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Relationship between Innovation Concept of Sports Industry and Economic Development on the Basis of Edge Computing of Internet of Things under Artificial Intelligence

Zhong Wu[1] and Shuang Wang[2,*]
[1] Physical Education School, Wuhan Business University, Wuhan, Hubei, 430056, China
[2] School of Railway Transportation Management and Logistics, Wuhan Railway Vocational College of Technology, Wuhan, Hubei, 430205, China
Corresponding authors: (e-mail: waxwingwz@163.com).

Abstract With the development of the Internet and the exponential increase in the number of customers in the sports industry, the traditional sports industry is no longer able to provide services to its customers in real time. By utilizing artificial intelligence (AI) as well as edge computing, the intelligence of Internet of Things (IoT) can be improved, which in the sports industry can handle the sports business of edge devices in time to ensure the timeliness of the sports industry, thus improving the sports industry's ability to process sports information. This paper has compared the traditional sports industry with the sports industry on the basis of edge computing of the IoT. The experimental results showed that between 2016 and 2020, the average economic development level of the conventional sports industry was 64.4%, while the average economic development level of edge computing of the IoT-based sports industry was 76.4%. Innovative ideas for the sports industry that use IoT to intelligently classify sports business data and process time-sensitive data in real time via edge computing of IoT can effectively improve economic development.

Index Terms Industrial Innovation Concept, Economic Development, Internet of Things, Edge Computing

I. Introduction

People can spend a lot of time on sports, leisure and entertainment, and their yearning for sports directly leads to the emergence of sports industry that can provide people with sports service products, broadcast sports events, and provide sports industry posts. The sports industry directly improves people's consumption level and promotes economic development. The sports industry has developed rapidly recently, but the traditional sports industry still focuses on the centralized processing of sports data by cloud computing, which results in the traditional sports industry consuming more resources in data analysis and processing, and cannot handle sports business in a timely manner. With the continuous development of AI and IoT technologies, edge computing can improve the processing deficiencies of cloud computing and provide edge intelligence services to enable real-time processing for sports business. Under the background of AI, the investigation of the association between the innovative concept of sports industry and economic development based on edge computing of the IoT is conducive to understanding the internal mechanism of sports industry to promote economic development, so as to steadily improve economic development. Therefore, this paper has research significance.

With the growth of social economy, sports industry as a rising industry can meet people's spiritual and cultural fitness and other needs. The association of sports industry and economic development has been studied by relevant researchers. Among them, Liu Shangjun's study indicated that the rapid advancement of China's economy had contributed to the advancement of the sports industry and that the sports industry had provided a large amount of jobs in China, which had also effectively increased the country's gross domestic product (GDP) [1]. Javani Vajiheh's study pointed out that sports industries affected the economy in the development process and the implementation of resistance economy could help the sports industry to meet the requirements of the economic environment [2]. Lindsey Iain said that economy is the basis for the development of sports industry, and the sustainable development of sports industry can also provide a stable economy for the society [3]. Cooper J A carried out a three-month economic tracking of the sports tourism industry, which effectively promoted economic development [4]. Sports industry plays a positive role in promoting economic development, but it lacks intelligent innovation.

With the continued development of AI technology, edge computing of the IoT can perform intelligent computing on real-time business. Many people have applied edge computing of the IoT to the innovation concept of the sports industry. Among them, Li Bin used AI technology to predict and analyze basketball shooting, which helped improve

the training level of basketball players and brings huge economic benefits to the basketball industry [5]. Song Honglian applied AI technology to the management system of sports events, which improved the performance of the sports event management system, and made it can receive more access services, thus effectively improving the revenue of sports events [6]. Zheng Yong said that the sports industry has developed rapidly, surpassing most of the physical industries, but the number of sports industries is still not very large. The use of computer technology to solve the huge sports industry data can promote the development of the sports industry [7]. Technologies such as AI being utilized to solve data computation problems in the sports industry can facilitate the development of the sports industry. However, there is a missing of comparative analysis with traditional sports industry theories.

