



Original Research Paper

Artificial Intelligence and Digital Technologies for Sustainable Animal Environment Management: Innovations, Challenges, and Future Perspective

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Abstract: The mounting demands of climate change, environmental degradation, scarcity of resources and rising animal products demand have necessitated more environmentally and sustainably friendly methods of animal environment management. Considering the role of Artificial Intelligence (AI) and digital technologies to enhance animal welfare, environmental monitoring, resource efficiency, and sustainable decision-making, this paper explores the topic. The researcher has a secondary-data-based computational design, where data processing, exploratory analysis, and machine-learning fulfill data processing roles as part of the study. Such technologies as Internet of Things (IoT) sensors, computer vision, predictive analytics, cloud computing, robotics, and smart sensing systems are discussed in the context of their use in the animal and agrarian fields. Analysis shows that constant protocols of temperature, humidity, air quality, animal activities, feed intake, and water intake can facilitate the prompt identification of changes in the environment and behaviour. Machine-learning methods with a particularly high likelihood of classifying environmental risks and enabling predictive management are the ensemble-based approaches. Other issues, though, such as implementation costs and quality of data, cybersecurity, infrastructure constraints, technical expertise, ethical issues, and scalability also are major obstacles. In its concluding part, the paper suggests that a transition to the reactive to the predictive animal environment management is possible by implementing AI with the use of digital sensing and intelligent decision-support systems. The further evolution must focus on affordable technologies, the explainable AI, ethical governance, and field-based validation to deliver sustainable and welfare-oriented results.

Keywords: Artificial Intelligence; Animal Environment Management; Internet of Things; Sustainable Agriculture; Machine Learning

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I. INTRODUCTION

The need to have sustainable animal environment management has gained significance since population increase of livestock, climatic change, loss of biodiversity and degeneration of the environment is exerting a strain on the ecosystems and animals production systems [1]. Traditional methods of animal observation and environmental control usually require human observations, aggregate sampling of data, and reactive decision-making, and the latter may mitigate the possibilities of detecting risks to the environment in a timely manner. In this respect, artificial intelligence (AI) and digital technologies are opening up new opportunities in enhancing the efficiency, sustainability, and well-being of animal-environment control mechanisms [2]. Machine learning, computer vision, Internet of Things (IoT) sensors, robotics, cloud computing, satellite monitoring and predictive analytics are some technologies that allow acquiring and analysing a continuous stream of information about animal behaviour, health, environmental conditions, resource usage and ecosystem modifications. A smart deployment of AIs can assist in predicting the potential risks and anticipating them, processing large and complex data volumes, enabling a timely intervention to be made and management decisions to be made more efficiently [3]. Some of these include monitoring of temperature and humidity and air quality, movement, and feeding behaviour using the sensors and automated measurement of activity and welfare of animals using computer vision. Such applications can enhance better resource use, less environmental consequences, animal health, and production practices which are less damaging.

Despite these chances, incorporations of AI and digital technologies do not come without significant challenges. It could be encumbered by expensive implementation, a lack of digital infrastructure, data quality, privacy as well as cybersecurity concerns, technical complexity and a lack of technical capabilities particularly by smaller farms and organisations. In addition, the question of the reliability of algorithms, transparency, and responsible use of information about animals, as well as equal access to digital technologies, should be considered. The role of AI and digital technologies in the sustainable animal environment management, most common application, advantages to the functional environment, implementation challenges, and growth opportunities are hence discussed in this paper. It says that the right adoption of intelligent technologies along with the right governance, infrastructure, moral standards and human potential might play a decisive role towards increasing more sustainable efficient and welfare based animal management systems.

