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Application Research of Artificial Intelligence Technology in Smart Stadium Management under the Background of Low Carbon Economy

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ABSTRACT

The purpose of this research paper is to investigate the use of AI in stadium management systems. Artificial intelligence (AI) technology is essential for fundamentally addressing the issues of optimum energy consumption, cost-effectiveness, and low carbon emissions in huge sports stadiums, which may utilise up to 10,000 kW of electricity on the day of any sporting event. Due to its intricate internal operations and comprehensive functioning, the Stadium's Electricity (SE) is both costly and crucial in meeting the stadium's capacity requirements. Due to the huge and variable nature of electrical consumption at a stadium, efforts to increase energy efficiency are labor-intensive and time-consuming. Whenever a sporting event concludes, the stadium's information feed is disconnected and emptied. For use in the event of a power failure during sporting events, the system is always prepared. Accurate representations and human-structure interaction models, as well as identifying acceptable facility vibration serviceability restrictions of crowd activities, are only two of the many factors that need to be carefully assessed. There are a number of challenges associated with large crowds, both in terms of coordinated movement and random motion, in a stadium setting. The term "Artificial Intelligence" (AI) is used in the field of computer science to describe the attempt to create computers with intelligence similar to that of human beings. Several fields may benefit from AI's versatility, including NLP, SR, and CV. In addition to improving stadium control in a number of ways, this paper also provided a novel approach to (SE-AI). The smart stadium design integrates construction machinery into the building process efficiently. The smart sports concept is established in the electrical layout of the stadium. The engineering design concepts are used to investigate the stadium's electrical design system in order to give useful information for the stadium's electrical design work. Because of scientific and technological progress and digitization, the stadium's equipment is evolving toward artificial intelligence. A greater societal effect is possible if the findings of this study can be used as a manual for improving the electrical design of stadiums.

Keywords: Artificial Intelligence, Stadium, Electricity, Sports, Lights, Machine Vision, Low-carbon Economy.

INTRODUCTION

Technology advancements have allowed for significant progress in the research of artificially intelligent sports stadium venues. In this increasingly digital age, more and more sporting events are making use of Internet of Things (IoT) technology. The study analysis looked at the issue of physical security in sports stadiums and found that it is an important factor in determining overall stadium security. This study uses a simulated fire scene model and applies an analysis of the simulated fire model to the stadium to assess the potential for a fire there. The report examines the safety features, construction, and evacuation procedures of various stadiums. The requirements and expectations of spectators and athletes alike have grown over the years, and today's stadiums are more than simply a collection of bleachers and a scoreboard. There are new requirements throughout sports to meet the expectations of spectators, and dated venues are not meeting them. Based on the evidence presented, it is recommended that stadiums undergo comfort and safety tests using pedestrian movement simulation. Studies show that hostile sports fans often make the move to the stadium. To properly design a sports arena, one must first identify the motivating factors that inspire fans to show up. This essay presents four prerequisite conditions for establishing the us field community network, which presents a challenge to the stadium-led rehabilitation programme. Large-scale events cannot function without constant access to power. This study demonstrates a method for gauging the dependability of stadium power distribution networks and identifying potential weak points (Gao, 2019). The construction of enormous sports stadiums is an integral part of China's public sports service. This study provides insight into the role of large stadiums in achieving sustainable development by developing an evaluation index that will be used to direct the design, development, and use of such facilities in the future. While the green performance potential of new stadiums may be higher, this does not render older stadiums useless from a low-carbon economic standpoint. This research casts doubt on the climate-saving claims made for new stadiums and investigates the potential re-uses of older facilities.

The report investigates the development of failure modes and the impact of strain energy on stadium electricity over periods of loading and unloading. More and more sophisticated technology, more and more athletic events, and more money all contribute to the creation of smart stadiums that employ AI. In this study, a novel power monitoring method is proposed using SE-AI, and linear interpolation is used to manage stadium lights. From these findings, we learn that it is possible to monitor mental capacity and output, as well as to control the error rate of loading and unloading in a defect detection system (Harati, Ashraf Ganjouei, Amirtash, Nikaeen, 2019). Making a computer behave and think like a person is the goal of artificial intelligence research. The motivation for starting this field was the hope that one day robots would be able to think and play with the same level of self-awareness and intellect as humans do.