The sports industry is not yet well developed enough to cope with the huge amount of data on sports business. This article compares the innovative concept based on edge computing of IoT with the conventional concept to analyze the impact of the innovative concept of sports industry based on edge computing of IoT on economic development. The experimental results show that edge computing of IoT-based sports industry can increase the employment rate in the sports industry in the same economic environment.

II. Methods for Understanding the Relationship between the Innovation Concept of Sports Industry and Economic Development

The sports industry has existed in a market economy for hundreds of years. From the 1950s to the present day, people's living quality has been increased significantly. Sports competition, fitness and other recreational activities have rapidly flourished, as have sports-centred service industries [8], [9]. Figure 1 shows the structure model of sports industry.

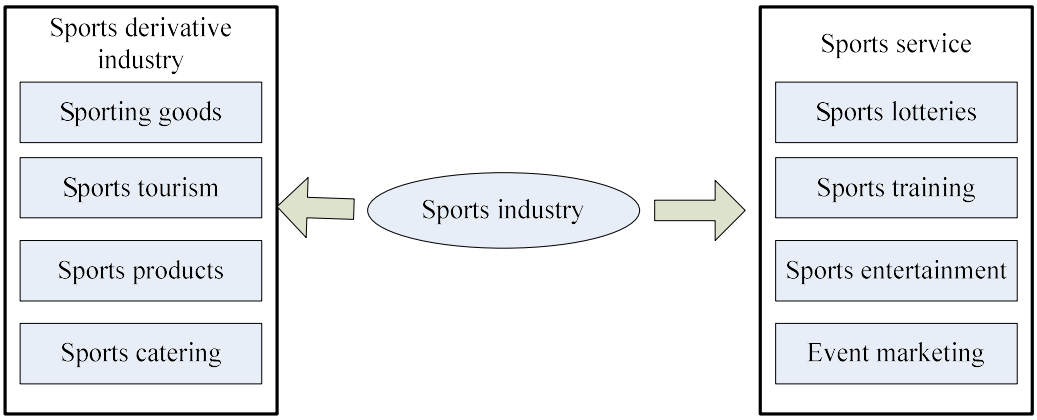


Figure 1: Structural model of sports industry

Figure 1 displays the structural model of the sports industry, which is divided into two major parts, namely sports service and sports derivative industry. Sports service refers to the economic activities that reflect the economic value of sports, including sports lottery, sports training and event marketing.

There are a few types of services in the traditional sports industry, most of which are live broadcast of sports events and have very low understanding of customers, and the design of sports equipment and other products is not new enough [10].

The sports industry is monopolized. It is mainly composed of sole proprietorship enterprises, limited companies and some sports sales individuals. There is an obvious industrial monopoly in the process of sports service. For instance, the sports live broadcast is directly monopolized by large companies.

The marketing strategy is old-fashioned. Conventional sports industry in marketing strategies are borrowed from other industries' marketing models, which lack innovation in the marketing process.

The profit mode is single. The profit mode of conventional sports industry is mainly to improve the economic returns by opening sports stores, stadiums, etc., increasing the number of sports franchise points. However, this profit model by expanding sales volume is not a long-term profit model.

II. A.Application of AI in Public Cloud IoT

The IoT is to use electronic information technology to combine sensing devices with objects, and to connect the sensing information of objects with the Internet through identification, positioning and other technologies to achieve information exchange between objects and intelligent control of objects by people [11], [12]. The emergence of IoT

has greatly facilitated people's daily lives, and it has been applied in various areas of people's lives, with widespread applications in smart healthcare, smart education and the sports industry [13].

The prototype for the advancement of AI is the simulation of human brain intelligent processing. AI is a set of systematic research methods, involving multiple disciplines, mainly studying machine learning, intelligent recognition, information optimization, etc. [14]. AI can also be integrated with other technologies to enhance the application of other technologies through intelligent computing, and it can be closely integrated with the IoT.

