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Computer applications and artificial intelligence and their technical and economic role in the poultry industry

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Abstract

Computer applications and artificial intelligence are vital factors that have greatly contributed to improving the poultry industry, so this study aims to review the role of these technologies in enhancing productivity, chickens welfare, quality control and food safety.

The study demonstrated the ability of artificial intelligence to predict productivity using environmental and health data, which contributes to making effective strategic decisions to improve marketing and distribution. It also showed the importance of artificial intelligence in improving the breeding environment through advanced environmental control systems that help control temperature and humidity within production fields, which improves bird health and reduces environmental stress. The survey also demonstrated the role of artificial intelligence in ensuring food safety through early detection of contamination or spoilage in meat and eggs, which reduces health risks. In addition, technologies helped improve market analysis by predicting demand and determining optimal prices, which contributes to improving marketing strategies.

Therefore, this study summarized the results of previous studies and confirmed that artificial intelligence contributes to improving resource consumption, reducing costs, and increasing operational efficiency, making it an innovative solution to meet the challenges of the poultry industry in the modern era.

Keywords: Artificial Intelligence, Environmental Control, Food Safety, Poultry Industry, Productivity Enhancement

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تطبيقات الحاسوب والذكاء الاصطناعي ودورها التقني والإقتصادي في صناعة الدواجن

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المستخلص

تُعد تطبيقات الحاسوب والذكاء الاصطناعي من العوامل الحيوية التي ساهمت بشكل كبير في تحسين صناعة الدواجن ، لذا تهدف هذه الدراسة إلى استعراض دور هذه التقنيات في تعزيز الإنتاجية، رفاهية الطيور، ومراقبة الجودة وسلامة الأغذية.

إذ أظهرت الدراسة قدرة الذكاء الاصطناعي على التنبؤ بالإنتاجية باستخدام البيانات البيئية والصحية، مما يسهم في اتخاذ قرارات استراتيجية فعالة لتحسين التسويق والتوزيع، كما كما بينت أهمية الذكاء الاصطناعي في تحسين بيئة التربية عبر أنظمة التحكم البيئي المتقدمة التي تساعد في ضبط درجة الحرارة والرطوبة داخل الحقول الانتاجية ، مما يحسن صحة الطيور ويقلل الإجهاد البيئي ، وأثبتت الدراسة المسحية أيضًا دور الذكاء الاصطناعي في ضمان سلامة الأغذية من خلال الكشف المبكر عن التلوث أو الفساد في اللحوم والبيض، مما يقلل من المخاطر الصحية، إضافة إلى ذلك، ساعدت التقنيات في تحسين تحليل الأسواق من خلال التنبؤ بالطلب وتحديد الأسعار المثلى، مما يساهم في تحسين استراتيجيات التسويق.

لذا لخصت هذه الدراسة نتائج الدراسات السابقة وأكدت بأن الذكاء الاصطناعي يسهم في تحسين استهلاك الموارد، تقليل التكاليف، وزيادة الكفاءة التشغيلية، مما يجعله حلاً مبتكرًا لمواجهة تحديات صناعة الدواجن في العصر الحديث.

الكلمات المفتاحية: الذكاء الاصطناعي، الرقابة البيئية، سلامة الغذاء، صناعة الدواجن، تعزيز الإنتاجية

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Introduction

The poultry industry is considered one of the important economic sectors in many countries, as it contributes significantly to providing animal protein and meeting the needs of the local and international market. However, this industry faces major challenges that affect production efficiency and quality, such as various diseases, lack of feed efficiency, and problems related to production management [1, 2]. These challenges lead to increased costs and deterioration in product quality, which requires the search for innovative solutions to improve production performance and reduce losses. In this context, the use of artificial intelligence and advanced computing technologies has become increasingly important in the poultry industry, as these technologies can contribute to improving the effectiveness of farm management, by diagnosing diseases early, monitoring the general health of poultry, and organizing feeding operations more accurately and realistically, which contributes to rapid decision-making [4 ،3].

The application of artificial intelligence in the poultry industry is a pivotal step towards improving productivity and reducing costs. These technologies can help improve feed efficiency and provide smart solutions to monitor poultry health using technologies such as machine learning and graphic analysis[5] .

These technologies also reduce the need to use medications through early detection of diseases, which contributes to improving production quality and reducing environmental impacts on bird health [6]. Through this study, the importance of applying artificial intelligence and advanced computing in the poultry industry will be reviewed, as the research aims to study the impact of these technologies in the poultry industry, and review the tools that enable improving the performance of the industry. The research seeks to solve the problem of challenges facing the poultry industry, such as controlling diseases and managing birds with high efficiency in a closed environment, as artificial intelligence can provide innovative solutions in early diagnosis of diseases, improving feeding efficiency, and better managing resources.

Employing computer applications and artificial intelligence in the poultry industry

Computer applications and artificial intelligence can be used in the poultry industry in several main areas, and Figure 1 shows a simplified graphic of automated production process, and this programmed production process will contribute to improving productivity, reducing costs and raising the level of health care for poultry, as shown in figure (1).