After this introduction, the study moves on to a literature review of the current technique, a discussion of the suggested method for using AI in the stadium, an experimental analysis, and finally a conclusion.

STADIUM POWER DISTRIBUTION BASED ON ARTIFICIAL INTELLIGENCE

Energy efficiency renovations in large sports venues are challenging and time consuming because of the enormous energy consumption and the wide variety of energy loads that must be met. There is a dearth of studies in this area at the moment. While existing energy-saving tactics don't change for building energy performance update applications, making a significant increase in a sports facility's energy efficiency is challenging and complicated. As a result of scientific and technological advancements, stadium machinery is moving in the direction of artificial intelligence.

Smart Stadium: Architectural Plan

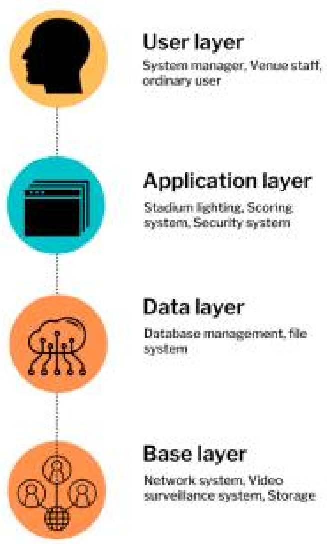

Figure 1. Smart Stadium System

Figure 1 displays the user layer of the smart stadium non-persistent virtualization system, where users may save their profile settings and data and launch programmes. The next layer is the application layer, which is where users may interact with networks and transmit and receive data. The application layer deals with the management of data in client-server architectures, whereas the transport layer is responsible for establishing the channels between hosts for the movement of data.

When a network is set up, it connects the sender and the receiver, the two halves of a communication system. Multiple stations in a communication network may act as relays to carry messages from a sender to a receiver or vice versa. Lights might be added on the field or in other areas of the stadium to make sure people can go about safely. Protecting the stadium and its patrons is a top priority, which is why security measures have been put in place. Damage from fire, smoke, and water may all be detected by a security system. Any hardware, computers, or portable devices and their associated software that are electronically coupled with other systems are collectively referred to as the "network system." A platform-specific Data Layer is a virtual disc layer that stores the configuration options, tools, and other programmes necessary to carry out an inputted command. Information security procedures that might compromise the data's integrity are taken to prevent unauthorised access and exposure of private information. Robots or cameras using artificial intelligence (AI) may record footage and give efficient ways to refine the data.

The smart stadium system derivatives

$$A = \sin(x+y) * \cos(z+w) \div \sqrt{(z)}2 - \int \int (x) + ([[2 \sqrt{x}]] - [[y]]/2) \qquad (1)$$

In the above-mentioned equation (1), A represents the application layer, x represents the data layer, y represents the platform layer, z represents the user layer, and w represents the communication system; sin represents the system manager and cos represents the average user; together, they make up the sin(x+y) site lighting system for the cos(z+w) processing of a stadium where (z) ([[2x]] [[y]]/2) is the security system, and (x) is the intelligent system that does the comparison in Eq. (1) and Eq. (2) below.

$$B = (v-1)(u-2) \pm \int \int \prod u-1 \div 1/\log vu \times \pi/2 \qquad (2)$$

For example, in the construction of a stadium equipped with an AI system, Eq. (2) may be written as follows: B represents the network system, u represents the timing and scoring system for v, and 2 represents the database and log for the file system and can be (v 1) host storage for represented in u1.

