Research on Innovation and Open Strategy in the Construction of Google's AI Ecology

Hexuan Qu *

Department of Management, UWA University, Perth, Australia

* Corresponding Author Email: 24757775@student.uwa.edu.au

Abstract. With the development of AI technology, how to maintain core competitiveness and promote the openness of the ecosystem to facilitate collaborative innovation has become an important issue for global technology companies. This study takes Google as a case study to analyze its strategy and practice of achieving a balance between technology openness and protection in the field of AI. This study explores the impact of Google's multi-level technology layered openness strategy on its core competitiveness and eco-innovation through literature review, SWOT analysis, Porter's Five Forces analysis model, and regression statistical model. The results show that Google has not only expanded its AI ecological influence but also significantly increased the overall innovation speed of the industry by opening up its tools setting industry standards and attracting the participation of global developers. Meanwhile, patent protection, technology encryption and the closed strategy of core algorithms effectively prevented the risk of technology leakage and ensured its technological dominance. However, the study also found that Google faces challenges such as core technology leakage, high maintenance costs of the open ecosystem and increased competition. In response, Google has achieved a balance between openness and protection by optimizing the depth of openness, strengthening partnerships, and expanding cross-industry applications. This study provides an important practical reference for AI companies to realize strategic balance between technology protection and ecological openness, and reveals the key role of technology ecological openness in driving industry innovation and maintaining market leadership.

Keywords: Open AI ecosystem; maintain technology core competitiveness; enhance ecosystem stickiness; technology layered openness; cooperative innovation.

1. Introduction

In recent years with the development of the times, the rapid development of Artificial Intelligence (AI) technology has become one of the core driving forces for technological progress, business innovation and social change. In this process, Google as a technology giant company plays an important role and Google AI technology innovation in many areas have made outstanding achievements, such as machine learning, natural language processing (NLP), computer vision and other areas. Moreover, Google's core technologies (e.g., the Transformer model, the TensorFlow framework) are highly competitive in the industry, which support its search engine, advertising services, cloud computing, and autonomous driving businesses. However, in order to promote innovation and cooperation, Google needs to maintain the competitiveness of its core technologies while opening up its AI ecological platform scientifically and effectively, and at the same time avoiding various types of risks. Therefore, the purpose of this paper is to analyze how Google balances between the competitive strategy of maintaining its technological core and the strategy of opening up the AI eco-platform.

2. Literature Review

First, Google, as a global leader in the technology industry, continues to maintain its core competitiveness through technological innovation, a multi-level open strategy, and a strong ecological construction. Jeff Dean et al. point out that Google's core competitiveness focuses on world-leading technologies, such as deep learning, powerful arithmetic and data integration capabilities, and the support of the industry's top research team [1]. These advantages enable Google

to develop iconic technologies such as Transformer and apply them in the fields of search engine, cloud service and advertising system, thus forming an irreplaceable industry position. At the same time, Google consolidates technical barriers through patent protection and technical encryption measures, and optimizes arithmetic performance and application efficiency through internal resources, enabling its products and services to occupy a leading position in the market [2]. In order to drive industry progress and promote collaborative innovation, Google views opening up the AI ecosystem as a key strategy. Second, Google attracts global developers to participate in the practice by opening up frameworks such as TensorFlow, which not only enhances the speed of innovation in the industry, but also helps Google to become a standard-setter in the AI industry [3]. By opening up big model APIs and providing developers with tool support, Google has enhanced the stickiness of the ecosystem while maintaining technological leadership. However, this open strategy also faces challenges, Google may face the risk of imitation of its core technology, high maintenance costs, and competitors' use of open resources to develop competitive products while opening up the ecosystem. In addition, data privacy, technical ethics and regulatory restrictions may also pose constraints on Google. Therefore, Google optimizes its open strategy by distinguishing the depth of openness between core and general-purpose technologies; at the same time, it strengthens its support for partners, expands the application scenarios of AI technologies, and enhances the overall competitiveness of the ecosystem. By finding a finer balance between openness and protection, Google can not only consolidate its core competitiveness, but also continue to lead the development of the AI industry.

