

Research on the Effect of High-tech Enterprise M&A on Innovation: Taking Hisense Vision's Acquisition of Toshiba TVS as an Example

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Abstract

Taking Hisense Vision's acquisition of Toshiba TVS as an example, this paper comprehensively analyzes the impact of technology mergers and acquisitions on innovation effects through financial analysis method and DEA analysis method. First of all, from the analysis of innovation input and innovation output, it is found that Hisense Vision has significantly improved these two indicators after technology mergers and acquisitions. Secondly, using Hisense Vision's input and output indicators in the past 8 years as the original data, the changes in the innovation effect before and after the merger and acquisition of enterprise technology are analyzed. Finally, the study found that Hisense Vision has achieved the improvement of enterprise innovation performance through the integration of technical resources, organizational talents and market resources.

Keywords

Technology M&A; Innovative Effects; Hisense Vision; DEA Analysis.

1. Introduction

Innovation is the first driving force for leading development and the strategic support for improving social productivity and comprehensive national strength. The "14th Five-Year Plan" proposes: It is necessary to adhere to the core position of innovation in the overall situation of China's modernization construction, take scientific and technological self-reliance and self-improvement as the strategic support for national development, deeply implement the innovation-driven development strategy, improve the national innovation system, and accelerate the construction of a scientific and technological power. In recent years, in order to deeply implement the development strategy driven by scientific and technological innovation, all provinces and cities across the country have accelerated the cultivation and expansion of high-tech enterprises. For high-tech enterprises, the state has also implemented various preferential policies to encourage major enterprises to increase investment in innovation. According to China News Network statistics, as of December 31, 2021, the number of high-tech enterprises in the country has increased from more than 100,000 in 2016 to more than 330,000, R&D investment has accounted for 70% of the national enterprise investment, and the amount of taxes paid has also increased to 2.3 trillion yuan. High-tech enterprises have made outstanding contributions to tax payment and job provision, and have become the backbone of local economic development.

With the rapid changes in the market environment and the increasingly fierce competition among enterprises, it is particularly important for high-tech enterprises to enhance their technological innovation capabilities. However, their own technology research and development activities often require more investment and a long research and development

cycle, so the excessive pursuit of research and development innovation may bring greater risks to the enterprise itself, therefore, compared with its own research and development, more and more enterprises are beginning to tend to quickly obtain technology from the outside. As a new way to obtain technological innovation, technology mergers and acquisitions have received more and more attention from enterprises in recent years.

For technology mergers and acquisitions, domestic and foreign scholars have conducted a lot of research on this aspect. Technology mergers and acquisitions can quickly bring corresponding resources, technology, etc. to enterprises, but due to the different characteristics of each enterprise, whether there can be synergies after mergers and acquisitions is often the key to determining the success of technology mergers and acquisitions [1]. Enterprises implement technology M&A strategies to improve their technology chain [2], while the effective combination of acquired new technologies and old technologies can further improve a series of problems such as the lack of innovation of enterprises [3]. Based on this, on the basis of previous research, this paper intends to first analyze Hisense Vision's acquisition of Toshiba TVS using the traditional financial analysis method, and then use the DEA method to analyze the impact of the company's technology merger and acquisition on the innovation effect of the enterprise.

2. Introduction of Research Methods and Event

2.1. Research Methods

The research method in this paper is a case study method. Compared with other research methods, the case study method is more specific and in-depth to a single typical case study, easier to explore the causes and consequences of the event, and more conducive to analyzing the representativeness and particularity of the case company. At the same time, this paper uses a combination of financial analysis and DEA analysis to analyze the technical mergers and acquisitions of case companies.

2.2. Case Introduction

2.2.1. Company Profile

Hisense Vision Technology Co., Ltd. (hereinafter referred to as Hisense Vision) (stock code: 600060) is a high-tech enterprise founded in 1997, is the largest subsidiary of Hisense Group, the main business scope includes display product research and development, production, sales and cloud services, chips and other new display business sectors. Hisense Vision, formerly known as Qingdao Hisense Electric Appliances, officially changed its name in December 2019. Hisense is deeply loved by consumers with its brand's technical strength, and has ranked first in the home appliance industry for many years. In 2021, Hisense TV user satisfaction ranked first in the industry and ranked 275th in the 2021 Fortune China 500.