Artificial Intelligence Technology

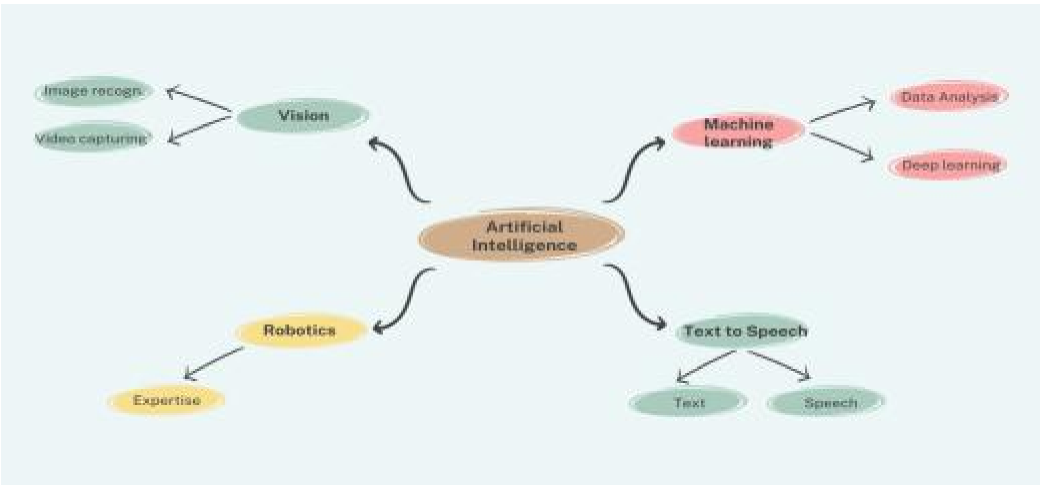

Figure 2. Artificial Intelligence

Artificial intelligence, as seen in **Figure 2**, is the process of programming machines to do tasks normally requiring human intelligence (AI). It is also appropriate to define machines that have human-like characteristics, such as the capacity to learn and solve problems. In predictive analysis, experts use past information, statistical models, data mining, and machine learning to foresee and assess possible risks and opportunities. The term "deep learning" refers to a method used in machine learning and AI that is designed to mimic the way humans learn. Deep learning methods are crucial to many areas of data science, including predictive modelling. An additional feature is a text-to-speech reader, which may be used to hear any text read aloud. Machine vision is able to identify objects and people in a scene or setting via the use of image recognition software. Computers can identify people and other things in photos by using machine vision and AI programmes. Machine vision artificial intelligence may do identification, presence inspection, and flaw detection, among other things. Images from digital cameras and smartphones are processed and analysed using image recognition software. An picture may be analysed by a computer to determine whether the object of interest is there and, if so, where. An expert system (expertise) is a computer software that employs AI methods to simulate the reasoning and actions of a knowledgeable human being. Robots may be able to do machine activities that people have traditionally done. Robots are used in many different industries, from the production of vehicles to the operating room, where they speed up processes and improve accuracy while doing tasks both basic and complicated.

The artificial intelligence

$$C = T + 2/S \times \int \log sT \div \csc T\ 2 \pm (\alpha - \beta) * \ \sqrt{\ } [[s]]/\delta B \tag{3}$$

Equation (3) shows that a combination of artificial intelligence (AI), deep learning (DL), machine learning (ML), text-to-speech (TTS), and text-to-lesson (LTT) may be achieved. We may use Eq. (4) below to determine that B is speech, and is picture recognition and the capacity to learn problem-solving.

$$D = \log\beta\ r * \ \ \omega\ 2 \pm \sum \Delta y/\Delta x \times r - 1 \div \csc \pi/2 \times \pi \tag{4}$$

For example, "D" may stand for "vision," "r" for "machine vision," "y" for "image recognition," "x" for "data extraction"—all of which would refer to "expert system," "r" for "robotics," and "c" for "classification system," "D" for "translation," and "r" for "repetitive activities." Professional expertise and logarithmic functions.

Connecting a Stadium's Electrical Lighting System

In order to regulate the lighting for a broad variety of events and situations, several systems must be set up. In order to have a dramatic impact on the audience, certain events and occasions call for specialised lighting effects such as dimming and scene settings. Lighting during stadium events has a significant impact on spectators' feelings. Multiple aesthetic elements, including contrast, hue, and pattern, play into the viewer's emotional response (Yao, Zhang, Liang, 2019). There is a specific purpose served by each component of a lighting control system. Input components like smart sensors, control panels, remote controllers, Touch screen displays, etc., allow AI systems to translate control signals from the outside world into signals that the system can use. To regulate the brightness, the data bus sends command signals to the output section.