The emergence of the IoT in the sports field has led to the creation of innovative applications, which can completely change the entire sports industry [15]. For example, using the IoT technology to build an intelligent stadium, sensors can be installed in the sports insole and sports equipment, so that the data of athletes' sports can be obtained, thus monitoring the physical conditions of sports in real time to ensure the health of athletes. The IoT sensor can also be used to collect the interests of spectators in sports events, and analyze the behavior of spectators through AI technology to better develop sports derivative industries that adapt to spectators. In addition, in the sports industry, the IoT can be used to self regulate the temperature of sports venues, which can not only meet the needs of customers but also maximize energy conservation.

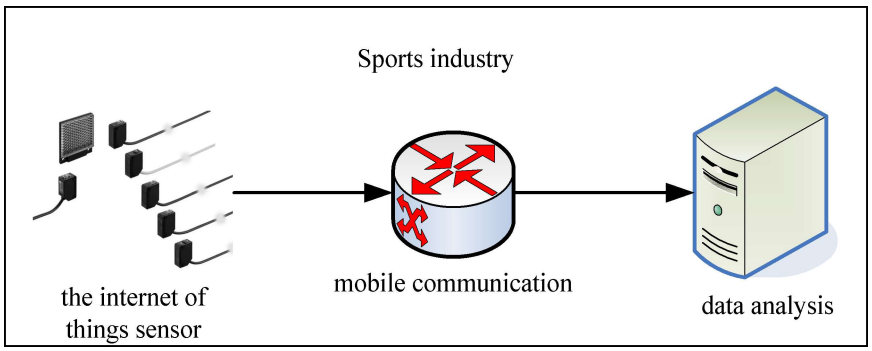


Figure 2: Application model of IoT in sports industry

In Figure 2, the model for the application of the IoT in the sports industry is described. The IoT sensors are mainly used to collect data information in the sports industry, and mobile communication and other technologies are used for data transmission. Then AI technology is used for data analysis to provide intelligent decision-making for the sports industry.

II. B.Edge Computing of the IoT

IoT is a technology that has emerged recently. By virtue of the information circulation of the Internet, information can be exchanged between different objects [16], [17]. The development of the IoT has effectively realized the identification and positioning of intelligent devices. The application of the IoT is very extensive, and the combination with the sports industry is also increasingly close. Many scenarios of the sports industry can not be separated from the IoT technology. For example, in the process of sports live broadcast, the IoT equipment needs to be used to record sports live broadcast in real time and upload data. In the sports industry, there are different types of business and different requirements for data, such as data security requirements, data classification requirements and real-time data processing requirements.

Although the IoT can improve the intelligence of the sports industry, there are still many drawbacks:

Difficulty in processing massive data: All businesses in the sports industry need to use IoT terminal devices, and the number of IoT devices is growing year by year. Although the huge sports industry data provides great business value, it is very difficult to process data information, causing great pressure on the sports industry cloud server.

Data timeliness: Some businesses in the sports industry require high timeliness. For example, sports ticket purchase requires the sports industry to respond in real time. However, the ECS (Elastic Compute Service) has high latency for data processing, which may cause great inconvenience to customers.

Edge computing makes up for the shortcomings of traditional sports industry cloud processing. In addition to providing fast and flexible computing features for sports industry edge devices, it can also ensure the timeliness, security and privacy of data processing. These capabilities of edge computing are very suitable for solving various challenges faced by IoT applications in the sports industry.

IoT is an essential tool to digitize the sports industry that can enhance the intelligence of the sports industry with the help of IoT. However, the volume of data caused by the sports industry is very large, and the real-time data processing can not be achieved only by relying on cloud computing. By utilizing new technologies such as edge

computing and AI, the intelligence of the IoT can be improved. The application model of edge computing of the IoT in the sports industry is shown in Figure 3.