3. Research Methodology

This study adopts a mixed-method approach, using the SWOT model and the Porter's Five Forces model to qualitatively analyze Google's strategic positioning as well as to explore its specific measures for balancing core competitiveness and open ecology. This study employs a combination of linear regression and diversified regression models for quantitative analysis to examine the direct impact of Google's AI ecological openness risk on innovation outcomes. Additionally, it investigates the combined effect of Google's AI ecological openness risk and the number of collaborations on market competitiveness. The analysis encompasses Google's strategic dimensions, technological dimensions, market dimensions, cooperation dimensions, innovation ecology dimensions, and the impact of risks and constraints.

4. Findings

The analysis of Google AI's strategy using SWOT and Porter's Five Forces shows that it focuses on open ecology to maintain its technology leadership. Google AI promotes industry innovation through technological differentiation and a wide range of cooperation ecosystems. It aims to consolidate its core competitiveness by building a dual moat of technology and market. The core goal of Google AI is to attract developers and partners to establish industry standards through an open ecology while protecting its technological advantages to handle competition and risks. Google AI's strategy involves creating a closed-loop with layered openness of technology, establishing trust with partners, and dominating industry standards with cutting-edge technology.

4.1. Interaction of SWOT Internal and External Factors

Table 1 is SWOT model analysis of Google AI's eco-strategy in terms of technology competitiveness and open ecological analysis.

4.1.1 Interaction of strengths and opportunities (S-O)

Google AI mainly dominates industry innovation through technology and ecology and promotes ecological openness through leading AI technologies (e.g., TPU, Bard model) and brand advantages. For example, it uses TensorFlow and other open-source projects to form industry standards, attracts

developers and enterprises to cooperate, and enhances the influence of the ecosystem, and provides customized AI solutions for enterprises with the help of Google Cloud AI to expand market coverage.

4.1.2 Interaction of weaknesses and opportunities (W-O)

There is also a contradiction between the protection of Google's core technology and the open ecosystem. Therefore, Google adopts a hierarchical openness strategy that strictly protects its core technology and gradually opens up its peripheral tools, proactively participates in the development of global AI standards, and ensures its dominant position in the technology by controlling its openness through technical agreements (Apache 2.0 license and OSAID 1.0) and AI standards are being developed globally.

4.1.3 Strengths-threats interaction (S-T)

Google AI maintains its leading position in the fierce industry competition by strengthening its differentiated technology and market stickiness in the fierce industry competition. For example, Google continues to launch differentiated products by focusing on high value-added areas (e.g., medical AI, autonomous driving), and defends against competitive threats by enhancing technology experience (e.g., TPU performance optimization) and service stickiness (e.g., developer support) [4].

4.1.4 Weaknesses and threats (W-T)

Open strategy may lead to Google AI technology leakage but can reduce the negative impact through risk management, therefore, Google AI strengthens the protection of intellectual property rights and the use of monitoring, to avoid improper use of technology; at the same time, Google AI to promote the combination of technology closure and openness, the formation of the partners and the core technology, but the reasonable isolation. This shows that Google AI can balance the relationship between core technology and open AI ecosystem and technological innovation by controlling the risk of open ecology.

Table 1. SWOT model analysis of Google AI's eco-strategy in terms of technology competitiveness and open ecological analysis