A digital stadium lighting system

$$E = \prod F2 * \ \cup \ \ L2 \pm (\ 2 \sqrt{\ } \ [[I]] - [[f\ ]]/2\ ) \times 1/f - I \tag{5}$$

In Eq. (5), we can see that E denotes stadium, F denotes lighting, f denotes an electronic system, I denotes frequency, and L denotes a shutter. The lighting system is processed as follows: 1 f I in the system of linkage of the electric system; (2 [[I]] [[f]]/2); L2 in an external signal; F2 under control of the loop (5),

$$G = \int \ \int \ \int l2 \times i2 \pm \sum \log 2\ i * \ \ \sin l2 + \ \sqrt{\ } \ h2/p1 \tag{6}$$

According to Eq. (6), the local control frequency of the electronic h 2 p1 control in a power supply of sin l2 for the lighting management system is represented by log2 I and G is for the circuit diagram, l is for the electric loss, I is the power control for p (a lamp), and h is the lighting management system.

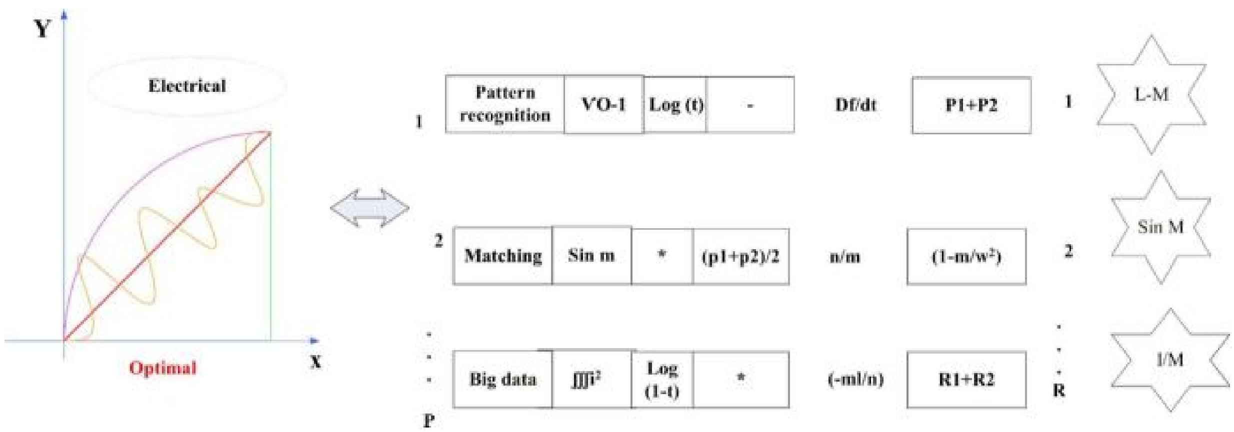

Figure 3. The Electric Stadium's Loading and Unloading Process, with the Help of Artificial Intelligence

As can be seen in **Figure 3**, the sheer size and complexity of the electrical loads needed make it difficult to implement energy-saving measures in stadiums. When the game event is over, it is turned off (unloaded). If there is a blackout during a sporting event, the mechanism may be activated at any moment.

$$H = P1 + P2/2 \times (1 - M/w2) \pm \sin MW-1 * \tan-1 PM-2 \tag{7}$$

In order to calculate the heat/cooling for P1+P2/2 loading for detection, we use Eq. (7), which states that H for stadium, P for electricity, and M for loading is a W for unloading and tan1 the trigonometric function for power efficiency.

$$I = (1/R1) \times (1/R2) + \surd\ 0 - 1/2 - \omega 12 \div [[\hat{W}\ ]] \tag{8}$$

In Eq. (8), I represents power regulation, R symbolises solar illumination, 0 represents load removal, W represents power wasted, and represents the relationship between electrical temperature and [[W]] loss. It is possible to switch off a (1/R1), which is the operational condition for a 01/2 unloading, at position 12. If the findings are used to deploy AI for the administration of sports stadiums, then the generator will start up automatically, and the public's opinion will be swayed in a big way. Upgrades to energy efficiency have increased in popularity as the size and diversity of energy demands have increased. To achieve energy efficiency, which in turn would reduce carbon emissions and preserve the economy, a summary of the research into energy performance upgrades is needed.