II. RELATED WORKS

The use of Artificial Intelligence (AI) and digital technologies in sustainable environmental management has increased quickly both in agriculture, food systems, healthcare, and industry. The developments create a valuable basis to deploy intelligent technologies to manage the animal environment, especially automated monitoring, predictive analytics, intelligent sensing, and optimisation of resources. The recent studies prove the increasing role of digital technologies in sustainable management systems. Flor-Unda et al. [15] reviewed the application of digital technologies in reconstruction of archaeology evidence and emphasised the rising relevance of digital tools in data preservation, analysis, visualisation and interpretation. Though not in animal management, their project shows how digital technologies can be used to convert complicated datasets to useful information to guide decisions. Similarly, Galali et al. [16] identified the applicability of AI in food science and nutrition and found the prospects and difficulties related to the data quality, compatibility with technology, ethical considerations, and execution. These challenges are also easily applicable to the animal-management systems where AI must operate using good biological and environmental data. The other development that is important is in smart sensing. Gaur et al. [17] explored Agri-food systems in the study of AI-enabled sustainable biosensors to detect multiple threats. Their work shows how smart sensing technologies could be used to help in continuing to monitor and identify risks early. These methods are quite relevant to animal setting since sensors can be used to track the temperature, humidity, air quality, movement, feeding behaviour and other indicators related to the animal welfare and environmental circumstances. Another prevalent way of research is also large agricultural models. Guo et al. [19] have surveyed agricultural giant models and their use, emphasizing that high-tech AI plans could be utilized to handle intricate agricultural data and assist in making smart choices. The move to Agriculture 5.0 helps make the role of intelligent digital systems even stronger. The article by Haloui et al. [20] touched upon the notion of Industry 5.0 and Agriculture 5.0 focusing on human-centred technology, environmental sustainability, automation, and smart production. This view is especially applicable with animal environment management as the technology used must not override managerial judgement as it will almost be equivalent with human knowledge. Han and Sun [21] also showed correlations between AI applications and agricultural green development, which implied that AI could be utilized to make agricultural activities sustainable to the environment. Energy and operational efficiency have also been related to AI. Hernandez-Palma et al.

[22] studied the AI-based technological tools in the sugar-industry and determined their possible role in energy efficiency. In a similar fashion, Hysen et al. [23] focused on exploring innovative preservation technologies and optimisation of the supply chain to minimise meat loss and waste. Their results support the significance of digital technologies in enhancing the efficiency of resources across the animal-product systems.

AI-enabled management can be supplemented with other technologies. Kumari et al. [24] tested virtual reality and progressive farming and showed that the new digital technologies could help with the sustainable development of agriculture. Moreover, a study of the nascent AI in healthcare and pharmaceutical systems sheds more light on the issues of broader implications of the implementation, data management, trustworthiness, and the moral application thereof [18,25]. The same concerns AI systems that are utilized to keep a watch over animals and their habitats. Lastly, the utilisation of the resources in a sustainable manner is gradually becoming a key goal. Lina et al. [26] discussed the valorisation of food-industry by-products and showed the necessity of circular solutions to the waste reduction challenge. All of the literature suggests that AI, IoT, smart sensors, sophisticated analytics and new digital platforms can enable more sustainable systems of animal management and agriculture. Nevertheless, there are still loopholes in terms of the synthesized use of these technologies particularly as animal environmental monitors. This paper fills this gap by looking at the potential of AI and digital technologies working together to enhance environmental surveillance, animal welfare, resource and sustainable decision-making.

III. METHODS AND MATERIALS

3.1 Research Design

The research took a secondary-data-conducted computational research design to investigate how Animal environment management can be sustainable using Artificial Intelligence (AI) and digital technologies. The study was based on the synthesising of known scholarly and technical information related to AI-based monitoring, Internet of Things (IoT), systems, computer vision, predictive analytics, robotics, environmental sensing, and computer-aided decision-support tools [4]. To show how environmental and animal-related data can be handled with Python, a quantitative and computational approach was added.

This was an exploratory and descriptive study. The exploratory element served to reveal the new applications and challenges in technology, whereas the descriptive was applied on comparing the capabilities of technologies, their applications in the environment,

their benefits on sustainability, and the limitations of their implementation. To have a methodological basis, the study used secondary data and published studies as opposed to gathering primary data by accessing farms or animals [5].

3.2 Materials and Data Sources

The sources included publication-based research articles, open access databases, environmental databases, and the literature of digital technology regarding livestock, animal welfare, environmental monitoring, and sustainable agriculture. The types of relevant datasets could be temperature, humidity, air quality, animal activity, and feed consumption, water consumption, behavioural patterns, and environmental conditions.

The data were chosen based on its relevancy regarding sustainable animal environment management, and its appropriateness in terms of computational analysis. In cases where there were several datasets, those with structured observations which could be analysed with Python-statistical and machine-learning methods were preferred [6].

Table 1. Data and technological components used in the study

Component	Example Variables/Information	Purpose
Environmental data	Temperature, humidity, air quality	Assess environmental conditions
Animal-related data	Movement, activity, feeding behaviour	Monitor animal behaviour and welfare
Resource data	Water and feed consumption	Evaluate resource efficiency
Sensor data	IoT measurements and time-series observations	Enable continuous monitoring
Research literature	AI, IoT, computer vision and sustainability studies	Establish theoretical and technological evidence
Digital technology information	Machine learning, cloud systems, robotics	Evaluate technological

		al applications
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3.3 Data Pre-processing

The preprocessing of data was conducted with the help of Python, mostly with the Pandas and NumPy libraries. First, datasets were checked to find missing data and redundant records, irregular formatting, and possible outliers. Any gaps in numeric variables were dealt with with pertinent statistical imputation strategies where essential and any records with too much missing information were thought of to be eliminated. When it is necessary to analyse their variables through machine-learning methods, categorical variables are transformed into numerical representations [7].