Figure (1): A simplified graphic of the automated production process

1- Improving feeding systems and feed management

Computer applications and artificial intelligence techniques help design balanced rations based on immediate analysis of nutritional components, as specialized programs can analyze data on poultry needs according to age, weight, and production level, leading to improved growth rates and reduced food waste. The poultry industry has witnessed a remarkable development in the use of artificial intelligence (AI) to analyze nutrition and improve production performance [7]. The use of deep neural networks to analyze poultry nutritional needs and modify diets is one of the most prominent scientific innovations in this field [8]. This analysis enables the identification of optimal feed components based on environmental and health data for poultry [9].

Another study examined the use of AI to improve animal feed composition by identifying the best combination of ingredients based on the birds' needs and environmental conditions [10]. For example, AI can predict utilization levels of different nutrients based on changing environmental factors such as temperature and humidity [11] .

In addition, machine learning (ML) applications are used to improve feed intake and achieve nutritional balance [12]. A recent study confirmed the ability of AI to analyze big data through algorithms to more accurately predict future nutrient needs of poultry [13].

Other research has shown that integrating AI into feeding determination can lead to significant improvements in overall flock performance [14]. This approach reduces waste and increases productivity efficiency, which contributes to reducing costs [15]. According to a recent study, AI enables better productivity levels while reducing costs Operational [16]. Finally, a recent study showed that the integration of AI and environmental analysis in nutrition leads to improved overall performance and increased productivity in poultry farms [17]. Previous studies have demonstrated the ability of AI to analyze nutritional components more accurately than traditional methods. For example, several researchers have used AI to analyze feed composition in poultry farms and achieve better productivity levels while reducing costs [18] .

A previous study also emphasized the importance of using predictive algorithms to determine the most effective feeding requirements based on environmental and health data of the flock [19]. These techniques have been critical in reducing waste and achieving improvements in overall performance, which enhances feed efficiency in the poultry industry. While another study examined the use of AI to improve animal feed composition by identifying the best combination of ingredients based on the needs of birds and their environmental conditions [9]. A recent study added that artificial intelligence is able to analyze big data through algorithms to more accurately predict future nutrient needs of poultry [20].

2- Early health diagnosis of poultry diseases

Computer vision and big data analysis techniques are used to detect early signs of diseases in poultry flocks. Cameras and sensors can analyze bird behavior, such as decreased activity or changes in feed and water consumption, and send immediate alerts to farmers to take preventive measures. Early diagnosis systems for poultry are among the most important innovations that have improved the ability of poultry farms to detect diseases and disorders early, allowing for improved health care

and reduced economic losses [21]. Studies have shown that artificial intelligence (AI) can play a crucial role in disease detection by analyzing medical images using deep learning techniques [7]. For example, artificial neural networks can be used to diagnose respiratory diseases in poultry based on the analysis of X-ray or ultrasound images [22]. The effectiveness of using AI in early diagnosis systems in poultry farms has also been confirmed to increase the speed of disease detection and improve treatment response [23]. In addition, pattern recognition techniques in environmental and health data contribute to predicting disease outbreaks before they become clearly apparent [20]. AI can also be used to track bird behavior and identify any changes that indicate potential health problems [24]. On the other hand, a recent study showed the ability of predictive algorithms to identify the onset of diseases such as avian influenza faster than traditional methods [15]. Finally, a recent study confirmed that the use of AI in early disease detection enhances the effectiveness of health interventions, reducing the spread of diseases and improving production performance [25].

3- Automating farms and improving the poultry breeding environment

Computer and artificial intelligence systems can automatically control temperature, humidity, and ventilation systems based on sensor data, which helps reduce heat stress and improve the breeding environment, thus positively affecting poultry productivity. Computer and artificial intelligence technologies are a powerful and effective tool for improving the breeding environment in poultry farms, as they contribute to improving environmental conditions within the fields to ensure bird health and increase productivity [26]. Artificial intelligence can be used in advanced environmental control systems to adjust temperatures, humidity, and air distribution within the farm to suit the needs of birds [27]. Previous studies have shown that artificial intelligence technologies are not only limited to improving the physical environment of birds, but also help improve their welfare by predicting potential behavioral problems, allowing the environment to be modified proactively [28].

In addition, AI technologies contribute to improving energy consumption by monitoring electrical systems and adjusting lighting and temperature using smart algorithms [29]. AI can also be used to continuously monitor bird behavior and analyze this data to identify any health problems that may arise due to environmental conditions, such as heat stress or high ammonia levels [30]. A recent study showed that applying these technologies can reduce waste and improve the overall environmental quality of the farm [31]. Another study showed that AI can improve airflow and use automatic systems to adjust oxygen levels and ventilation, which contributes to improving bird health and well-being [32].

4- Improving the efficiency of artificial insemination and production of poultry

Artificial intelligence is used to analyze genetic data and predict the best pairs to improve productivity. Robots are also used in artificial insemination processes to enhance the efficiency of production processes and achieve desirable genetic traits. Artificial intelligence can contribute significantly to improving the efficiency of artificial insemination and increasing productivity in the poultry industry, by analyzing genetic data using machine learning techniques, the best poultry pairs can be predicted to improve genetic

traits and increase mating efficiency. Research has indicated that integrating artificial intelligence into breeding processes increases the efficiency of artificial insemination and achieves positive results in improving genetic traits [33].