Internal factors / External factors	Strength	Weakness
	1. Has the world's leading AI technology (such as TensorFlow and TPU) and brand influence. 2. Using the Apache 2.0 license, which allows technology to be open and shared, helping Google expand its technology ecosystem reach. 3. By participating in the development of OSAID 1.0 (Open-Source AI Definition), Google has taken a leading role in industry standardization, further consolidating its industry position.	1. An open strategy may lead to leakage of core technology and intellectual property risks, weakening competitive advantages. 2. Google needs to find a balance between protecting core technologies and promoting ecological openness. 3. Competitors (e.g., Microsoft and Meta) can also utilize open-source technology open source to rapidly close the technology gap.
Opportunities	S-O	W-O
1. The open AI ecosystem drives industry standardization and enables Google to attract more developers and entrepreneurs to its ecosystem. 2. Google has the opportunity to expand into more fields such as healthcare and autonomous driving through the commercialization of AI applications (such as Google Cloud AI). 3. The growing demand for global AI cooperation provides Google with opportunities to strengthen international cooperation and technology output.	Leading industry innovation through technology and ecology	Optimizing technology layering
Threats	S-T	W-T
1. Increased threats from competitors (e.g., Microsoft's OpenAI collaboration, Meta's open-source big models) and emerging startups, and a more competitive market. 2. Increasingly stringent policy and regulatory restrictions on AI technology may hinder the implementation of Google's open strategy. 3. The open ecosystem may lead to a weakening of partners' reliance on Google, resulting in the emergence of new competitors.	Strengthen differentiated technology and market stickiness	Controlling Open Ecology Ecological Risks

4.2. Porter's Five Forces Analysis Model

This research also applies Porter's Five Forces analysis model (Figure 1) to Google AI's eco-strategy in terms of the balance between competitive pressure and collaborative innovation.

Google AI is in an extremely competitive and complex marketplace. First, at the forefront of the industry, Microsoft, OpenAI, the open source community, and Apple are all showing strong competitiveness, posing multifaceted challenges to Google. Microsoft and OpenAI have joined hands to integrate cutting-edge AI technologies into Bing search engine and various productivity tools, such as fully integrating Copilot in the Windows system and interfacing with ChatGPT, which directly hit Google's core business and triggered a significant impact; OpenAI relies on the constantly evolving GPT series models, such as GPT-4 turbo, to provide excellent upgrades in multiple fields[5]. OpenAI, relying on its constantly evolving GPT series models, such as GPT-4 turbo, has been upgrading its functions in many fields, dominating the direction of natural language processing and other AI technologies, attracting a large number of developers and enterprise customers, and diverting potential resources from Google. Relying on its complete hardware ecosystem, Apple has deeply implanted AI technologies in devices such as iPhone, iPad and Mac, and with the unique layout of Siri intelligent functions and consumer-grade AI applications, it is competing with Google on multiple levels with the strategy of hardware and software synergy to grab market share and user attention[6].

However, the rise of the open source community with open source models such as Llama released by Meta. The ability of many developers to quickly get up to speed and customize their development on-demand have emerged in the field of AI development with low-cost and high-adaptability qualities.Additionally, developers not only capture a large amount of market share and developer groups, but also lowers the barrier to entry for AI technology. This allows emerging companies and small and medium-sized enterprises (SMEs) to utilize the cloud platforms of Google and AWS to develop vertical applications, and even regional giants such as Baidu and Ali have taken advantage of the situation to expand into the international market, resulting in the weakening of Google's global influence[7]. What's worse, open source AI models (e.g., LLaMA, Stable Diffusion) have attracted many developers with their low-cost advantage, while hardware optimization solutions from NVIDIA and others have allowed companies to avoid Google's cloud services, further squeezing Google's business space.

In addition, Google's supply chain also has hidden problems, its dependence on hardware (such as NVIDIA GPUs) and data resources, the lack of supply of hardware and the tightening of privacy regulations, increasing the difficulty of obtaining high-quality data and powerful arithmetic, and may even cut profits. Finally, in the customer dimension, enterprise customers have stronger bargaining power due to the price war between Microsoft Azure and AWS, and individual users have high expectations of generative AI and low replacement costs, which all exacerbate the risk of Google's user loss[8].