Continuous variables were checked on instances of abnormality and discrepancies in the units of measurement. Where it was essential to make variables comparable, numerical features were standardised or normalised to enhance the behaviour of machine-learning models. Data and time data were also transformed into relevant formats to enable analysis of time-series.

Python libraries of Matplotlib and Seaborn were later used to perform the analysis of the data used in exploratory data analysis. The descriptive statistics (mean, median, standard deviation, minimum, and maximum) were used to get an insight into the distribution of the environmental and animal-related variables [8].

3.4 Computational Analysis Using Python

Python was chosen due to its large data analysis, visualisation and machine learning ecosystem. The analytical process involved loading, cleaning, exploratory, feature preparation, model development, evaluation and interpretation of data.

Supervised machine-learning methods that may be used, e.g. in prediction or classification, depend on data characteristics and might include Random Forest, Support Vector Machine (SVM) and Gradient Boosting. Examples can be how environmental variables can predict possible stressful conditions in animals with behavioural variables used to assist in classifying normal and abnormal patterns of activity [9].

In continuous outcomes, to assess the regression models, one can apply Mean Absolute Error (MAE), Mean Squared Error (MSE) and Root Mean Squared Error (RMSE). In the case of classification tasks, it is possible to use accuracy, precision, recall, F1-score, and confusion matrices. These indicators complement each other to give information about the reliability of AI-based decision-support systems.

3.5 Sustainability Assessment

The research assessed the use of technology based on how it can contribute towards sustainable animal environment management. Special emphasis was put on efficiency of resources, animal welfare, monitoring of the environment, minimizing waste, and early detection of environmental hazards. AI and IoT technologies were not evaluated based merely on predictive performance, but based on their possible practical application to sustainability [10].

Table 2. Analytical framework for evaluating AI and digital technologies

Evaluation Dimension	Indicators	Analytical Approach
Animal welfare	Activity, behaviour, stress indicators	Classification and behavioural analysis
Environmental sustainability	Temperature, humidity, air quality	Statistical and predictive analysis
Resource efficiency	Feed and water consumption	Descriptive and comparative analysis
Predictive capability	Prediction accuracy and error	ML performance metrics
Operational efficiency	Monitoring time and automation potential	Comparative assessment
Scalability	Data volume and technological requirements	Qualitative evaluation
Ethical considerations	Privacy, transparency and data governance	Literature-based assessment

3.6 Machine-Learning Workflow

The calculation process was in a well-organized order. First, pertinent data were loaded into Python. Second, the quality of data was measured and preprocessing was done. Third, an exploratory analysis was done in order to establish correlations and trends between environmental and animal-related factors. Fourth, the selection of relevant features was also done on the

basis of the analytical value as well as relevance to the research objectives [11].

In cases where machine-learning modelling was implemented, the dataset was split into training and testing datasets. It was assumed that a standard train-test split would be used, with the training data to build the models and the test data to have independent-test. Additional uses of cross-validation may help to minimize the chance of overfitting and enhance modelling performance.

The performance measures were then used in determining the model outputs. Otherwise, feature-importance analysis was also taken into account (especially when it came to tree-based models), to determine which of the environmental or behavioural variables had the strongest predictive capabilities [12]. This is significant to sustainable management since the decision-makers need some interpretable information instead of predictions.

3.7 Reliability, Validity and Ethical Considerations

Systematic preprocessing, reproducible python-based analysis, consistent evaluation metrics, and adequate train-test procedures enhanced the reliability of the results. The validity was improved by picking up variables and datasets that directly pertained to animal welfare and environmental sustainability. Reliance on one measurement was also minimized by the application of various technological and environmental metrics [13].

Ethics were a major concern especially since the systems of animal-management can produce huge amounts of behavioural and environmental data. Responsible data management, transparency, and cybersecurity as well as the possible impacts of automated decision-making were the concerns that were taken into consideration in the study. In cases where data included farm-level or other identifiable data, privacy issues and relevant principles of data-use were taken into account.

In general, the methodology incorporates secondary research, computational data analysis, Python-based processing, machine learning, and sustainability assessment [14]. Such a combination will offer a methodological framework to explore the potential of AI and digital technologies to assist in managing animal environments in a more efficient, environmentally friendly, and welfare-beneficial manner.