THE DISCONNECTION OF ELECTRIC LOAD IN STADIUMS: AN EXPERIMENTAL ANALYSIS

Engineering concepts providing sufficient source value for the stadium's entire design, including the electrical plan, are the starting point for appropriate ideas. System analysis and design at various levels of financial management may help provide an effective budget and a realistic timeframe for financing such initiatives. Lighting at stadiums often falls into one of three categories: primary, auxiliary, and auditorium. The stadium's lighting is designed with the auditorium, the venue, and other factors in mind. Emergency lights powered by batteries should be installed in the auditorium, and signs indicating where to exit the building should be strategically placed. Think about the following on a range of scales, standards, and intensities (McGuire, 2019; Montolio & Planells-Struse, 2019).

Battery energy storage system (BESS), Frequency Domain Decomposition (FDD), Reinforced Concrete (RC) grandstand module (RC), Photovoltaic (PV)-based renewable energy system (BEMS), Frequency Domain Decomposition (PDD), and Artificial Intelligence (AI) for managing the stadium's electrical needs (SE-AI) (**Table 1**).

Table 1. Comparative Analysis of Stadium Loading and Unloading

Number of Stadium	PV	BEMS	RC	BESS	FDD	SE-AI
1	57.5	66.8	57.7	81.6	86.5	78.5
1	88.6	57.8	55.8	85.1	76.6	78.6
6	16.7	16.1	67.1	60.1	77.7	87.8
8	11.8	60.6	51.8	67.6	56.7	81.1
5	16.1	17.6	60.6	88.1	70.6	76.6
6	61.6	81.7	57.1	70.1	58.5	87.5
7	18.8	67.6	51.1	76.8	86.6	71.1
8	81.8	58.7	61.8	81.1	71.1	88.1
7	81.8	61.7	68.6	56.8	87.1	76.5
10	81.8	68.1	55.7	88.6	88.7	77.1

Due to the large and complex electrical loads that may be controlled, as shown in **Table 1**, the stadium energy efficiency measures are a difficult and time-consuming operation. After the game is over, the stadium broadcaster is disconnected. The system enters a standby state during the gathering, waiting to be triggered in the case of a power failure. We need to handle these difficulties with caution. At the conclusion of the event, the stadium's contribution is unplugged and unloaded.

$$J = \int \cot(\alpha + \beta) \div (j - 1) \sqrt{h} \quad (9)$$

Eq. (9) shows that the trigonometric function for electricity in a stadium of (j1) measure the electricity is h load unloading in the analysis, where J is the stadium, cot is the trigonometric function for electricity in the unloading, is an electric load, and j is the analysis and h is energy efficiency.

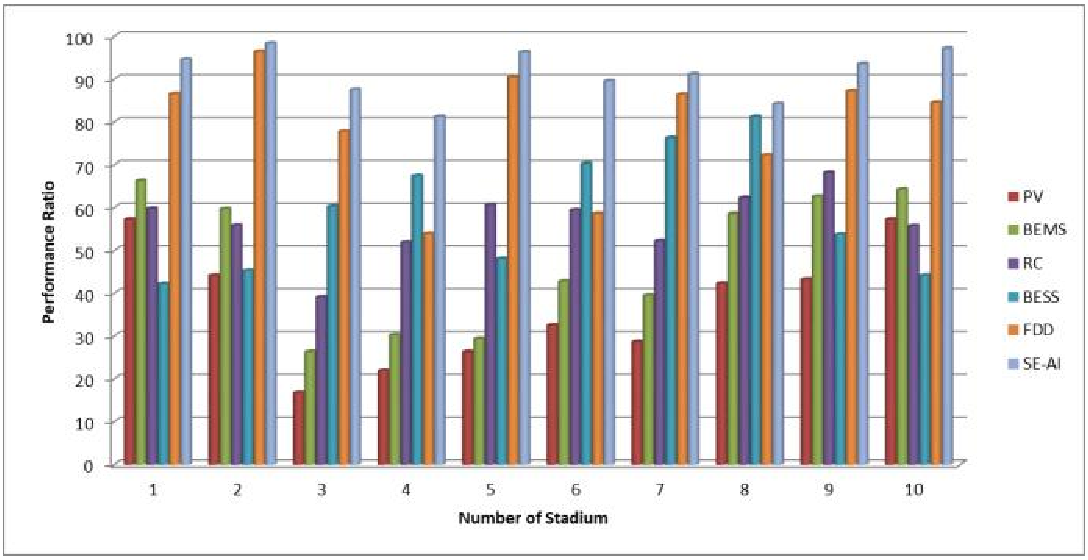

Figure 4. Ratio Performance (in a percentage)