Figure 1. Porter's Five Forces model analysis of Google AI's eco-strategy in terms of the balance between competitive pressure and collaborative innovation

4.3. Linear Regression Model

Therefore, the qualitative analysis of this study provides logical support and hypothesis basis for the quantitative analysis. In the SWOT model, two key hypotheses can be put forward: one, openness risk has a significant negative impact on innovation outcomes; the other, the number of cooperation has a positive effect on market competitiveness, and the interaction effect between it and openness risk is particularly significant. Meanwhile, the logic of variable selection is further clarified through the analysis of Porter's five forces model. First, in the context of potential entrants and the threat of substitutes, the intensification of competitive pressure amplifies the negative impact of openness risk on market competitiveness; second, in the bargaining power of suppliers and buyers, whether the increase in the number of cooperation can effectively alleviate the external competitive pressure, which becomes an important intermediary mechanism to promote market competitiveness. This logic provides a clear path and data support for the study. Therefore, combining the SWOT model and Porter's Five Forces analysis model in the qualitative analysis, the linear regression model is used to analyze the risk of openness of Google's AI eco-platform (e.g., the degree of openness of technology and data) on the direct impact of innovation outcomes on. The aim is to assess whether there is a negative risk to openness of Google's AI eco-platform, which in turn has a significant impact on innovation outcomes. The independent variable is Openness Risks which refers to the risks that the eco-platform may be exposed to in the process of technology or data openness, such as competitor plagiarism or privacy leakage. The dependent variable is Innovation Outcome, which is used to measure the platform's technological innovation capability, such as the frequency of new technology releases and the degree of performance improvement. The blue crosses represent actual data points aimed at the innovation outcomes (vertical axis) actually achieved by the firm or organization at a specific level of openness risk (horizontal axis) by Google AI. The trend of negative correlation, the significant negative regression coefficient (slope), the goodness of fit (R^2=0.09) and the degree of dispersion of the data (distribution of the data points around the regression line) in this model (Figure 2) show that openness risk has some negative impact on the innovation outcomes, but its impact is not significant. The data suggests that despite the openness risk, Google's AI ecosystem has been able to maintain a certain level of innovation outcomes, suggesting that other factors such as technological advantage, R&D investment, and market strategy play a greater role in the innovation process [9]. However, in the long term, Google must be wary of the potential threats posed by openness risk, especially in the context of increased competition and rapid technological development. Google needs to find the right balance between openness and risk management to ensure the sustainability and competitiveness of innovation.

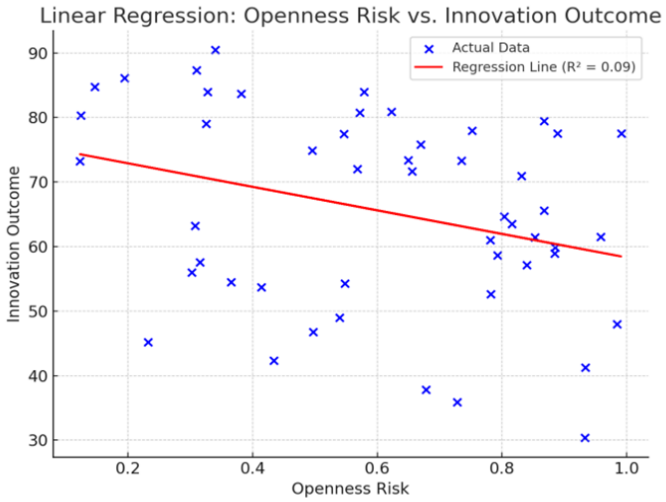

Figure 2. Plot of linear regression model analyzing the impact of openness risk on innovation outcomes in Google's AI ecosystem

This research not only analyzes Google AI's ecological strategy from linear regression models, but also from diversified regression models with multiple perspectives (Figure 3).