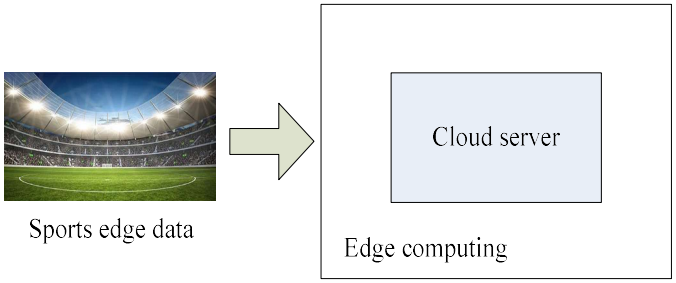


Figure 3: Application model of edge computing of the IoT in sports industry

In Figure 3, the application model of edge computing of the IoT in the sports industry is described. Edge computing is mainly used to solve the data problem of edge devices and provide the most direct services for users in the sports industry.

Distributed computing: In edge computing, edge gateways can be applied to collection and processing of information from nearby devices, reducing communication between terminal devices and ECS.

Edge intelligence: AI can be used to classify edge tasks, quickly process the tasks that need to be processed in time at the edge, and assign complex, time insensitive tasks to ECS for processing.

Privacy processing: The data processed by edge computing is stored in the edge device, which greatly improves the security and privacy of the data. When data needs to be transferred to the ECS, it also needs to encrypt the data.

Edge computing of the IoT is widely used in the sports industry. Edge computing data are all data that need to be processed in real time. AI is utilized to sort the data from the sports industry. Data that require fast processing are divided to edge computing and data that are complex and do not require real-time processing are divided to cloud servers for processing [18], [19].

There are many kinds of AI classification algorithms, among which support vector machine (SVM) is a simple and efficient data classification algorithm, which can accurately divide the attributes of sports industry data.

The crucial for SVM to classify sports industry data is to find the optimal classification hyperplane, that is, to analyze the characteristics of the data processed by edge computing and the data processed by ECS. The optimal classification hyperplane is set as:

$$r^T x + t = 0 \tag{1}$$

Then determining the distance between the sports industry data and the optimal classification hyperplane is the key to classify the sports industry data, such as the distance between the sports live broadcast data and the optimal classification hyperplane. The distance between sports industry data x_j and the optimal classification hyperplane can be divided into two situations:

When sports industry data is on the optimal classification hyperplane, there is Formula (2):

$$l = \frac{1}{\|r\|}\left|r^T x_j + t\right| = 0 \tag{2}$$

When the sports industry data is not on the optimal classification hyperplane, there is Formula (3):

$$l = \frac{1}{\|r\|}\left|r^T x_j + t\right| \tag{3}$$

In Formula (3), the positive and negative directions of the value of $r^T x_j + t$ represent the direction of the distance between the sports industry and the optimal classification hyperplane.

In the classification model of SVM, data can be above or below the classification plane. The different directions of data in the classification plane represent different data characteristics. The distance between the sports industry and the optimal classification hyperplane needs to be set in the direction.

$$l = (r^T x_j + t) \times \frac{1}{\|r\|} \tag{4}$$

Therefore, as long as the values of *r* and *t* are required to be solved, the optimal classification hyperplane can be determined. The solution process of the characteristic parameters of the optimal classification hyperplane is as follows:

$$D(r,t) = \frac{1}{2}\|r\|^2 - \sum_{j=1}^{n}[(r^T x_j + t) - 1] \tag{5}$$

II. C.Innovation Concept of Sports Industry and Economic Development

The sports industry is an industry based on sports services. Like other industries, the sports industry needs to meet economic interests, but its emphasis is different from other industries. The sports industry not only requires economic benefits, but also has the purpose of promoting the development of sports, providing people's physical quality and promoting cultural integration. Sports industry is different from sports cause. Sports cause is simply to spread sports related activities to the society, focusing on social benefits.

