers, and games [7].

The third category of research questions delves into the ethical considerations surrounding the application of generative AI in the game industry. The recent joint strike by the Screen Actors Guild-American Federation of Television and Radio Artists (SAG-AFTRA) and the Writers Guild of America (WGA) exemplifies the growing concerns regarding the use of generative AI in creative fields, specifically film. The striking unions express anxieties about generative AI potentially infringing upon actors' portrait rights and product copyrights during the creative process. Additionally, they raise concerns about the potential impact of AI's evolving creative capabilities on actors' and writers' job security and career prospects [8].

The game industry also faces similar challenges. Generative AI models are trained on existing content, which can lead to generated content that copies or plagiarizes previous works, especially in art style and game design. Artistic content, such as character designs and game environments, is particularly susceptible to AI "copying". Additionally, the content generated by generative AI is not always fully controllable. It may contain elements that violate social ethics, promote social bias, or raise ethical concerns about fairness, privacy, and security. Therefore, standardized operation and product copyright protection are critical in the game industry [8].

Most existing research focuses on the role of generative AI in game production and development, such as in terms of efficiency, simplification, process improvement, and playability. Other research focuses on the potential ethical and moral issues that may arise after generative AI is applied to the game industry [9, 10]. However, more research needs to be conducted to analyze the actual profits of generative AI after its application. This study focuses on whether generative AI investment and income can benefit enterprises considerably. This is a critical issue that needs to be addressed.

3. Methodology

This paper adopts a case study approach to investigate the actual benefits achieved by NetEase after using generative AI. Analyzing NetEase's quarterly and annual reports from 2019 to 2023 (20 quarters and 4 years in total) and combining this with an analysis of NetEase's deployment of generative AI in its game industry through three indicators to conduct our analysis: quarterly revenue, number of players, and investment-to-output ratio. These three dimensions are used to qualitatively analyze NetEase's generative AI deployment strategy and actual benefits.

NetEase was founded in 1997. Initially, it focused on personal homepage and email services. By adopting the "portal website + advertising monetization" model, NetEase achieved great success in traffic and revenue, becoming one of China's four major portal websites alongside Sina, Tencent, and Sohu.

In 2000, NetEase entered its transformation stage by acquiring Guangzhou Tianxia Game Studio and launching the games "Westward Journey Online" and "Fantasy Westward Journey Online". These games, representing valuable intellectual properties (IPs), continue to generate significant revenue for NetEase. From 2001 to 2012, NetEase gradually transformed into a game-oriented company while venturing into online education with products such as Youdao Dictionary and NetEase Open Course. After 2012, NetEase implemented a "mobile-first" strategy and expanded into the music, e-commerce, and education industries.

NetEase has evolved into a diversified global internet company, holding leading positions in games, online education, music, e-commerce, and other sectors. NetEase's core business remains the game segment, contributing most of its revenue. According to financial reports released by NetEase, the game business accounted for over 80% of the company's revenue in the first three quarters of 2023, with the proportion remaining high at 76% in the fourth quarter.

According to the survey data released by Sensor Tower, NetEase Games ranked fourth in the global mobile game market revenue in 2023, reaching \$2.37 billion, representing the industry to a certain extent.

NetEase's game business is mainly based on online mobile games, which require continuous investment in resources and research and development of technologies. By regularly releasing new versions and/or expansion packs, NetEase maintains and improves the popularity of its online games. This long-term operation mode is more conducive to studying the impact of R&D and investment in AI technology on the company.

4. Results

4.1. NetEase's Layout and Progress of generative AI

Based on a survey, NetEase had already applied artificial intelligence (AI) technology in its game business as early as 2019. The main applications were user profile analysis, intelligent non-player characters (NPCs), and natural language processing (NLP).

4.1.1 User profile analysis

NetEase utilizes AI technology to analyze user behavior and performance, in-game purchase preferences, and other game data and information to conduct in-depth analysis of user profiles. This information then guides game development and upgrades, marketing, and other activities.