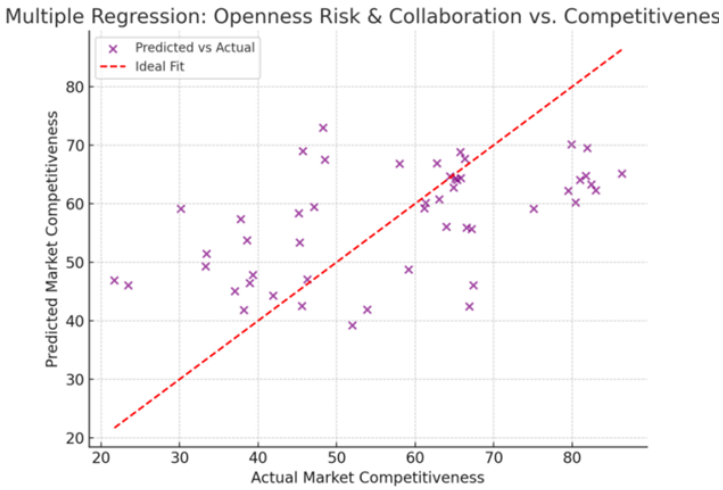

Figure 3. Plot analyzing a diversified regression model of the impact of openness risk and number of collaborations on market competitiveness in Google's AI ecosystem

This multivariate regression model (Figure 3) is used to analyze the combined impact of the risk of openness and the number of collaborations on market competitiveness of the Google AI ecosystem. The objective is to assess the potential threat or facilitation of openness strategies and collaboration patterns on the market competitiveness of Google's AI ecosystem platform by analyzing the combined effect of multiple key factors. In this model, the independent variables are Openness Risks and Collaboration Count, and the dependent variables are Market Competitiveness, such as market share, user growth rate, which are used to measure the comprehensive competitiveness of the platform in the market. In the multiple regression model, the openness risk factor has a more significant effect on the market competitiveness factor, while the cooperation count factor has a smaller effect. And combining the two factors of openness risk and the number of cooperation, the model explains part of the changes in market competitiveness, which can be seen from this model, which reflects the limited explanatory power of the dependent variable (market competitiveness) because the R^2 value of 0.29 in the figure means that 71% of the changes in market competitiveness are caused by other factors that are not included in the model. This suggests that although the openness risk factor and the number of collaborations factor have an impact on the market competitiveness factor, they are not the main drivers, and it is possible that other factors (e.g., technological strength, market environment) may have a greater impact on market competitiveness, but still cannot be ignored. Therefore, these two regression models can be used to quantitatively assess the openness strategy of the Google AI ecological platform and the risks it brings, and provide data support for the platform to optimize its openness and cooperation strategy.

5. Discussion

This research provides an in-depth analysis around how Google maintains its core competitiveness, promotes cooperation and innovation, and copes with the corresponding risks by opening up its AI ecosystem. This paper uses the results of regression statistical model analysis, SWOT analysis and Porter's five forces model for analysis. This study explores the core competitiveness of Google AI. It stems from the world's leading artificial intelligence technology advantages, strong algorithm and data integration capabilities, and the support of the industry's top research team. For example, the development of technologies such as TensorFlow and TPU not only consolidates its technological leadership, but also further enhances the overall level of innovation in the industry through openness. As can be seen from the SWOT analysis diagram, Google has successfully occupied an industry

leadership position through its participation in the development of industry standards, further consolidating its brand influence. In addition, while opening up the ecosystem, Google has achieved a balance between technology protection and industry dominance through the strategy of distinguishing between core and general technology. Second, the regression model shows that both the risk of openness of Google's AI ecosystem and the number of collaborations have a significant impact on market competitiveness [10]. In particular, Google attracts global developers and enterprises to participate in the open ecosystem, which realizes the development of industry standards and ecological expansion. This echoes the Porter's Five Forces model of "increasing ecological stickiness", indicating that an open ecosystem helps to increase partner dependence, thus promoting industry innovation. Meanwhile, the external opportunities in the SWOT analysis also provide Google with the opportunity to obtain more market growth points through open ecology; however, although Google's open ecosystem strategy has achieved remarkable results, it also faces the risk of its core technology being imitated or surpassed, the high cost of maintaining the open ecosystem, and the risk of competitors' use of open resources to develop competing products Porter's Five Forces model further reveals that potential entrants and intense market competition may threaten Google's industry dominance[11]. In addition, data privacy, technological ethics and regulatory pressure also constitute external constraints on Google's openness strategy; therefore, in order to find a balance between openness and protection, Google adopts a multi-level openness strategy: keeping the core technology closed, opening up the use of peripheral tools, and protecting the distribution of ecological benefits through the framework of business cooperation. This strategy is not only in line with the recommendation of "optimizing the layered openness of technology" in the SWOT analysis, but also can reduce the risk of core technology leakage. The "layout of cutting-edge technologies" in the Five Forces model further suggests that Google can transform its technological advantages into broader market opportunities through cross-industry cooperation and expanding application scenarios [12]. In addition, Google needs to continue to support its partners to consolidate the stickiness of the ecosystem, and at the same time, improve the efficiency of computing power through internal resources to maintain competitiveness.