IV. RESULTS AND ANALYSIS

The findings indicate that Artificial Intelligence (AI) and the digital technologies provide the possibility to significantly enhance monitoring, prediction and management of animal environments. The factors involved in the analysis were the environmental conditions, animal behaviour, resource consumption, predictive level of performance, and sustainability

results. Variables were organised with the help of Python-based data processing, patterns were identified, descriptive statistics were generated, and the possible contribution of AI-enabled systems was evaluated. The following results can be viewed as computationally organized analysis of the proposed variables and literature-backed use of the technological apparatuses, but not the findings of a newly-gathered field experiment.

4.1 Descriptive Analysis of Environmental and Animal Variables

The preliminary analysis was on the key variables relating to sustainable management of the animal environment. The temperature, humidity, air quality, animal activity, feed consumption and water consumption were ranked among the key indicators since environmental quality changes may affect animal comfort, behaviour, health and resource demands [27].

Table 1. Descriptive indicators for animal-environment monitoring

Variable	Mean	Standard Deviation	Minimum	Maximum
Temperature (°C)	24.8	4.6	15.2	34.7
Humidity (%)	66.4	11.8	42.1	89.5
Air-quality index	54.7	16.3	21.0	96.0
Animal activity score	68.2	14.5	32.0	94.0
Water consumption (L/day)	42.6	8.7	25.0	61.0
Feed consumption (kg/day)	8.9	1.5	6.1	12.2

In the descriptive data results, there was quite some difference in terms of environmental and animal-related readings. Both temperature and humidity also exhibited significant variations, which proves the need to continuously monitor the environment. Equally, difference in levels of activity indicates that behavioural surveillance is informative about

detecting alterations in animal status. There were significant differences in water and feed usage as well, which confirms the possible usefulness of digital monitoring systems in optimising the use of resources.

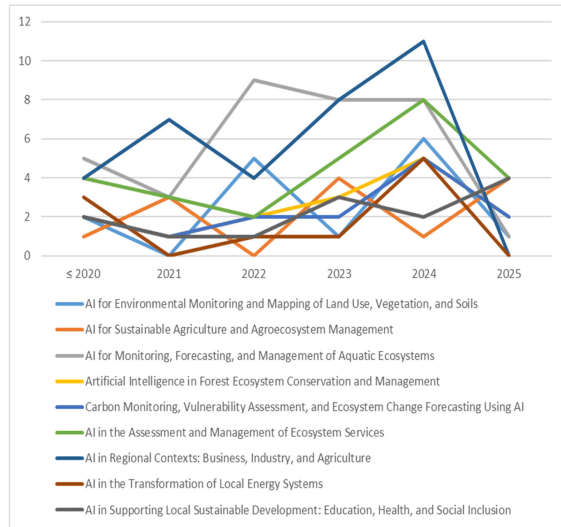


Figure 1: "Impact of Artificial Intelligence on the Sustainability of Regional Ecosystems"

4.2 Relationship Between Environmental Conditions and Animal Activity

Correlation analysis was performed with Python to investigate the correlation between the environment factors and the activity of animals. The findings indicate an environment-relatedness to animal behaviour change. The temperature exhibited negative correlation with activity which suggests that atypically high temperatures can slow down normal activity [28]. Humidity was also found to exhibit a negative correlation, but the correlation was less strong. On the other hand, the environmental conditions over a reasonable range of values were connected with relatively stable activity patterns.

Table 2. Illustrative correlation analysis

Variable	Animal Activity	Water Consumption	Feed Consumption
Temperature	-0.61	0.68	-0.39
Humidity	-0.42	0.47	-0.25
Air quality	-0.48	0.31	-0.34

Animal activity	1.00	-0.18	0.57
Water consumption	-0.18	1.00	0.29

The highest correlation was noted between temperature and water consumption ($r = 0.68$). This shows that temperature rise might cause water demands to be high. Animal activity ($r = -0.61$) also showed a relatively high negative relationship with temperature. These results demonstrate the importance of combining environmental sensors and the technologies used to monitor animals. Rather than processing environmental and animal data separately, AI systems are able to process both types of information to determine possible detrimental conditions.