4.1.2 Intelligent non-player characters (NPCs)

NetEase has created intelligent NPCs through deep learning technology. These NPCs can join players' in-game activities, simulate real-life interactions, facial expressions, and body language, and provide a more engaging gaming experience. Additionally, NetEase has deployed various reinforcement learning techniques to create NPCs of different styles and difficulty levels to cater to a wide range of player preferences.

4.1.3 Natural language processing (NLP)

NetEase applies NLP technology in its games, allowing players to develop their storylines and explore hidden elements in the game through dialogue with NPCs. This creates an immersive gaming experience for players.

Furthermore, NetEase has also applied AI technology in other business areas, mainly including natural language processing, automatic speech recognition (ASR), and text-to-speech (TTS) technologies. NetEase utilizes AI and machine learning to process the massive data its services and products generate. Based on this data, NetEase conducts optimization and recommendation, customizes personalized products, and predicts user behavior to better focus on user experience.

By 2023, NetEase had announced that its self-developed generative artificial intelligence (GAI) and other key technologies had fully permeated the game development workflow, significantly enhancing digital productivity. The mobile game "Ni Shuihan" launched by NetEase in the same year is a representative example of GAI integration, the first AIGC mobile game developed in China. The game's most notable feature lies in its intelligent NPCs, which extensively utilize GAI technologies such as reinforcement learning, natural language processing (NLP), and speech generation. Furthermore, GAI applications can also be found in various other aspects of the game, including player character creation, map generation, and dynamic changes within the game world.

In addition to the strong performance of "Ni Shuihan" in 2023, another game, "Eggy Party," also achieved remarkable success. Unlike "Ni Shuihan" which integrated various generative AI technologies upon its launch, "Eggy Party" was officially released on May 27, 2022, without incorporating many generative AI technologies. Nevertheless, the game still achieved tremendous success, with a continuous strong performance after its release. It even broke NetEase's daily active user (DAU) record in the fourth quarter of 2022.

The success of "Eggy Party" cannot be separated from its unique UGC mode, which stands for User Generated Content. The UGC mode implies that users can create content on their own, acting as both the audience and users of the content and the creators of new content.

However, the even more outstanding performance of “Eggy Party” this year lies in its unique AIGC+UGC mode. The application of generative AI in the game further lowers the threshold for players to create their content, propelling the UGC ecosystem towards a new era of co-creation and sharing by all.

4.2. Evaluate the Impact of Generative AI on NetEase’s Gaming Business

According to the 2023 financial report, NetEase Corporation achieved a total revenue of RMB 103.5 billion in 2023, a year-on-year increase of 6.7%, exceeding the RMB 100 billion mark for the first time. In 2023, NetEase’s core business game revenue was RMB 81.6 billion, accounting for about 79% of the total revenue, an increase of 9.4% compared to 2022, with a growth rate higher than the overall and other businesses. The net revenue of NetEase’s online games contributed approximately 92.9% of the game revenue, and the net revenue from mobile games accounted for approximately 75.2% of the net revenue of online games. NetEase stated that the increase in profit was mainly due to the increase in the net revenue of mobile games such as “Eggy Party” and “Ni Shuihan”.

According to the 2023 annual report of NetEase Corporation, its game business revenue reached RMB 74.6 billion, and the R&D investment of the game business was approximately RMB 13.4 billion. The ROI of the game business was 24.2%, close to that of Tencent, the leading company in the domestic game industry, which was 26.1% in 2023. NetEase’s game business’s R & D investment in 2023 has achieved a relatively ideal return.

According to the data, the cumulative number of registered users of Eggy Party has reached 500 million, and the “Ni Shuihan” mobile game has attracted over 100 million active users. “Ni Shuihan” mobile game has occupied the top of the best-selling list of MMO games since its launch.

According to NetEase founder Ding Lei, at the 2024 financial report conference, the daily active users (DAU) of “Eggy Party” exceeded 40 million on New Year’s Eve 2024. NetEase’s layout of generative artificial intelligence (AIGC) and the construction of the "AIGC+UGC" ecosystem in the game have significantly promoted the increase of DAU.

In contrast, Tencent’s competing game "Metaverse Star", launched on December 15, 2023, invested 1.4 billion yuan in marketing and promotion costs. However, its popularity quickly receded after the intensive promotion period. On the other hand, “Eggy Party” has maintained its dominant position in the market with its unique gameplay and operation strategy.