Sports industry is closely linked to economic development. The relationship is shown in Figure 4.

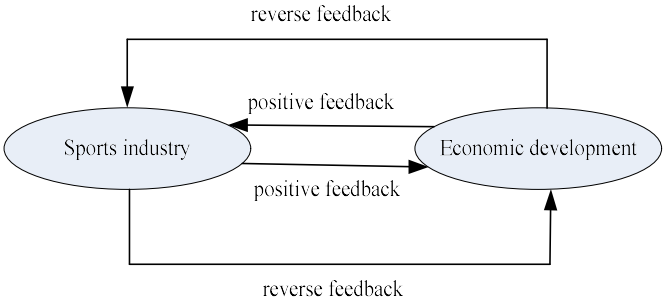


Figure 4: Relationship

The sports industry involves many related industries, such as sports live broadcast, sports lottery and sports products. A large economy is needed in building the sports industry, which supplies the material basis for its development. The sports industry can contribute to sustained economic growth in the process of development. For example, it can increase investment in other industries to obtain sustainable economic benefits through advertising, sponsorship and other ways. It also can also create a large amount of jobs for society to solve the problem of social population employment, so as to promote economic growth.

However, the traditional sports industry does not do very well in information services. The traditional sports industry cannot process real-time information in a timely manner, resulting in busy networks when there is a lot of business [20]. AI technology is constantly evolving and edge computing of the IoT is being applied to the sports industry to enhance the processing of real-time information.

III. Experiment of Sports Industry Innovation

III. A. Data Source of Sports Industry Innovation

This article also conducted data statistics on 200 sports industry economic experts through questionnaire survey, mainly investigating the sports industry economic experts who believed that the impact of the sports industry on the economy could be measured. The survey findings of the influence of sports industry on economic development are described in Table 1.

Table 1: Investigation results of the influence of sports industry on economic development

Serial number	Impact index	Number of people (persons)	Percentage
1	Employment proportion of sports	44	22%
2	Sports consumption level	54	27%
3	Per capita consumption level	46	23%
4	Level of economic development	56	28%

There are four indicators, among which the economic development level accounted for 28% at the highest level, followed by the sports consumption level of 27%.

As the statistical results obtained from the questionnaire survey had serious subjective factors, the above four indicators needed to be further analyzed to determine specific factors that could evaluate the influence of sports industry on economic development. The purpose of the correlation test on the above four indicators was to eliminate the human interference. The greater the correlation of the indicators, the better the indicators could be used to evaluate the influence of the sports industry on economic development. The findings of the correlation analysis on the above four indicators are described in Table 2.

Table 2: Findings of correlation analysis of indicators

Impact index	Correlation	Correlation intensity
Employment proportion of sports	0.24	Strong
Sports consumption level	0.25	Strong
Per capita consumption level	0.22	Strong
Level of economic development	0.29	Strong

In Table 2, the correlation analysis results of indicators are described. The correlation of all indicators was 1. The highest correlation of economic development level was 0.29, followed by sports consumption level of 0.25, and the lowest correlation of per capita consumption level was 0.22.