Toshiba TVS, whose full name is Toshiba Image Solutions Co., Ltd., is one of the subsidiaries of the Toshiba Group of Japan, specializing in the research and development, production and sales of multimedia products, the main products include: smart home, display and color TV. Toshiba TVS has been attaching importance to technology research and development for many years, and it has become a leader in the field of display with its own unique research and development technology, which is one of the reasons why Hisense Vision acquired Toshiba TVS.

2.2.2. Introduction to M&A Event

Toshiba Group's acquisition of Westinghouse Electric at a high premium of \$5.4 billion brought huge financial pressure to the company, and then Toshiba Group was exposed to negative information such as financial fraud and huge losses, making it have to make the choice to sell its subsidiaries. In 2017, Toshiba Group announced the sale of its subsidiary, Toshiba TVS, and Hisense Vision conducted a detailed investigation and held a board meeting in November of

that year. After the board of directors, Hisense Vision announced that it will purchase a 95% stake in Toshiba TVS held by the Toshiba Group, and the remaining part is still owned by the Toshiba Group, and the purchase price is planned to be 12.9 billion yen (about 753 million yuan). On February 28, 2018, after negotiations between Hisense Vision and Toshiba, the equity transaction amount was initially changed to 76.82 yen (about 453 million yuan). On July 25, 2018, the two parties adjusted the purchase amount again, and the final delivery price was 5.985 billion yen (about 353 million yuan), and the transaction was finally delivered in cash, and the merger was completed.

2.2.3. Analysis of M&A Drivers

2.2.3.1. Comply with Policy Orientation

In 2015, the China Home Appliance Association issued an announcement that all home appliance enterprises should attach importance to accelerating industrial upgrading, focus on technological innovation, and shift from "manufacturing" to "intelligent manufacturing" to improve the comprehensive strength of China's home appliance industry. In the same year, the state actively issued a number of policies, industry policies to guide the home appliance enterprises to seize the opportunity in such a severe environment, so enterprises must pay attention to research and development innovation, and constantly improve their own technical strength, in this context, Hisense Vision actively conforms to the policy orientation to carry out technology mergers and acquisitions to quickly enhance the innovation ability of enterprises.

2.2.3.2. Quickly Obtain Technical Resources

Hisense Vision has always attached great importance to the R & D and innovation of enterprises, and constantly introduces new products, and its technical level in the display has been in the leading position in the industry. However, with the rapid development of OLED TVs, the market share of the product continues to increase, Hisense Vision has to enter the OLED product market, but although Hisense Vision has been deeply developed in this area for many years, it has not broken through the technical problems. As a world-renowned Japanese company, Toshiba TVS is excellent in both display technology and chip technology, and has also mastered the unique technology of OLED screens. For Hisense Vision, the advanced technology of Toshiba TVS is very valuable, and the two can play the technical advantages of both sides through technology integration, make up for the technical shortcomings of Hisense Vision, achieve technological breakthroughs in the OLED field, and enhance the comprehensive strength of enterprises.

3. The Impact of Technology Mergers and Acquisitions on the Effectiveness of Innovation

3.1. Based on a Financial Analysis Perspective

3.1.1. Selection of Evaluation Indicators

In this paper, the literature of domestic and foreign scholars in technology mergers and acquisitions and innovation effects is sorted out, and it is found that most scholars construct an innovation effect evaluation system from the aspects of innovation input and innovation output. Therefore, this paper will also select evaluation indicators from the above two aspects.

3.1.2. Innovation Input Indicators

The innovation investment indicators selected in this paper are mainly considered from the two aspects of R&D capital investment and R&D personnel investment.