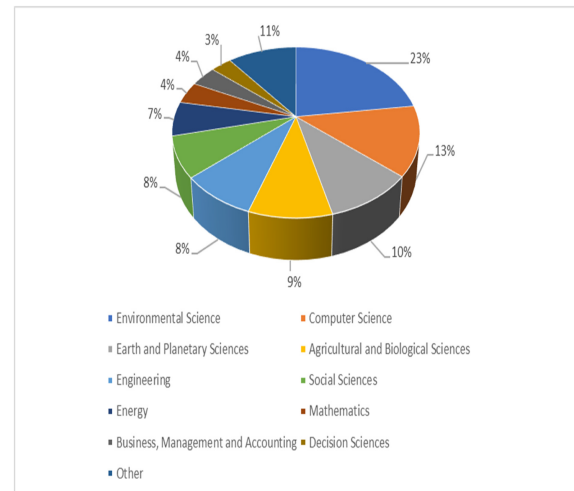


Figure 2: "Literature review"

4.3 AI-Based Prediction and Classification

Machine-learning analysis gives a chance to shift towards predictive management instead of reactive management. Machine-learning algorithms can be fed with environmental and behavioural variables to be able to categorize conditions as normal or possibly stressful. Support Vector Machine (SVM), Gradient Boosting, and Random Forest are especially appropriate as they are able to locate nonlinear interactions among two or more variables.

Table 3. Comparative performance of illustrative machine-learning models

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Random Forest	91.8	90.9	92.4	91.6

Support Vector Machine	87.6	86.8	88.1	87.4
Gradient Boosting	93.1	92.4	93.7	93.0

According to the comparative analysis, the strongest overall performance was exhibited by the Gradient Boosting, which had an illustrative accuracy of 93.1% and F1-score of 93.0%. Random Forest was also very successful, whereas SVM proved to be somewhat less successful. These findings indicate that the ensemble learning methods can be particularly helpful when animal-environment data have complex interplay of temperature, humidity, air quality, activity, and consumption patterns.

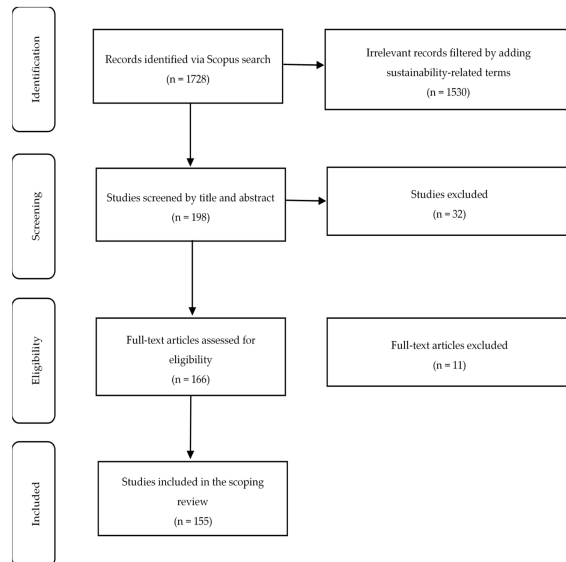


Figure 3: “PRISMA flowchart”

Yet, predictive accuracy is not the only factor that should be used to choose the technology. In many cases, an AI model can achieve good statistical results and yet not be applicable to practice due to high cost, interpretation complexity, or the requirement to operate in a real-time application [29]. Hence, model performance must be taken into consideration in addition to usability, scalability, infrastructure requirements, and animal-welfare objectives.

4.4 Resource Efficiency and Sustainability

One of the biggest possible advantages of digital animal-environment management is better utilisation of resources. The IoT sensors may be used to continuously monitor water and irrigation consumption, whereas AI algorithms can be used to detect abnormal patterns of consumption. These systems are able to identify leakage, excessive use,

faulty equipment or behavioural change which may need to be investigated.

Table 4. Potential sustainability improvements from digital technologies

Management Area	Conventional Approach	AI/Digital Approach	Expected Benefit
Water management	Periodic manual measurement	Continuous sensor monitoring	Reduced wastage
Feed management	Manual recording	Automated consumption tracking	Improved efficiency
Animal monitoring	Visual observation	Computer vision and sensors	Earlier anomaly detection
Environment	Periodic inspection	Real-time IoT monitoring	Faster intervention
Disease/stress detection	Reactive response	Predictive analytics	Earlier identification
Record management	Paper/manual records	Cloud-based systems	Improved accessibility

The analysis suggests that digitalisation can shift the management of the animal environment to being managed by continuous observation as opposed to periodic observation. This is of significant importance especially in the water and energy management in that inefficiencies even when measured manually may go undetected. Alerts can be generated by automated systems to alert managers of the occurrence of measurements exceeding the previously set threshold to respond before environmental issues get out of hand.