Combining the literature review, regression statistical model analysis, SWOT model, and Porter's Five Forces model, this study shows that Google not only maintains its core competitiveness but also successfully promotes innovation in the industry through the combination of technology protection and open ecosystem. However, the risks associated with the open strategy require Google to further optimize its technology layering management and expand its market influence in cross-industry cooperation [13]. In the future, how to fine-tune the adjustment between openness and protection will be the key to Google's continued leadership in the AI industry.

6. Conclusion

To summarize, the key to Google's open AI ecosystem to promote cooperation and innovation while maintaining its core competitiveness of world-leading technological advantages, powerful arithmetic power, and data integration capabilities lies in Google's implementation of a "multi-level technology layered open strategy". Google through open tools (such as TensorFlow), development industry standards to attract global developers to participate in these initiatives to expand the influence of the ecosystem and enhance the speed of innovation in the industry. At the same time, Google ensures that key technologies are not copied or surpassed through measures such as patent protection, technical encryption, and core algorithm closure. By optimizing the depth of openness, Google has strengthened partnerships and expanded cross-industry applications. At the same time, Google avoids core technology leakage, maintenance costs, and protects core technology in this way. By optimizing the depth of openness, strengthening partnerships and expanding cross-industry applications, Google is able to avoid the risks of core technology leakage, high maintenance costs and intensified competition, and ultimately achieve a balance between openness and protection to further consolidate its industry-leading position.

References

[1] Dean, J. Google's annual AI technology summary: Future prospects for artificial intelligence. 2021. Retrieved from https://cloud.tencent.com.

[2] Vzkoo. Comprehensive analysis of Google AI strategic layout: 2023 artificial intelligence industry special report. 2023. Retrieved from https://www.vzkoo.com.

[3] Goodfellow, I., Bengio, Y., & Courville, A. Deep learning. MIT Press, 2016.

[4] Pattani, A. How Google AI is transforming search and advertising. Forbes, 2020, January 23. Retrieved from https://www.forbes.com/sites/forbestechcouncil/2020/01/23/how-google-ai-is-transforming-search-and-advertising/.

[5] Russell, S., & Norvig, P. Artificial intelligence: A modern approach (3rd ed.). Pearson Education, 2016.

[6] The Paper. Google: AI as the core, enhancing developer efficiency with large models. 2023. Retrieved from https://www.thepaper.cn.

[7] Wu, T. The master switch: The rise and fall of information empires. Knopf, 2018.

[8] Dai, Y., & Liu, G. Survey of Intelligent Chatbot Technology. Comput Sci Appl, 2018, 8: 918.

[9] Sun, Z., Li, H., Xi, Y., & Li, Q. Development analysis of artificial intelligence and neural networks. Comput. Sci. Appl, 2018, 2: 154-165.

[10] Shilong, M. A., Qi-Qige, W. U. N. I. R. I., & Xiao-Ping, L. Deep learning with big data: state of the art and development. CAAI Transaction on Intelligent Systems, 2016, 11(6): 728-742.

[11] Callaway, E. 'It will change everything': DeepMind's AI makes gigantic leap in solving protein structures. Nature, 2020, 588(7837): 203-205.

[12] Floridi, L. AI as agency without intelligence: on ChatGPT, large language models, and other generative models. Philosophy & technology, 2023, 36(1): 15.

[13] Aydın, Ö., & Karaarslan, E. Is ChatGPT leading generative AI? What is beyond expectations? Academic Platform Journal of Engineering and Smart Systems, 2023, 11(3): 118-134.