3.1.2.1. R&D Capital Investment

R&D expenditure is an important indicator to evaluate the innovation effect of enterprises, which measures the capital investment of enterprises in R&D innovation, and is also the first

step for enterprises to increase technological innovation [4]. The larger the index, the greater the possibility of the enterprise obtaining technological innovation, so this paper selects the scale of R&D expenses and the proportion of R&D expenses of the case company from 2014 to 2021 to analyze the R&D capital investment before and after the merger and acquisition of the case company.

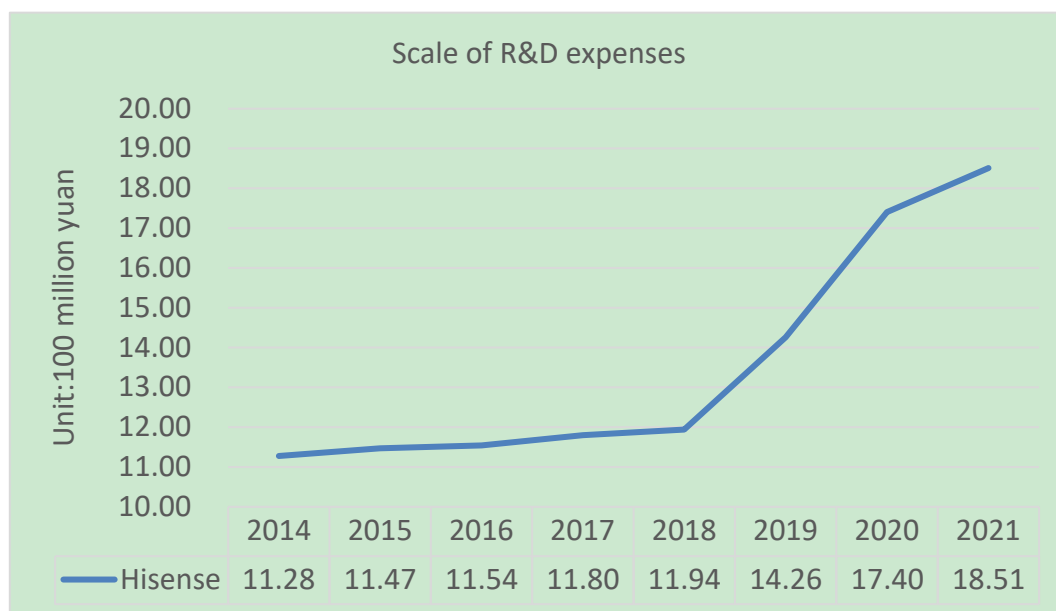


Figure 1. The scale of R&D expenses of Hisense Vision from 2014 to 2021

As can be seen from Figure 1, Hisense Vision's R&D investment in 2014-2018 was generally stable, and it increased slightly in the past five years. However, Hisense Vision increased its investment in research and development funds in the second year after the completion of the formal merger and acquisition in 2018, and the research and development expenditure reached 1.851 billion yuan by 2021. It can be seen that this technology merger and acquisition has brought greater R&D impetus to Hisense Vision, and also because of the advantages of Toshiba TVS in OLED technology, Hisense Vision has vigorously entered the field. In 2019, Hisense Vision finally successfully broke through the OLED technical problems and successfully launched a number of new products.

Examining the scale of R&D expenses of enterprises alone may ignore the impact of the size of the enterprise on this indicator, so the proportion of R&D expenses of Hisense Vision will be further analyzed. The proportion of R&D expenses of Hisense Vision in 2014-2021 is shown in Table 1 and Figure 2.