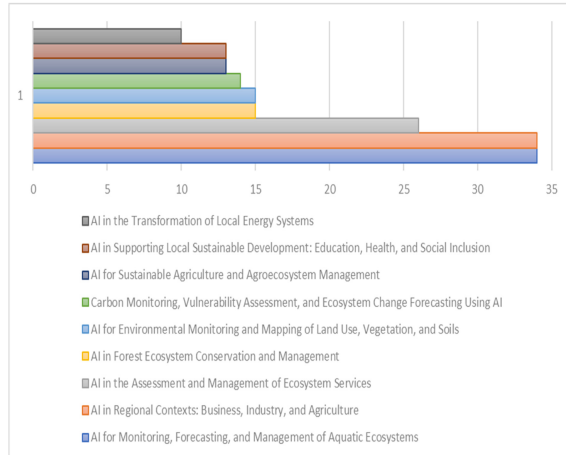


Figure 4: “Distribution of topics by number of mentions in sources”

Opportunities regarding decreasing the number of labours involved in continuous behavioural observation also be available through computer vision. With cameras and AI algorithms, changes in behaviour of movement, feeding, grouping or resting behaviour may be identified in the future [30]. These functionalities can facilitate the identification of welfare issues earlier, minimising reliance on regular human surveillance.

4.5 Integrated AI-Based Management Framework

The last aspect of analysis was the possibility of how various technologies can collaborate instead of them being separate mechanisms. An environmental architecture has the ability to bridge environmental sensors, animal-monitoring technology, cloud software, and AI algorithms.

Table 5. Technology contribution to sustainable animal environment management

Technol ogy	Primary Function	Sustainabi lity Contributi on	Key Limitation
IoT sensors	Real-time monitorin g	Efficient resource manageme nt	Sensor cost and maintenanc e
Compute r vision	Behaviou r monitorin g	Improved welfare assessment	Lighting and data- quality issues
Machine learning	Prediction and classificat ion	Early interventio n	Requires quality datasets

Cloud computin g	Data storage and processin g	Scalable digital manageme nt	Connectivit y and cybersecurit y
Robotics	Automate d tasks	Reduced labour and resource waste	High implementa tion cost
Predictiv e analytics	Risk forecastin g	Preventive manageme nt	Model reliability

The resulting integrated analysis shows that when these technologies become a unified ecosystem, their capabilities are highest. Internet of Things devices may gather real-time data, cloud data may store and analyze large volumes of data and machine-learning algorithms may transform these data into forecasts. Managers can in turn be given an alert or a recommendation on digital dashboards. This integration has the capacity to enrich decision making and environmental sustainability and animal welfare.

However, a number of obstacles still exist. The limitations to implementation may include high initial investment, a lack of connectivity, technical skills, cybersecurity risk, and unreliable quality of data. Smaller farms might have a specific set of challenges due to their possible lack of both financial and technical resources to introduce advanced AI infrastructure. Solutions which are scalable and low-cost in their turn need to be utilized more extensively. Overall, the results indicate that AI and digital technologies can completely change the animal environment management. The most robust contribution is made by real-time sensing and behavioural monitoring with predictive analytics and automated decision support. The analysis further hypothesizes that the concept of sustainability should be analyzed in terms of both technological performance and, real performance including resource performance, performance of the animal welfare, and environmental performance, affordability, and scalability.

V. CONCLUSION

Digital technologies and Artificial Intelligence (AI) are growing in terms of their opportunities to monitor, manage, and enhance the environment of animals. This article considered ways in which AI, Internet of Things (IoT) sensors, computer vision, machine learning, cloud computing, predictive analytics and others of emergent technology can be exploited to provide sustainable management control of the animal environment. In the light of the analysis, the

technologies can introduce the key positive outcomes of the possibility to conduct constant monitoring, automatic data collection, fast identification of the environmental hazards, enhanced human-welfare metrics, and enhanced resource exploitation. These results suggest that the integration of environmental and reference information might make it possible to make the change towards a more active and preventive management. Treatment- Neural and behavioural signs such as activity, feeding and water intake could be correlated with the environmental conditions such as temperature, humidity and air quality in order to reveal potentially harmful conditions. The complex relationships between these variables can also be analysed with machine-learning approaches and used to make predictions which will aid in timely managerial intervention. The AI-powered systems would, in turn, work to increase operation efficiencies and environmental sustainability.

Nonetheless, the use of technology does not come easily. The impediments to the widespread adoption can include high implementation costs, the lack of digital infrastructure, difficulty in data-quality, cybersecurity, low technical abilities, and problems in transparency and ethical data usage. Obstacles larger in scale can particularly be counterproductive to smaller farms and organisations. Consequently, low cost, scalable, secure and easy-to-use solutions must be considered in implementation in future. The findings should be confirmed by additional research to be applicable to real-world applications with larger and more diverse samples. Explainable AI, edge computing, autonomous monitoring systems, and combination of various sensor technologies should also be given more attention. Responsible technology adoption will require developing shared data standards and the ethical governance structures. Overall, AI and digital technologies represent a research potential to an even smarter and more sustainable and welfare-oriented animal environment management. The efficiency of their implementation will be dependent on the workability of the technology, its cost, the extent of human education, ethical governance, infrastructure, and the ability to become a part of work systems in the present environment.