Figure 4 depicts how regular approximation may be used in the design of an intelligent energy monitoring system and the automation of stadium lighting. The system's capacity to keep tabs on power use and output was validated via testing. Lighting, larger screens, air conditioning, and security systems all need energy, and this is especially true on game days in sports stadiums. Major amounts of power are needed to maintain stadiums in pristine condition even when they are not in use.

$$K = \sqrt{L} - M \pm \sum 1/2 (L \times M) \quad (10)$$

In eq. (10), K stands for performance ratio, L stands for electricity in the stadium, and M stands for power monitoring in a L M representation, which is what the intelligence of the stadium uses to turn its electric lights on and off automatically at a rate of 1/2 (L M).

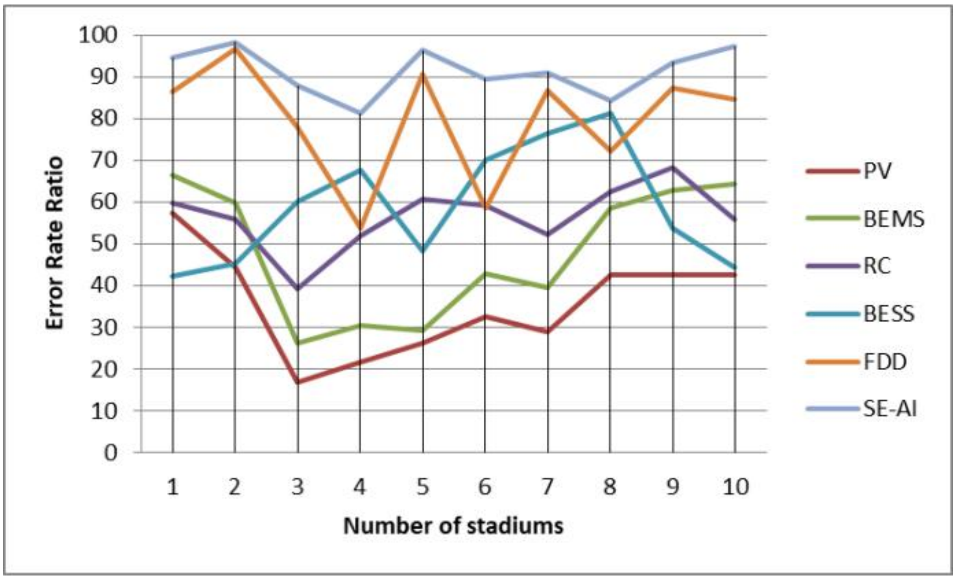

Figure 5. The Percentage Ratio of Errors

As can be seen in **Figure 5**, large stadiums have been negatively impacted by the low transformer load rate, which has led to higher electricity prices, less efficient use of electricity, and more pollution. This research first analyses data on the load rates of transformers at two major stadiums, and then offers advice on how to optimise the operational load rates of stadium transformers by selecting the appropriate demand coefficient.

$$L = (\alpha + \beta) \int l \times \sqrt{l/k} \quad (11)$$

In Eq. (11), L represents the error rate, represents the energy, represents a large stadium, and l in load rate in k load energy converted w.r.t. the load rate is a coefficient in electric power that can increase l l Stadium's load rate and (+) k the mathematical function for stadium electric load and spots stadium of the transformer load rate data (**Table 2**).

Table 2. Identification of Electricity Fault Detection in the Stadium

Number of stadium	PV	BEMS	RC	BESS	FDD	SE-AI
7	76.8	78.8	70.7	79.7	66.7	77.6
6	69.7	79.7	77.6	77.6	60.7	70.7
7	76.7	77.6	66.7	78.6	67.7	77.7
6	79.9	77.9	69.6	79.6	76.6	68.7
7	66.9	77.9	77.6	66.9	77.7	87.7
6	69.7	79.7	67.7	69.6	77.7	97.7
7	79.6	77.6	69.9	77.7	67.6	76.7
8	66.7	68.7	78.7	76.7	76.7	86.6
9	67.6	70.6	76.6	68.7	77.6	97.6
70	77.7	69.7	79.7	67.7	67.7	90.7