Table 1. Proportion of R&D expenses of Hisense Vision from 2014 to 2021

Year	2014	2015	2016	2017	2018	2019	2020	2021
R&D expenses (100 million yuan)	11.28	11.47	11.54	11.80	11.94	14.26	17.40	18.51
Operating income (100 million yuan)	290.10	301.90	318.30	328.70	351.30	341.00	393.10	468.00
Percentage of R&D expenses (%)	3.89%	3.80%	3.63%	3.57%	3.40%	4.18%	4.43%	3.96%

Source: Hisense Vision Annual Report

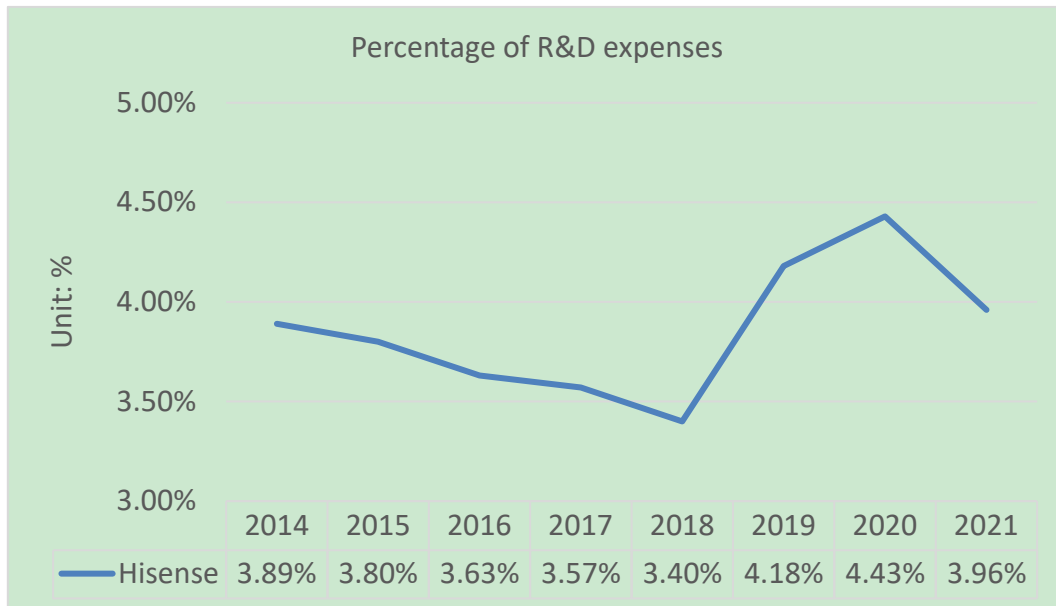


Figure 2. The proportion of R&D expenses of Hisense Vision from 2014 to 2021

Hisense Vision has always attached great importance to scientific research and innovation, and has been taking "innovation and development" as the development concept of the enterprise for many years. From 2014 to 2018, the proportion of the company's research and development expenses decreased year by year, and no major technological breakthroughs were made during this period, which is certainly not a good thing for Hisense Vision. However, after Hisense Vision's acquisition of Toshiba TVS, the proportion of R&D expenses has increased significantly. On the one hand, Toshiba TVS has injected more R&D talents at home and abroad into Hisense Vision, and will increase investment in R&D funds to a certain extent. On the other hand, Hisense Vision and Toshiba TVS have complemented each other's technical resources, and the acquired OLED technology has also enabled Hisense Vision to increase its research and development efforts in this market products. At the same time, the integration of resources after technology mergers and acquisitions will also bring more revenue to enterprises, so that enterprises will invest more funds in research and development.