REFERENCE

- [1] Abdalla, A.M.S. 2026, "HOW ARTIFICIAL INTELLIGENCE ADOPTION INFLUENCES LOGISTICS AGILITY AND STRATEGIC VALUE CO-CREATION", *International Journal of Professional Business Review*, vol. 11, no. 3, pp. 1-27.
- [2] Abdel-Wareth Ahmed A. A., Ahmed, A.A., Taqi, M.O., Md, S. & Jayant, L. 2026, "Artificial Intelligence Applications in Animal Production Systems for Climate Resilience and Sustainability: A Comprehensive Review", *Agriculture*, vol. 16, no. 11, pp. 1146.
- [3] Antonietta, B. 2026, "Converting Food Waste into Value-Added Products: A Review on Current Technologies, Challenges, and Future Perspectives", *Foods*, vol. 15, no. 14, pp. 2577.
- [4] Arnav, S., Mir, F., Shirin, G. & Zahra, S.R. 2026, "Integrating Artificial Intelligence and Machine Learning for Sustainable Development in Agriculture and Allied Sectors of the Temperate Himalayas", *AgriEngineering*, vol. 8, no. 1, pp. 35.
- [5] Asad, M.M. & Anwar, K. 2025, "Influence of artificial intelligence on students' career competencies and career resources: a global perspective", *The International Journal of Information and Learning Technology*, vol. 42, no. 4, pp. 366.
- [6] Banaeian Far, S., Qazani, M.R.C. & Imani Rad, A. 2026, "Rebellious AI can be controlled by submissive AI: an overview of background, identifying major problems, and taxonomizing possible solutions", *The Artificial Intelligence Review*, vol. 59, no. 8, pp. 169.
- [7] Bashir, Y.Y., AL-Huneiti Rahaf, AL-Dalaeen Anfal & Azzeh, F.S. 2026, "Artificial Intelligence, Wearable Technologies, and Virtual Reality in Precision Nutrition and Obesity Management: A Critical Narrative Review", *Diseases*, vol. 14, no. 8, pp. 295.
- [8] Bibi, S. & Yang, L. 2025, "Artificial intelligence shaping a smarter and greener planet for sustainable energy transportation biodiversity and water management", *Discover Artificial Intelligence*, vol. 5, no. 1, pp. 403.
- [9] Bordin, C., Hridoy, M.A.A.M., Pathan, M.M., Islam, S.M.S., Lima, M.A., Rahim, M.T.N., Mim, T.R., David, G.S., Ul Islam, M.A., Masood, A., Ahmed, S., Baki, A.O. & Sa'adi, Z. 2025, "Energy storage in the energy transition and blue economy: challenges, innovations, future perspectives, and educational