III. B. Experimental Design of Sports Industry Innovation

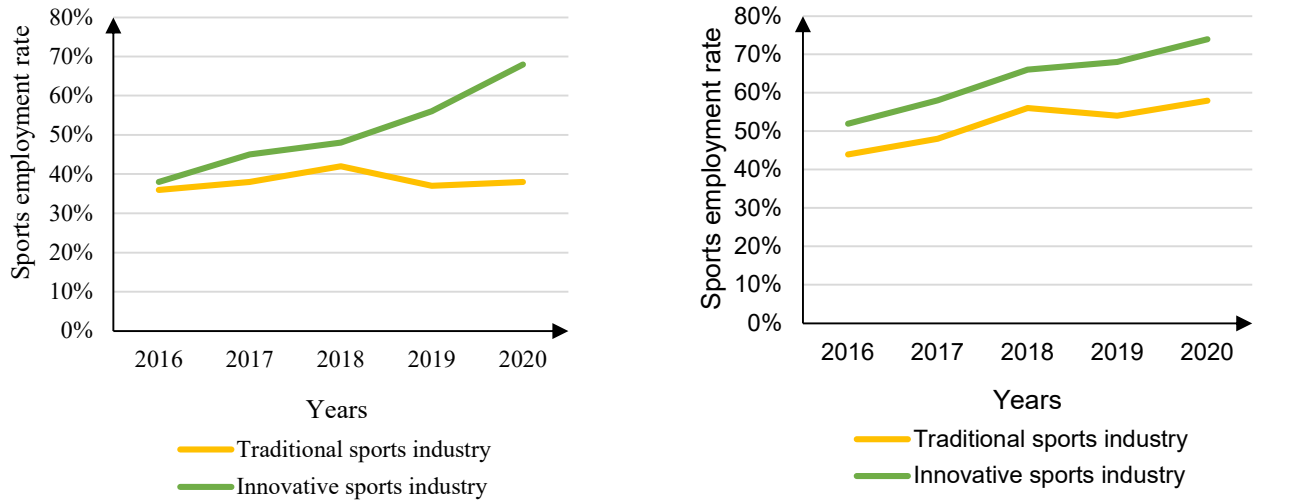
A large amount of IoT devices have been utilized in the sports industry to make it more intelligent. However, with the exponential growth of terminal devices, real-time processing of IoT data is required. In this paper, AI was used to classify the data of the IoT, and edge computing was used to process real-time data to improve the rapid response to the IoT terminals.

The experimental objects of this paper were taken from two cities with similar economic development in China. City A used the conventional sports industry, and City B used the sports industry based on edge computing of the IoT. As the sports industry had a long impact on economic development, this paper made statistics on the economic development of the sports industry from 2016 to 2020.

IV. Results of Sports Industry Innovation

IV. A. Proportion of Sports Employment

The sports industry can provide many jobs for the society, such as sports fitness coaches, sports lottery sales posts, sports live broadcast posts, etc. The comparison results are shown in Figure 5.



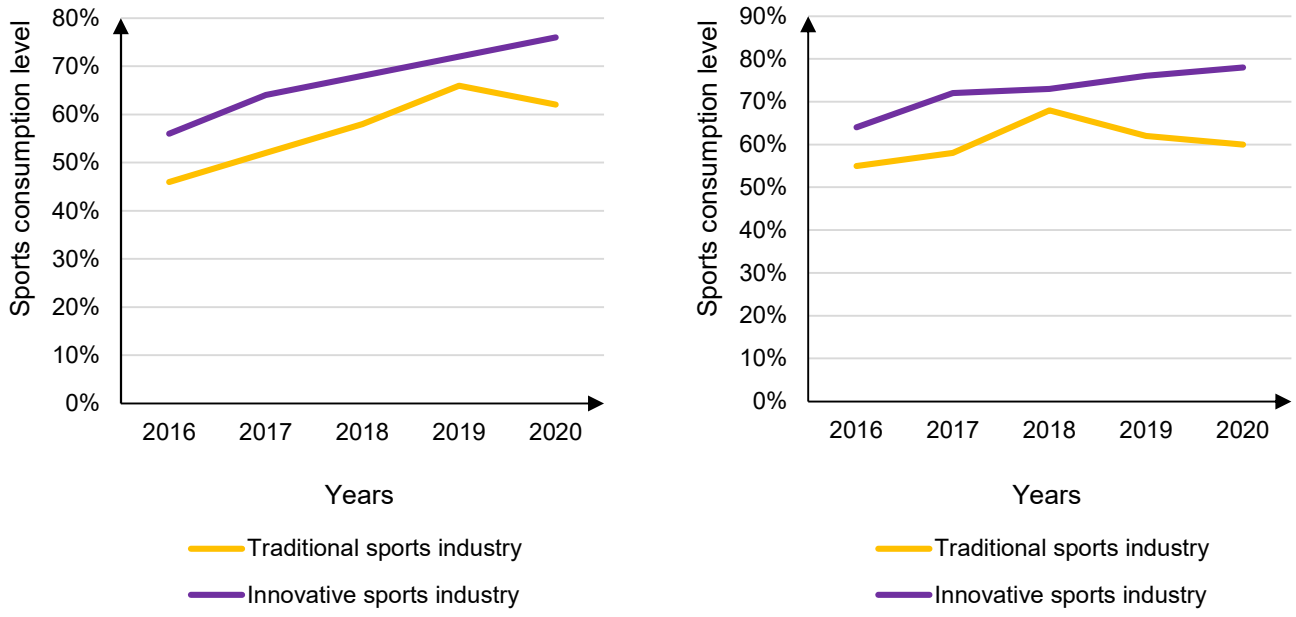
(a) Sports employment rate of sports service industry (b) Sports employment rate of sports derivative industry