3.1.2.2. R & D Personnel Investment

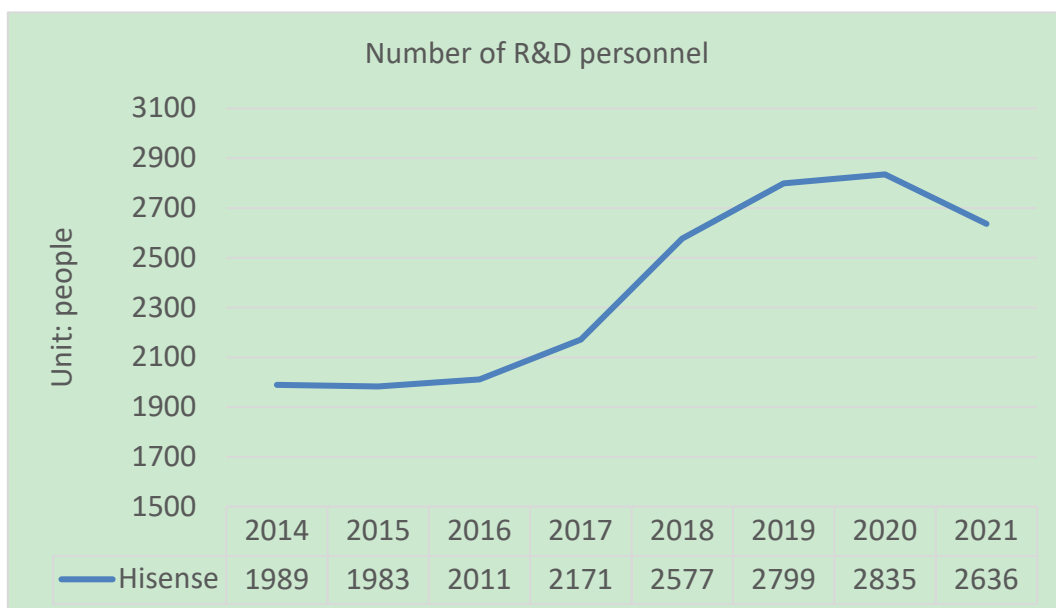


Figure 3. Hisense Vision's number of R&D personnel from 2014 to 2021

The number of R&D personnel is one of the important indicators to measure the innovation effect of enterprises [5]. Enterprise R & D personnel are the creators of enterprise R & D results, is the core competitiveness of enterprises. The greater the number of R&D personnel, the higher the importance of technology research and development of enterprises, and further explains the high scientific research and innovation ability of enterprises.

As can be seen from Figure 3, the number of R&D personnel of Hisense Vision in 2014-2021 showed an overall upward trend. Before the merger, Hisense Vision's R&D personnel increased slowly. In 2018, the number of R&D personnel of Hisense Vision increased by 406, which is because Toshiba TVS has injected more fresh blood into Hisense Vision and expanded the R&D team of Hisense Vision. It can be concluded that this technology merger and acquisition has improved the overall innovation ability of Hisense Vision, and the continuous introduction of new products has also increased the market share of enterprises.

At the same time, this paper also supplements the analysis of the proportion of R&D personnel. This indicator is consistent with the overall trend of the number of R&D personnel indicator, as shown in Figure 4. This indicator has been greatly improved from 2018 and reached its highest value in 2019, mainly because Hisense Vision has continuously adjusted the organizational structure of the enterprise in 2019, and the total number of employees has declined, but the number of R&D personnel has increased, which can be seen that the company is continuously optimizing the functions of each position, reducing idle personnel as much as possible and reducing the expenditure of the enterprise.