In conclusion, it can be seen that NetEase’s large-scale R&D investment and rapid application of generative AI have enabled these two games to quickly improve their gaming experience and consolidate their advantages with the help of AI technology, thus quickly widening the gap with other domestic games of the same type.

4.3. Suggestions for Revenue Enhancement Based on Generative AI

Maintain investment in research and development to consolidate the company’s current leading position in applying generative AI technology.

In 2023, NetEase’s R&D investment reached a record high of over 16.5 billion yuan for the whole year, with an R&D intensity of 16%, ranking at the forefront of the industry. In contrast, Tencent’s R&D investment 2022 was 61.4 billion yuan, but its R&D intensity was only 11.07%. Over the past decade, Baidu’s average R&D intensity has remained around 15%. Sustained high-intensity R&D investment is key for NetEase to maintain its leading position in applying generative AI technology.

Expand the AI game category matrix and explore more AIGC models. AI games are still in the early stage of development, and many game genres still need to be able to integrate and apply AI effectively. As a game giant, NetEase possesses the advantages of rich game genres and abundant R&D resources. It should further explore breakthroughs in other game genres in terms of AIGC and explore more “AIGC+” modes to promote the innovative development of AI game technology.

Actively explore and deploy overseas markets. Compared with the domestic game market, which has entered stock competition, the overseas market still holds great potential. Going global is an

inevitable strategy for Chinese game companies to acquire more profits. NetEase should leverage its advantages in some games and R&D in the field of generative AI, quickly lay out the overseas market, and launch games that cater to the cultural background of global users to further expand its revenue share in the overseas market.

5. Conclusion

NetEase Company achieved a rapid and comprehensive layout in the field of generative AI technology in 2023 and applied it to its main game business with remarkable results.

The launch of “NiShuiHan” exemplifies the remarkable potential of generative AI in games. This title leverages cutting-edge technologies like reinforcement learning, natural language processing (NLP), and speech generation to create highly intelligent non-player characters (NPCs). These advancements offer a more realistic and immersive interactive experience for players and provide a way for a future where generative AI plays a transformative role in game design.

NetEase has actively applied generative AI technology in its two games “NiShuiHan” and “Eggy Party” and achieved remarkable results. This practice proves the application value of generative AI technology in game design, content innovation, player interaction, etc. It provides a very reference case for the future development of the game industry.

Furthermore, the phenomenal success of “Eggy Party” this year underscores the efficacy of the “AIGC+UCG” model. This model utilizes generative AI as a foundation to empower players with robust user-generated content (UGC) creation tools. The “AIGC+UCG” approach enhances player agency and promotes a more dynamic gameplay experience by fostering player creativity and facilitating interaction. This success provides valuable insights for developing the “AIGC+” model and offers new paradigms for future game development endeavors.

This study predominantly centers on NetEase’s application of generative Artificial Intelligence (AI) technologies in its gaming ventures, particularly on mobile platforms. This examination of mobile gaming’s contribution to NetEase’s revenues aims to highlight the concrete effects of generative AI on corporate financial outcomes. Nonetheless, it’s crucial to recognize that the gaming sector spans beyond mobile gaming, including PC and console gaming. According to Newzoo’s 2023 Global Games Market Report, mobile gaming constitutes 49% of the market share, with the remaining 51% distributed among PC games, console games, and browser PC games. Delving into the function of generative AI across these gaming sectors and its specific fiscal advantages for gaming firms emerges as a pivotal direction for forthcoming research.

NetEase, a prominent gaming enterprise with various games, significant R&D capabilities, and ample financial resources, naturally holds advantages in exploring and implementing AI in gaming. Conversely, in the Web 3.0 era, where internet authority is increasingly dispersed, how individual or small team developers can benefit from the rise of generative AI remains a critical research area. The potential of generative AI to aid individual or team developers needs further scrutiny.

Additionally, this study points out the need for more quantitative analysis. Future studies could use a more thorough quantitative evaluation of diverse factors affecting the gaming market to accurately gauge the revenue generative AI contributes to gaming businesses, significantly augmenting research in this domain.

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