Figure 5: Comparison results of sports employment rate

In Figure 5(a), it describes the comparison of the employment rate of the traditional sports industry and the sports industry based on edge computing of the IoT in the sports service industry. Among them, the sports employment rate of conventional sports industry reached the highest of 42% in 2018 and the lowest of 36% in 2016. In Figure 5(b), the sports employment rate of traditional sports reached a minimum of 44% in 2016 and a maximum of 58% in 2020, while the sports employment rate of the sports industry based on edge computing of the IoT reached a minimum of 52% in 2016 and a maximum of 74% in 2020.

IV. B. Sports Consumption Level

In essence, the sports industry is still a business model. The purpose is to promote people's consumption level of sports. The higher people's consumption level in sports, the better the degree of economic development can be reflected to a certain extent. The comparison result of sports consumption level is shown in Figure 6.



(a) Sports consumption level of sports service industry

(b) Sports consumption level of sports derivative industry

Figure 6: Comparison results of sports consumption levels

In Figure 6(a), it describes the comparison of sports consumption level between the conventional sports industry and the sports industry based on edge computing of the IoT in the sports service industry. Among them, the sports consumption level of traditional sports industry rose first and then decreased, reaching a minimum of 46% in 2016 and a maximum of 66% in 2019, while the sports consumption level of the sports industry based on edge computing of the IoT was constantly improving, from 56% in 2016 to 76% in 2020. In Figure 6(b), The sports consumption level of traditional sports industry reached a minimum of 55% in 2016 and a maximum of 68% in 2018, while the sports consumption level of the sports industry based on the edge computing of the IoT reached a minimum of 64% in 2016 and a maximum of 78% in 2020, the overall sports consumption level of which was higher than that of the traditional sports industry. Therefore, the innovative concept of sports industry based on edge computing of the IoT can effectively improve the level of sports consumption.

IV. C. Per Capita Consumption Level

The per capita consumption level can well reflect the degree of economic development. The comparison results are shown in Figure 7.