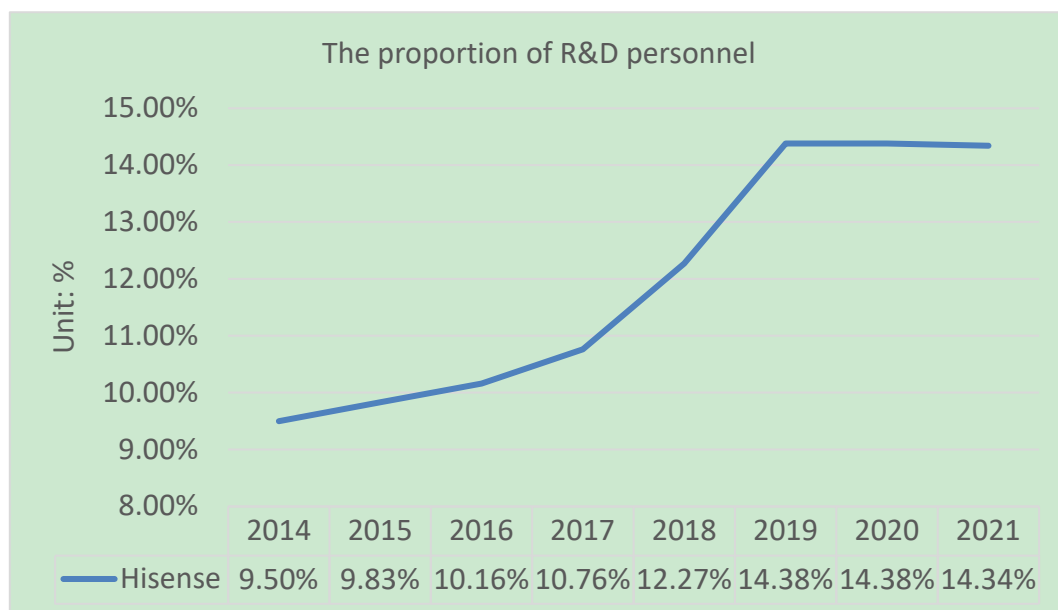


Figure 4. Hisense Vision's proportion of R&D personnel from 2014 to 2021

In summary, after the technology merger, Hisense Vision not only expanded the scale of R&D expenses, but also optimized the quality of talents of the enterprise, and further reflected Hisense Vision's emphasis on R&D innovation. At the same time, the technical resources of the two sides have played a good synergistic effect, providing a strong technical guarantee for the future development of Hisense Vision.

3.1.3. Innovation Output Indicators

3.1.3.1. Technical Output

Technology output is the most direct indicator to measure the effectiveness of enterprise innovation [6]. In this paper, the number of patent applications filed by Hisense Vision from

2014 to 2021 is analyzed, as shown in Figure 5. The number of patent applications is the most direct embodiment of the innovation output index of the enterprise, the larger the index, the stronger the innovation ability of the enterprise, and the indicator can well reflect the innovation results of the enterprise.

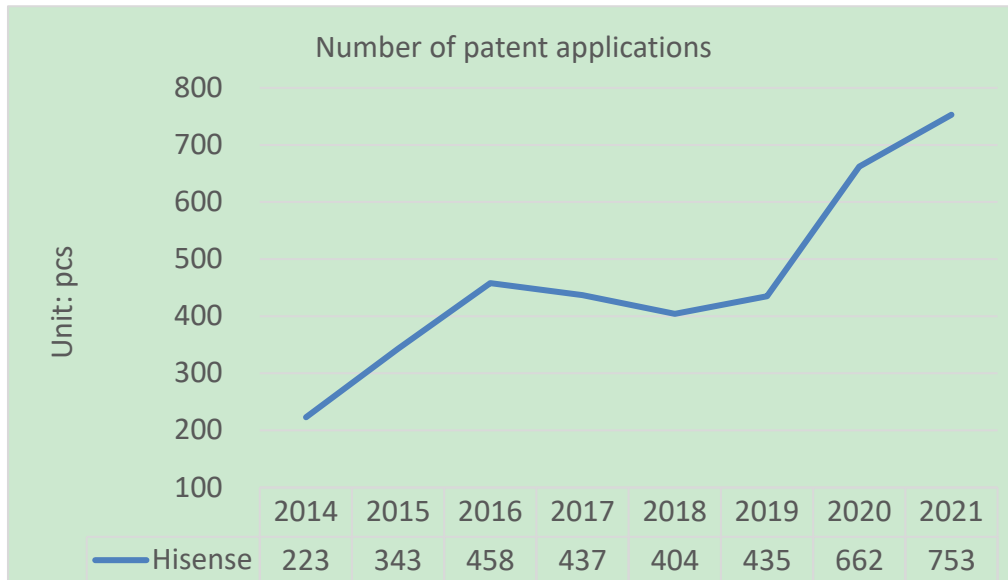


Figure 5. Number of patent applications filed by Hisense Vision from 2014 to 2021

Source: China National Intellectual Property Administration

As can be seen from Figure 5 above, Hisense Vision has steadily increased the number of patent applications from 2014 to 2016, which is due to the introduction of various policies by the state in 2015 to guide enterprises to attach importance to scientific research and innovation. In 2017, the number of patent applications of enterprises began to decline, indicating that Hisense Vision's technology research and development encountered bottlenecks and urgently needed breakthroughs. After the acquisition of Toshiba TVS, the number of patent applications began to rise continuously, which shows that the merger has improved the overall research and development level of Hisense Vision.