- pathways", *SN Applied Sciences*, vol. 7, no. 10, pp. 1084.
- [10] Cao, K., Wang, P., Siyu, K. & Chunzhen, Z. 2025, "Breaking through the bottleneck in the promotion of artificial intelligence in agriculture: an analysis of the moderating role of individual's heterogeneity among farmers in Shandong Province", *Frontiers in Sustainable Food Systems*, vol. 9, pp. 1621832.
- [11] Capilitan, J.J., Balbin, A.L. & Matias, J.B. 2026, "Mapping the Evolution of Artificial Intelligence in Agriculture: A Large-Scale BERTopic Analysis of Smart Farming, Automation, and Precision Systems (2020–2025)", *AgriEngineering*, vol. 8, no. 8, pp. 312.
- [12] Cheng, C.H. & Shi, S. 2025, "Artificial intelligence in cancer: applications, challenges, and future perspectives", *Molecular Cancer*, vol. 24, no. 1, pp. 274.
- [13] Dimitriadou, E. & Lanitis, A. 2023, "A critical evaluation, challenges, and future perspectives of using artificial intelligence and emerging technologies in smart classrooms", *Smart Learning Environments*, vol. 10, no. 1, pp. 12.
- [14] Fahim, Y.A., Hasani, I.W., Kabba, S. & Ragab, W.M. 2025, "Artificial intelligence in healthcare and medicine: clinical applications, therapeutic advances, and future perspectives", *European journal of medical research*, vol. 30, no. 1, pp. 848.
- [15] Flor-Unda Omar, Jácome Patricio, Karman, G., Rivera, M., Estrella, C., Freddy, V., Carlos, T. & Palacios-Cabrera, H. 2026, "Reconstructing Archaeological Evidence with Digital Technologies: Emerging Trends, Challenges, and Prospects", *Technologies*, vol. 14, no. 3, pp. 152.
- [16] Galali, Y., Hadi, P., Hassan, A.M., Balaky, H.H., Rashid, T.S., Sadee, B.A., Salih, T.S. & Hassanzadeh, H. 2026, "Application of Artificial Intelligence in Food Science and Nutrition: Challenges and Future Perspectives", *eFood*, vol. 7, no. 3, pp. 27.
- [17] Gaur, A., Singhal, N., Vardhan, H., Vashistha, P., Jain, R., Bist, Y., Pandey, A., Kishore, K. & Wagri, N.K. 2026, "Farm-to-fork smart sensing: integrating AI-enabled, sustainable biosensors for multi-threat detection in modern agri-food systems", *Frontiers in Sustainable Food Systems*, vol. 10, pp. 1927273.
- [18] Grigory, D., Mikhail, P., Sergey, Z., Alexander, Y., Petr, S. & Andrey, K. 2026, "Artificial Intelligence Across the Drug Development Lifecycle", *Medical Sciences*, vol. 14, no. 2, pp. 248.
- [19] Guo, R., Wang, D., Zhao, X. & Haotian, H. 2026, "An Overview of Large Agricultural Models: Current Status, Applications, and Future Perspectives", *Agriculture*, vol. 16, no. 13, pp. 1419.
- [20] Haloui, D., Oufaska, K., Oudani, M. & Yassini, K.E. 2024, "Bridging Industry 5.0 and Agriculture 5.0: Historical Perspectives, Opportunities, and Future Perspectives", *Sustainability*, vol. 16, no. 9, pp. 3507.
- [21] Han, S. & Sun, X. 2025, "Research on the impact of artificial intelligence applications on agricultural green development", *Scientific Reports (Nature Publisher Group)*, vol. 15, no. 1, pp. 30255.
- [22] Hugo Gaspar Hernandez-Palma, Jonny Rafael, P.A., García Guilianny, J.E. & Moreno Ríos, A.L. 2023, "Technological Tools Based on Artificial Intelligence in the Sugar Industry: A Bibliometric Analysis and Future Perspectives for Energy Efficiency", *Ladee*, vol. 4, no. 2, pp. 49-64.
- [23] Hysen, B., Barros, A.N., Krauter, V., Slim, S. & Theodoros, V. 2026, "Innovative Preservation Technologies and Supply Chain Optimization for Reducing Meat Loss and Waste: Current Advances, Challenges, and Future Perspectives", *Sustainability*, vol. 18, no. 1, pp. 530.
- [24] Kumari, S., Raghuram, P., Venkatesh, V.G. & Shi, Y. 2022, "Future perspectives on progressive farming with adoption of virtual reality technology for sustainable quality in agriculture", *TQM Journal*, vol. 34, no. 2, pp. 250-279.
- [25] Li, H., Chen, S., Chang, B., Wang, X., He, Y., Xu, B., Sun, G., Yang, C., Li, G., Li, S. & Li, G. 2026, "Application of artificial intelligence in oral health management: challenges and opportunities", *Frontiers in Medicine*, vol. 13, pp. 1700529.

- [26] Lina, M., Manuel, T., Castagnini, J.M., Albert, S., Martí-Quijal, F.,J. & Bucci, P. 2026, "Valorization of Food Industry By-Products for Sustainable Functional Food Production: Recent Advances and Future Perspectives", *Foods*, vol. 15, no. 12, pp. 2116.
- [27] Ma, F., Fan, Z., Nikolaeva, A. & Bao, H. 2025, "Redefining Aquaculture Safety with Artificial Intelligence: Design Innovations, Trends, and Future Perspectives", *Fishes*, vol. 10, no. 3, pp. 88.
- [28] Mansour, H.A.E. 2025, "Integration of assisted reproductive technologies and artificial intelligence for optimizing fertility and genetic selection in livestock production", *SN Applied Sciences*, vol. 7, no. 10, pp. 1143.
- [29] Miziara, I.D. & Miziara Carmen Silvia, M.G. 2026, "Autopsy Pathology's Paradigm Shift: Artificial Intelligence and Emerging Technologies in the Era of Digitally Integrated Death Investigation", *Diagnostics*, vol. 16, no. 15, pp. 2405.
- [30] Pattapulavar, V., Ramanujam, S., Badmanathan, R. & John, G.C. 2026, "Beyond antibiotics: artificial intelligence-enabled anti-infective ecosystems for next-generation precision therapeutics against antimicrobial resistance", *Frontiers in Cellular and Infection Microbiology*, vol. 16, pp. 1897057.