Another study has shown that AI-supported technologies have helped improve insemination results through accurate analysis of genetic data and selection of optimal pairs [34]. Moreover, robots that manage artificial insemination processes have enhanced the accuracy and efficiency of these processes, reducing human errors and improving consistency in production. Research has shown that the use of robots in artificial insemination saves time and increases the success of the process, which contributes to achieving desirable genetic traits such as disease resistance and increased growth [35]. Recent studies have shown that the use of artificial intelligence in genetic analysis helps improve egg and broiler production, leading to increased farm productivity and improved quality [36]. In this context, artificial intelligence represents a crucial step towards improving artificial insemination processes and increasing productivity in the poultry industry.

5- Monitoring product quality and food safety in the poultry industry

Artificial intelligence technologies are used to inspect the quality of eggs and meat, and monitor any changes in chemical composition or potential contamination, which contributes to improving food safety standards.

Artificial intelligence technologies are effective tools in monitoring product quality and food safety in the poultry industry, as they contribute to improving the effectiveness of biological and chemical examinations of final products [37]. These technologies help monitor the quality of meat and eggs and identify any contamination or spoilage that may occur during the production process or after slaughter or collection [38]. These systems also contribute to providing detailed reports that help in compliance with international food safety standards [39]. Temperature and humidity data in production plants can be analyzed by artificial intelligence algorithms to ensure that products are processed and stored in optimal conditions to ensure their safety [40].

AI can use imaging analysis of products to detect any impurities or damage, facilitating quick decisions about rejecting non-compliant products [41. These systems integrate environmental control, biological analysis, and smart technology to achieve the best product quality and ensure their safety in the market [42]. Previous studies have shown that the use of AI technologies in quality control contributes significantly to reducing food contamination and improving reliability in the production chain [43].

6- Smart surveillance cameras in poultry farming and industry

AI-based surveillance systems play an important role in improving management within farms. Smart cameras can automatically analyze bird behavior, such as tracking movement, distributing birds within the barn, and identifying abnormal gatherings that may indicate health or behavioral problems. These systems also provide visual recordings that facilitate monitoring the overall performance of the flock, smart surveillance cameras are modern tools that contribute to improving the management of poultry farms by continuously monitoring bird behavior and providing accurate analyses of the flock's condition [44].

A recent study showed that integrating smart surveillance cameras with environmental control systems increases productivity and improves bird health [45]. In addition, smart cameras can be used to analyze environmental conditions such as temperature and humidity, which contributes to adjusting the farm environment to be more suitable for bird health [46]. These cameras operate with artificial intelligence (AI) technologies that enable them to recognize bird behavior and alert farmers to any abnormal behavior that may indicate a health or environmental problem [47]. Previous studies have also shown the use of smart surveillance cameras to reduce the incidence of infectious diseases by providing accurate monitoring of bird behavior and identifying disease outbreaks early [42]. Furthermore, these systems help reduce operational costs by reducing the need for constant manual monitoring [48].

For example, smart surveillance cameras can analyze the movement of birds inside the cages to determine activity levels or signs of stress or illness [31]. These systems also provide information on feed and water consumption, which helps improve feed quality and reduce waste [49].

7- Productivity forecasting and market movement

Analysis Modern systems rely on artificial intelligence to analyze market data and predict poultry prices based on supply and demand, which helps farmers make better marketing decisions and achieve maximum profitability. Productivity forecasting and market analysis are vital areas that can be greatly improved using artificial intelligence technologies in the poultry industry. Previous studies have shown that artificial intelligence can be a powerful tool in improving productivity and reducing costs in poultry farms by improving marketing strategies and analyzing related data [50]. Another study showed that using artificial intelligence technologies in market analysis may contribute to improving supply chain decision-making and distributing products at the ideal time [51].

Using predictive algorithms, poultry farmers can predict future production based on multiple factors such as nutrition, environmental conditions, and bird behavior [52]. These tools help improve production planning and determine the best marketing times to maximize profits. For example, artificial intelligence can be used to analyze environmental and health data to predict changes in Productivity based on climate shifts or potential diseases [28].

In addition, AI technologies contribute to market analysis and demand forecasting for poultry products, helping producers make strategic marketing decisions and reduce losses resulting from market fluctuations [53] These systems can also predict market prices based on demand and supply patterns, helping determine the best time to market or store products. A recent study showed that AI can contribute to improving production planning and anticipating future changes based on advanced data analysis [54]. AI can also be used to analyze markets and predict price changes, helping farmers maximize profitability by timing product marketing optimally [55].

Conclusion

Computer and artificial intelligence applications in the poultry industry have greatly improved production and operational performance, through monitoring bird health, predicting productivity, and analyzing markets. These technologies have also contributed to reducing costs, ensuring food safety, and improving the rearing environment,

which contributes to the sustainability of the industry and reducing environmental impacts. In general, artificial intelligence is considered a major driver for improving the efficiency of the poultry industry and achieving greater sustainability in resource management.

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