3.1.3.2. Economic Output

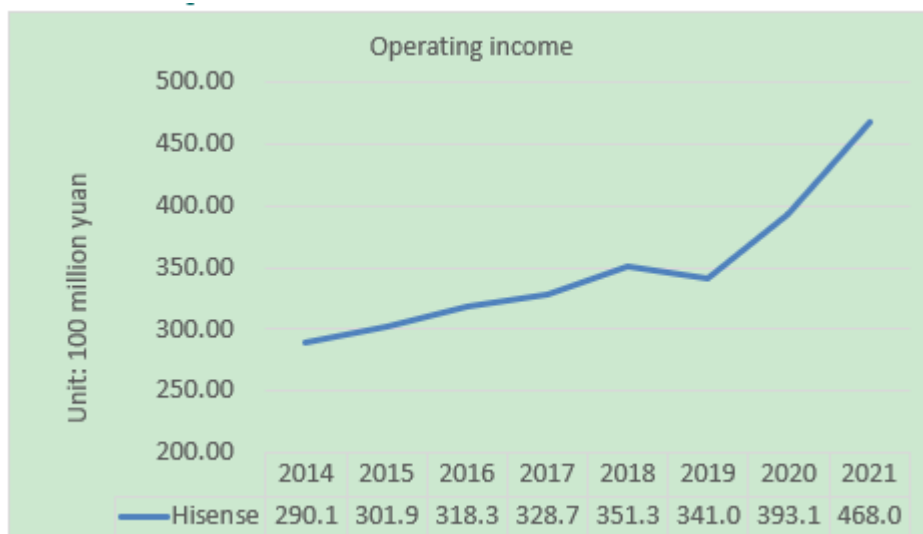


Figure 6. Hisense Vision's 2014-2021 revenue trend

Hisense Vision and Toshiba TVS continue to integrate resources, giving full play to the synergy effect of mergers and acquisitions, improving the comprehensive competitiveness of enterprises, but also bringing good revenue to enterprises and creating more value.

Hisense Vision's revenue in 2014-2021 showed an overall upward trend, as shown in Figure 6. Operating income only declined slightly in 2019, mainly because after the merger was completed, the company needed enough time to integrate resources with funds. At the same time, the company increased the investment in research and development funds that year, broke through the technical difficulties, and developed new products, which also made the company's operating income rise sharply in 2020. This shows that this technology merger and acquisition has enabled Hisense Vision to quickly acquire new technologies, continuously launch high-quality products, and win the love of consumers.

3.2. Based on the Perspective of DEA Analysis

3.2.1. Selection of Data Indicators

The data envelopment analysis method (DEA) differs from the previous evaluation analysis method of single input and single output, which can compare the relative efficiency between multiple input and multiple output decision units (DMUs) [7]. When using this method, multiple indicators of multiple companies can be cited for comparative analysis, or the data of multiple years of a company can be analyzed, and finally the relative effectiveness of the evaluation is analyzed by the deviation of the decision unit [8].

In the specific application, the DEA method does not need to determine the functional relationship between the data, can directly enter the acquired first-hand data into the model, to some extent, the method can reduce the influence of subjective factors [9], so that the experimental results are more objective and more convincing, which is why the DEA method is used for research in this paper.

According to previous research literature, the selection of data indicators is crucial for the presentation of research results [10]. For the research of the innovation effect of enterprises, there are many indicators for researchers to choose, many scholars often choose according to their previous research experience and preferences when choosing data indicators, and some scholars will learn from the methods of many authoritative journals and then synthesize their own topic selection characteristics for data indicators.