The hardware backbone of the modern, secure sports venues is shown in **Table 2** and consists of a firewall, a specialised switch, and an information system. Internet access at major stadiums is protected by cutting-edge firewalls and networking hardware. If the transformer fault deduction is performed, this data system will reach the same result. After a given series of circumstances, a faulty transformer might occur at any moment. Inputs from the outside may join internal and external factors like ground faults, core faults, inter-turn faults, tank faults, and so on. To detect transformer faults in stadiums, the AI-based technology takes into account a number of parameters unique to each transformer as well as other relevant data.

$$M = \int \int (x)\, dx + \int \cos(t)\, \pi/2 \tag{12}$$

Calculations in Eq (12). The fault detection system, represented by the letter M, calculates the mathematical function for similar faults based on the cosine of the tangent (t) of the electrical stadium, which is represented by the letter x.

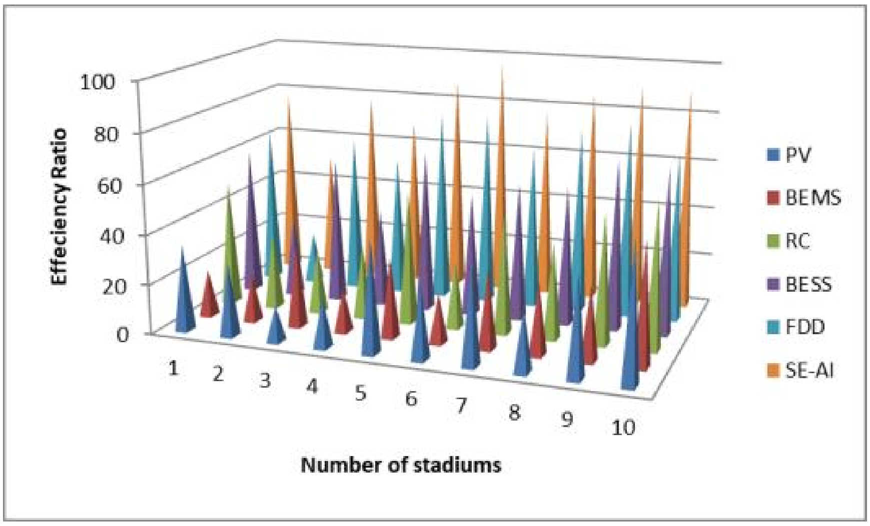

Figure 6. Energy Loading Unloading Efficiency Ratio (%)

As can be seen in **Figure 6**, several sports venues have plans to build new energy-efficient buildings, while others are modifying their pricey energy consumption habits, despite the fact that many stadiums have undergone substantial restorations. But in an effort to reduce costs and environmental impact, stadiums are replacing their outdated lighting systems. Some stadiums include programmable lighting systems that turn down the lights when there is no one in the stands or when natural light is sufficient (Panton & Walters, 2019; Xie et al., 2021; J. Guo, Zhu, & Hu, 2020).

$$N = \pi/2 + \sqrt{a} + b \int \sin\beta \tag{13}$$

According to Eq. (13), N represents the efficiency ratio, b represents the existing stadium's energy efficiency, a represents the stadium's energy consumption, and an is the sine of the trigonometric function for the stadium's lighting system and other amenities. The high efficiency power may be calculated as a price.

CONCLUSION

Stadium improvements, which are increasingly using AI, mirror the overall trend in IT development. Modern information and communication network technologies may be included into the stadium's electrical architecture to save costs and increase efficiency. Once the game is over, the stadium's contributor is taken out of service and unloaded. In the event of an electrical failure during a sports event, the system is ready to be taken over at any moment. The architecture of an artificially intelligent stadium includes an integrated management system to improve oversight of all stadium operations. Solar power will eventually replace fossil fuels as the primary means of generating electricity. Solar photovoltaic power system performance may be enhanced and generally accepted with the backing of national policymakers (government) and cutting-edge solar technology. Since the usage of fossil fuels has a significant impact on climate change due to their emissions of hazardous gases and their finite supply. Better still, combining clean energy with AI will allow us to maximise our use of all available energy sources while having almost no negative impact on the environment.

However, further study is needed to determine the applicability of AI in smart stadiums in terms of user advantages such parking issues, Virtual Reality, event planning, and surveillance systems to guarantee a more satisfying sports event experience for the audience.

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