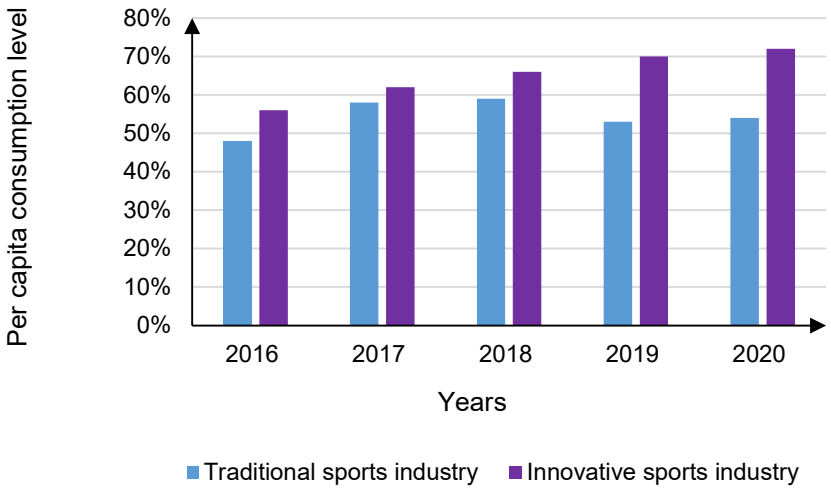


Figure 7: Comparison results of per capita consumption level

The per capita consumption level of the conventional sports industry rose first and then declined, reaching a maximum of 59% in 2018, a minimum of 48% in 2016, with an average per capita consumption level of 54.4%. The per capita consumption level of the sports industry based on edge computing of the IoT was constantly improving, with an average per capita consumption level of 65.2%. In the context of AI, the innovation concept of sports industry based on edge computing of the IoT can significantly improve the per capita consumption level.

IV. D. Economic Development Level

The sports industry creates economy by providing sports services for the society. This paper compared the economic development level of the traditional sports industry with that of the sports industry based on edge computing of the IoT. The comparison results are shown in Figure 8.

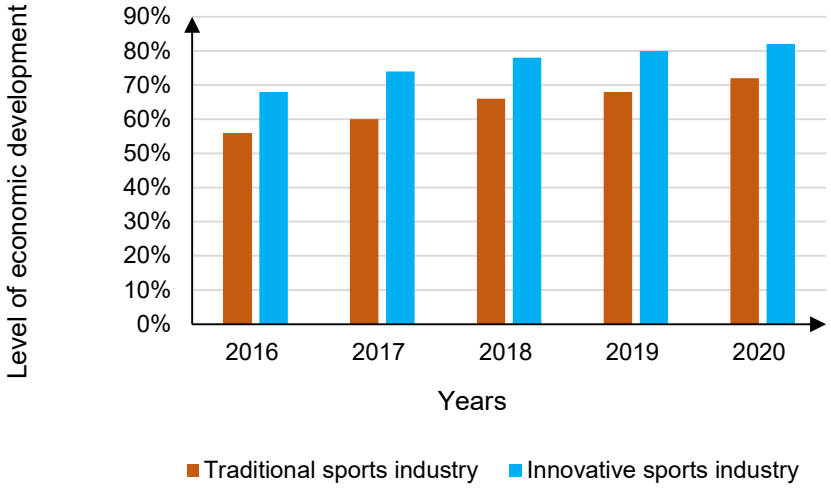


Figure 8: Comparison results of economic development levels

In Figure 8, it describes the comparison of economic development between the traditional sports industry and the sports industry based on edge computing of the IoT. Among them, the economic development level under the conventional sports industry reached a minimum of 56% in 2016 and a maximum of 72% in 2020, with an average economic development level of 64.4%.

V. Conclusions

This paper uses edge computing of the IoT to solve the problem that the sports industry cannot process edge devices in real time. This paper has obtained the indexes to evaluate the effect of sports industry on the economy through questionnaires, which are respectively the proportion of sports employment, sports consumption level, per capita consumption level and economic development level. It also compared and analyzed the conventional sports industry and the sports industry based on edge computing of the IoT. The experimental findings showed that the sports industry based on edge computing of the IoT can effectively improve the employment rate of the sports industry, the level of sports consumption and per capita consumption. AI can be used to classify sports industry data, and the edge computing of the IoT can be used to process sports industry business in real time and safely, so that the sports industry can follow the development of the times and further promote economic development. However, in this paper, only 200 economic experts in the sports industry were investigated by questionnaire when obtaining indicators to evaluate the influence of the sports industry on the economy, and the number of people counted was too small. Therefore, it is the direction of future research to investigate more people related to the sports industry and make statistics on more comprehensive indicators of the impact of the sports industry on the economy.

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