DEA analysis is the same as other innovative effects analysis methods, and the selection of data is crucial if this method can be used effectively [11]. When using different analysis methods, it is necessary to combine the characteristics and development directions of each company, so when applying the DEA method, there is no unified standard for the selection of indicators [12][13]. According to the existing research literature at home and abroad, the selection of relevant authoritative literature data indicators in recent years is summarized, and the input indicators and output indicators are selected for analysis in this paper.

Table 2. Financial indicators selected in this article

Input indicators		Output indicators	
R&D expenses	X_1	Number of patent applications	Y_1
R&D personnel	X_2	Operating income	Y_2

Specifically, the financial indicators (i.e., from 2014 to 2021) of Hisense Vision Technology in the four years before the merger and four years after the merger were selected for analysis.

Taking each year's business data as a decision-making unit of the DEA methodology, a total of 8 DMUs (decision-making units) are selected, and two innovation input indicators and two innovation output indicators are selected, as shown in Table 2.

3.2.2. DEA Calculation and Evaluation

This paper takes Hisense Vision as the research object, and studies the company's annual financial data from 2014 to 2021 as a decision-making unit. First, by collating and collecting the main financial data of Hisense Vision from 2014 to 2021, and then conducting a routine financial analysis of the data, and finally entering the selected input and output indicators into DEAP2.1, the calculated data is shown in Table 3 below:

Table 3. DEA Model Measurements

Year	crste	vrste	scale	
2014	0.865	1.000	0.865	irs
2015	0.900	1.000	0.900	irs
2016	1.000	1.000	1.000	irs
2017	0.777	0.947	0.820	-
2018	0.715	1.000	0.715	irs
2019	0.578	0.827	0.699	irs
2020	0.931	0.966	0.963	irs
2021	1.000	1.000	1.000	-

Judging from the results of Table 3, the overall efficiency of Hisense Vision will be effective in 2016 and 2021, respectively. Although Hisense Vision's overall efficiency gradually increased in 2014-2016 and 2019-2021, it gradually declined in 2017-2019, mainly due to the integration of resources after technology mergers and acquisitions by enterprises during this period. Hisense Vision in 2014-2016 the overall technical efficiency is relatively stable, mainly around 2015 the national macro policy to guide enterprises to pay attention to technological innovation, but due to the shortcomings of Hisense Vision in OLED technology, so that its technical efficiency in 2017 has declined, mainly due to enterprises began to start technology mergers and acquisitions, hoping to quickly obtain technical resources through technology mergers and acquisitions. In 2018, the merger and acquisition of enterprise technology was completed, and the overall technical efficiency of Hisense Vision increased year by year from 2019 to 2021. From 2019 to 2021, both technical efficiency and scale efficiency will gradually increase, and overall efficiency will also rise steadily. From this point of view, after the completion of the technology merger and acquisition, Hisense Vision has improved to a certain extent in terms of management and technology, and the innovation effect has been significantly improved.

4. Conclusion

This article conducts in-depth analysis and research on Hisense's Vision technology mergers and acquisitions, and explains the relevant background and merger motivations of the company's technology mergers and acquisitions. Firstly, the indicators selected by the subsequent DEA analysis method were analyzed by the financial indicator analysis method, and then multiple input and output indicators were selected by the data packet network analysis

method, and the innovation effect before and after the merger and acquisition of Hisense Vision Technology was fully compared.

On the whole, this paper comprehensively analyzes the innovation effect of Hisense Vision's acquisition of Toshiba TVS from the perspectives of financial analysis method and DEA analysis method. The analysis of both methods shows that this technology acquisition has brought good revenue to Hisense Vision. This technology merger and acquisition mainly enhances the comprehensive strength from three aspects. First, the acquisition of technical resources makes up for the technical shortcomings of Hisense Vision. Second, the injection of overseas R&D personnel optimizes the organizational structure of Hisense Vision. Third, the integration of market resources has helped Hisense Vision explore a new direction of development. Hisense Vision actively promotes technology mergers and acquisitions from the above three aspects, and finally achieves the improvement of enterprise innovation performance.

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